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ENGLISH MECHANIC

AND

WORLD OF SCIENCE.

WITH WHICH ARE INCORPORATED

"THE MECHANIC," "SCIENTIFIC OPINION," AND "THE BRITISH & FOREIGN MECHANIC."

ILLUSTRATED WITH NUMEROUS PRACTICAL ENGRAVINGS.

VOLUME LIV.

PUBLISHED (FOR THE PROPRIETOR) BY E. J. KIBBLEWHITE,
AT THE
Office: 332, STRAND, LONDON, W.C.
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INDEX TO VOL. LIV. ENGLISH MECHANIC.

ABYSSINIAN pump, 163
Accessories, lantern, 299
Accident, Humberstone-road, 534, 552, 578
Accumulator : 403, 424, 580
  plates, forming, 238
Accumulators : 139, 140, 161, 205, 269, 448, 539, 559
Acharging, 184, 357, 556
  dynamo to charge, 43, 227, 337
  new arrangement of, 338
  chromatic : object-glass, the new form of, 67
Adams, Prof., J. C., death of, 499
Adjustable resistance, 270, 377
Advertising, scientific, 88, 137, 175, 201, 222, 238
Aëro-dynamics, some remarks on, 231
Age and evolution of the stars, 348
Ages, ice, 66, 112, 134, 156, 486, 549, 574, 575
Aid, first, 118, 205
Air : compressed, 315, 337, 354, 377
  engines, compressed, 249, 315
  — pressure, 368
Air-pump ventilator, Boyle's, 568
Air-vessel, 356
Airy, Sir G. B., death of, 436
Alabaster, 270
Alarm, electric fire, 268, 270
Alarms, burglar, 337
Albo-carbon, 516
Alcohol, 448
Alcohol-proof cement, 204
Almonds, false bitter, 316
Alternating current motors, condenser for, 9
Altitude, solar, 18, 38
Alumina, iron and, 19
Aluminium, 513, 535
Amalgam, sodium, 515
Amateur : glass-blowing, 334, 400, 464
  photographers, for, 66
Amateurs : lathework for, 99, 187, 297, 361, 475, 568
  practical photography for, 3, 50, 144, 234, 281, 324
American : glass-cutter, 357
  organ, 95, 96, 115, 116, 137, 138, 158, 159, 184, 201, 204, 225, 226, 246, 289, 311
  — reeds, 96, 115, 159, 180
  — springs, 71, 115, 137, 158, 180
Ammeter : 537
  and voltmeter combined, 71, 117
Amoeba, 354
Analysis : gas, technical, 346
  of beeswax, 456
  of peptones, 503
Andromeda nebula, variable nucleus of, 238, 263, 350
Aneroid, pocket, 354
Angels coming to the point, 175
Angle for lathe centres, standard, 41
Anglo-German concertina, 158
Angular subtense of field of telescope, 307, 312, 336, 354
Ani, proleptosa, 514, 535, 555, 579
Annunciator for burglar alarms, 327
Antarctic exploration, 36
Anti-freezing liquid, 403
Antique press for playing cards, 509
Ants, 400
Aquatic insects, 9
Arachnids, fluid for preservation of, 533
Arc : circuits, switch for storing batteries from, 483
  elliptic, length of, 533, 576
  lamps, 117, 533, 536, 558, 582
  lights, 338, 558
  — small, 180
  of contact, 290
Arctic moonlight, 227
Arithmetic, questions in, 490, 534, 554
Armature : drum, 472
  winding, 205
  — laminated, 558
Armatures : laminated, 471, 558
  speed of, 515
Artificial : foot, 18, 43
  incubation, 197
  marble, 554
  oyster cultivation in France, 518
  plant barometer, 559, 580
  rain-making, 178
  teeth, from a hygienic point of view, 517
Assembling parts of engines, 504
Asthma, 161, 181
Astrolabe and cross-staff, 262
Astronomical : 350
  causes of glacial epochs, 530
  driving clocks, 175, 312, 376
  eyepiece, 206, 216, 395
  notes, 4, 104, 210, 300, 406, 501
  societies, amateur, 88
  spectroscopes, principles of, 437, 458
  telescopes, 88, 307
  watch, 205
Astronomy : in the tropics, 91
  progress of, 429
  study of, 138
Astro-photography, 262
Astro-physics, 530
Atlantic steamers, coal burnt on, 306
Atmolysis, 380, 402
Atmosphere : height and limit of, 362
  London's, 418
Atmospheric : gas burner, 116
  pressure and gaseous expansion, 92
Atomic and molecular volumes, 468
Attachment, shaping, 301
Attraction, magnetic, 270
August : meteors, 61, 90
  Perseids, 112, 134, 156, 177
Auriga, new star in, 574
Aurora, 308, 463
Automatic : rifle, 185
  screw, 526
Axle boxes, radial, 48

BALANCE, torsion, 449, 492, 518, 535, 555, 578
Balanced swell pedal, 313, 335, 376, 401
Ball bearings, 15, 41, 70, 72, 118
Ball, Sir R., on the Ice Ages, 66, 505
Balloon : 249, 314
  fire, 163
Balls, sand, 298
Bandsaw, brazing, 356, 378
Banjo, five-string, 116
Barbados, geology of, 176
Barley bread, 425, 448
Barlow lens, 155, 530
Barometer, artificial plant, 559, 580
Baron cells, 163
Basis of music, physical, 15, 241
Bath : arrangements, hotwater, 208
  electro-plating, 271, 291
  salt, 182, 289
  the electric, 354
Batteries : Bunsen v. Daniell, 448, 470
  chronic acid, 183, 538, 559
  dry, 271
  dynamos and, 533, 556, 579
  for arc lamp, 392
  for electric light, 380
  for medical coil, 557
  switch for storing from arc circuits, 483
Battersea enamel, 403
Battery : bichromate, 515, 580
  cells, 448, 470
  chloride of zinc, 117
  constant, 140, 183
  dry, 96, 390, 537,
  Edison's carbon, 283
  Faure's regenerating, 28
  for incandescing wire, 45, 139
  for small motor, 227, 248
  Fuller's, 21, 515, 535, 538, 581
  hand-shaking, 356
  Hart's chloride of silver, 109
  Lalande's oxide of copper, 33
  Leclanché, 228
  Maquay, 402, 423
  Osbo-premier, 17
  testing, 45
  — internal resistance of, 515, 557, 579
Bearings, ball, 15, 41, 70, 72, 118
Beauchene's boring bit, 110
Bedroom, heating, 515
Beer, tainted, 246
Beeswax, analysis of, 458
Belgian royal observatory, annuaire of the, 530, 574
Bell : and telephone connections, 369, 390
  cracked, 581
  electric, 19
  — for clock, 96, 117, 580
  — hints for hangers of, 108, 135
  shop, electric, 313, 336, 354
  single-stroke, 392
  telephone, 271
Bellphone, the, 17
Bells, magneto, 408, 425
Belt : electric, 71
  strain on engine, 469
Belting, rubber versus leather, 554
Bench, a carpenter's, 456
Bending : gauge tubes, 180
  wood, 379
Benzoline blowpipe, Paquelin's, 414
Berliner and Fiddler violins, 463
Bichord piano, 228
Bicycle : electric lamp for, 449
  tires, 137
Bicycles : chemical application to, 266
  safety, 469, 491
  seat attachment for, 384
Bitter almonds, false, 216
Biunial, condensers for, 535, 578
Black : dead, 293
  for zinc, 357
  ground, photography on a, 129
  magic mirrors, 227
Bladder, softening, 338
Bleaching : guttapercha, 337
Block, scribing, 375
Blocks, surfacing wood engravers', 228
Blower : for gas generator, 140, 180, 202, 226
  for organ, 491
Blowing, glass, 334
Blowpipe : Moor's improved, 215
  Paquelin's benzoline, 414
Blue : copying process, 45, 72
  of the heavens, 131, 152
  prints, photographic, 288
Blueing small steel articles, 338
Blushing, 493
Boat : electro-motor for, 21, 73
  motor for, 161, 426, 471
Bodies, falling, 249, 290, 335, 354, 581
Body vermin, 204, 334
Boiler : black paint for, 371
  covering, 313
  damaged, 313
  design, practical hints in, 30, 80, 147, 213, 302, 384, 432, 482
  hot water, 237
  paraffin spray for, 447
  priming, 21
  safety-valve, 379
  small, 492
  testing condition of, 45
Boilers : greenhouse, 403
  protective lining for, 360
  vertical, heating surface of, 489, 553
Boiling, steam, 73
Bolt-holder, handy, 548
Bookcase, a hanging, 541
Books, best forty, 463, 485, 511
Borax solution of rubber, 94
Boring : 356
  bit, Beauchene's, 110
  cylinders, 448, 513
  holes in long posts, 209
  — through glass, 289
  square holes, 379
Boxes, corner fastenings for, 145
  small, 49, 121
Boyle's air-pump ventilator, 568
Brain : bullet in the, 339
  overtaxed, 350, 395, 442, 445, 490
  worry, 463
Brass : bronzing, 554
  browning, 180, 554
  castings, 557, 579
  coating iron with, 469
  colour for solder, 379
  melting, 380
Brasswork, 314

Brazing: and soldering, 139, 160
  copper, 181
  cycle joints, 45, 377
  saws, 356, 378
Bread, barley, 425, 448
Breathing of a locomotive, 135
Brick kiln, 428
Brickmaking, 355
Bricks: coal-dust, 161, 181
  enamelling, 312
Bridge, Wheatstone, 494, 514
Brightest stars, twelve, 216
Bristol steamships, 471
British association: 36
  addresses at, 10
  is it to be allowed to perish, 42
  papers read at, 12
Bronze casting, 561
Bronzing: brass, 554
  electro, 516
Browning brass, 180
Brown's rotary engine, 64
Brushes, cleaning ivory, 558
  dynamo, 250
Bryant, Dr. Robert, 511
Bubbles, soap, 416
Bullet in the brain, 329
Bumping of railway trains, 538
Bunions, 581
Bunsen: burner, substitute for, 378
  v. Daniell battery, 448, 470
Burglar alarms, 327
Buried alive, 97
Burners, incandescent gas, 469
Burnham's double-star catalogue, 216
Burnt: paper, 20
  woodwork, 160
Buzzer, 288

CABLE: faulty, 336
  tramways, 200
Cables, underground electrical, 154
Cailletet's cryogen, 193
Calculating speed, 161
Calculus, differential, lessons in the, 260, 284, 367, 392, 415, 448
Californian tree, remarkable, 155
Cam: motions, 483
  one kind of, 389
Camera: a pocket, 493
  hand, 292
  pinhole, 205
Cams: cutting, 437
  designing, 108
Canals of Mars, 66, 111, 134, 155, 175
Cancer: 118
  in the stomach, 45, 72
Candles, Jablochkoff, 558
Carbolic acid and insects, 506
Carbon: battery, Edison's, 283
  depositing, 471
  filaments, 408, 434
Carbonaceous cement, 494
Carbonising wool, 116, 159, 160, 201, 225
Carbons: cutting retort, 558
  zincs and, best arrangement of, 183
Cards, antique press for playing, 509
Carlisle, late bishop of, 348
Carpenter's bench, 456
Carriage wrench, 129
Cart: grease, 271
  hand, 18
Case-hardening, 116
Casing for gas furnace, 160, 180
Cast-iron, soldering, 356, 402
Casting: brass, 557, 579
  bronze, 561
  fine-art, 494, 555
  in cuttle-fish, 159, 180
  in lead, 183, 204, 401
  metal, moulds for, 205
  silver, 472
Castings: brass, 557
  galvanising, 358
  zinc, 559
Cast-metal, softening, 378
Castor-oil plant, 294
Cat, worms in, 73
Cataract, 471, 492, 535, 555, 578
Catgut for clocks, 246
Cauld Kale made het again, 17
Cave, fairy, 337
Cavern, crystal, 537
Ceiling, papering a, 18
"Celestial Objects," new edition of, 575
Cell: dry, 205, 315
  Judson's, 149
Cellar, damp, 423
Celluloid: moulding, 559
  polishing, 516, 536
Cement: 182
  alcohol proof, 204
  carbonaceous, 494
  for glass troughs, 71
  for lamps, 291, 512, 554, 578
  indiarubber, 94
Cementing glass and metal, 555
Cements, oxychloride and other, 516
Centres, cone fittings for, 511
Centring short lengths of steam pipe, 292, 312
Cepheï, Mu, 307
Chair, observing, 395, 535
Chandelier, relacquering, 380
Changeable speed gearing, Heath's, 195
Channel tubular railway, 36
Charcoal: making, 559
  Mullein, 182
  soluble, making, 181
Check valve, 428
Cheesemaking, 376
Chemical laboratory, 378
Chemistry for students, 54, 190, 303, 341, 386, 543
Chess: 23, 47, 74, 99, 120, 142, 164, 186, 208, 230, 252, 273, 296, 317, 340, 360, 382, 404, 428, 451, 474, 496, 519, 540, 561, 581
Chessboard, pocket, 576
Chicken rearer, 555
Child marriage in India, 114, 187
Chimborazo, sunset on, 485
Chimney, smoky, 379
Chiming clock: 200, 223
  how to construct a quarter, 25
China, gilding, 447
Choosing a pianoforte, 288, 402
Chromic acid: 183
  cell, 538
Chronometer, sea error of, 493
Chuck: Jordan's planer, 387
Circular saws, running, 391
Clamp for wheelwrights, 484
Clarence, duke of, 489
Clay, tempering, 369
Cleaning: coins, 315, 337
  copper utensils, 291
  sink pipes, 314
  wood saws, 129
Clicking noise in telephones, 357, 402
Climate, 176
Clock: Daniell's gravity battery for electric, 494
  electric bell to, 96, 117, 557, 580
  how to construct a quarter chiming, 25, 200
  making, 182, 228, 275, 356
  self-winding, 385
  St. Paul's cathedral, 505
Clocks: astronomical driving, 175, 262, 376
  catgut for, 246
Clouds, rain without, 506
Clover, four-lobed, 118, 293, 336
Coal: burnt on Atlantic steamers, 306
  gas, sulphur in, 472, 492
  in the south-east, 12
  smokeless, 161
  spontaneous ignition of, 37
Coal-dust bricks, 161, 181
Coalfield, new, in Derbyshire, 162
Coal-mines, explosives used in, 359
Cognac, what is? 215
Coil: 118
  boiler, 578
  condenser for, 293
  dimensions, 515
  induction, 118, 182, 271, 291, 314, 471, 514
  medical, 425
  — pocket, 513
  one inch spark, 425
  two inch spark, 472
Coils: 538
  medical, 44, 183
  — batteries for, 557
Coins, cleaning old, 315, 337
Cold: extreme, production of, 288
  heat and, 91
Colds, 269
Colouring steel, 159
Colours: complementary and supplementary, 460
  distemper, washable, 558
  locomotive, 226, 247
  luminous paints in, 305
  preserving water, 270
Combustion, spontaneous, 472
Comet: a watery, 574
  crossing the sun, 88
  Tempel-Swifts, 91, 350
  Wolf's, 66, 88, 111, 134, 155, 177, 197, 240
Comets: 485, 575
  source of light of, 38
Common, Dr., and F.R.A.S., 216
Communication between ship and shore, 308, 332
"Companion to Observatory," 348
Compass, mariner's, 62, 115
Compensated pendulum, 535
Composition, printer's roller, 311
Compound principle, 559, 580
Compressed air engine, 249, 315, 337, 354, 377
Concertina, Anglo-German, 158
Concrete, crown iron in, 201
Condenser: 206, 226
  for alternating current motors, 9
  for coil, 293
Condensers: electric, 119
  for biunnial, 585
Condensing, 45
Condy's fluid, removing stains of, 227, 248
Cone fittings, tapers and, 511, 532, 552
Conjunction of Venus and Jupiter, 506
Connections, bell and telephone, 290
Constant battery, 140, 183
Consume, what we, 419
Contact, arc of, 290
Contacts, floor, 355
Cookery, oil stove, 471
Cool chamber without ice, 289
Copal varnish, 314, 336
Copernicus, 216
Copper: brazing, 181
  coating iron with, 515, 536
  oxide battery, Lalande's, 33
  refining, 505
  scrap, 183
  strips, covering with indiarubber, 139
  utensils, cleaning, 291, 313, 425
  — tinning, 425
Coppersmithing, 313
Copying process, blue, 45, 72
Cork-cutting, 492
Corn cures, 441
Corner fastenings for boxes, 145
Cost of electric lighting, 181, 206
Cotton seeding, 400
Couch, 18
Counting on the lathe, 352
Cracked bell, 581
Crane, size of bars for, 117
Crank without a dead point, 482
Craters, new lunar, 216
Creosote tanks, fastening covers of, 180
Crown iron in concrete, 201
Crucible: 492, 537, 556
  for gold melting, 314, 492
Cryogen, Cailletet's, 193
Crystal cavern, 537
Crystallisation, 19, 337, 355
Cupola steam-jet, 554
Cure for injured heads, 504
Curves, 428, 515, 536
Cutlery exports to United States, 181
Cutter-bar, Haydon's, 558
Cutter, dial, 356
Cutters, speed of milling, 268
Cutting: carbons, 558
  cork, 492
  microscopical sections, 242
  mounts, 536
  screw, 162, 182, 203, 271, 283, 313
  steel, 21
  wheel, 470
Cuttle-fish, casting in, 159, 180
Cyanide, gold, 45
Cycle: brazing, 377
  joints, brazing, 45
  trainer, Guignard's, 412
Cycles: cushioned tires for Pugh's, 61
  Juno, 545
Cyclone, weather, 440
Cyclostat, the, 345
Cycling: and health, 162
  its uses and abuses, 262
  mathematics of, 515, 536
Cygnus, unrecognised variables in, 350
Cylinders: boring, 448, 513
  gas, 180
  proportions of, 469
  two in one, 21

DAMAGE from lightning in Germany, 196
Damp cellar, 423
Damper, regulating, 338
Dancing floor, 426
Daniell, Bunsen v., 448, 470
Dead black, 293
Dead-point, crank without a, 482
Deafness, 425, 447, 469, 558
Deal sticks, ebonising, 562
Death, growth after, 449
Delhi, dial at, 395
Derbyshire, new coalfield in, 162
Desiccator, 557
Design, boiler, practical hints in, 30, 80, 147, 213, 302, 394, 433, 482
Designing cams, 108
Detached retina, 312
Developer, dry plate, 490
Devil insect, 470
Dextrine, solution of, 378
Diabetes, 492, 514, 579
Diagrams, photographing, 44, 72
Dial: cutter, 356
  at Delhi, 395
Dialling, 67, 92, 134, 175, 178, 223, 240, 309, 353, 444, 467, 511
Diaphragm, iris, 288
Dignity and impudence, 485
Diatonic intervals, estimation of, 375, 422
Diet, ice cream, 512
Differential calculus, lessons in the, 260, 284, 367, 392, 415, 448
Diffraction spectroscope, 447
Dimensions, space of four, 88, 92
Diphtheria, cure for, 222
Disease, origin of influenza and, 40, 61
Dissolving elements, 96
Distance: by trigonometry, 520, 537
  of the moon, mean, 216
  of the sun, 443
Distemper colours, washable, 558, 580
Distilled water for domestic use, 425, 448, 469
Distilling, 268
Distortion of object in a refractor, 88
Division plate, 447
Dog, milling machine, 571
Donkey pump, locomotive, 20
Double: image object-glass, 1 7
  stars, 14
Drainage, primitive system of, 176
Draper memorial, 443
Draught, stove, 378
Drawing, geometrical, 160
Drawings from the Lick lunar photographs, 574
Driers, terebene, 72, 159, 180, 333
Drill: jigs, 128
  pad, useful, 413
  safety, and tap-holder, 328
Drilling: machine, square, 472
  machines, notes on, 502
Drills: grinding twist, 396
  sharpening, 439
  twist, 557
  watch pivot, 45
Drinking: tea, 204
  water, germ-free, 154
Drinks, natural, 268, 294, 313, 332, 397
Driver, patent staple, 267
Driving clocks, astronomical, 175, 262, 312, 376
Drum armature, Siemens, 250, 472
Dry: battery, 96, 290
  cell, 205
  — recharging, 471
  plate, developer, 490
  — exposures, 472
Drying hose-pipes, 535
Dubbin, 182
Dulcimer, 492
Dust fuel, 268
Dustfall on the moon, meteoric, 61
Dwelling houses, 491
Dynamics, 45, 72
Dynamo: 161, 271, 403, 581
  and motor, 57, 449
  connection for compound wound, 580
  Edison, 356
  getting hot, 249, 269
  150 candle-power, 516
  regulating, 338
  running with light load, 493
  series wound, 139
  small, experiment with, 352
  sparking, 117, 162
  suggested, 558, 576
  Taunton, 493
  to fit a ring, 271
  to run 16c.p. lamps in series, 161
  20 candle-power, 516
Dynamos: 18, 20, 43, 96, 117, 206, 337, 379
  and batteries, 536, 556, 579
  and motor, 57
  compound, 494
  Gramme, 226
  Manchester, 313, 425, 538
  plating, 408
  to charge accumulators, 43, 150, 337
  to give shocks, 379
  velocity of, 516, 536
  waste in magnetic circuit of, 357
  winding, 206, 356

EARTH: and sun, 574
  fuller's, 116
  longitude of, 88
  projectiles and rotation of, 307, 333 348, 351, 375, 395, 421, 446, 487, 532, 551, 577
  tremors, 12
Earth's: orbital velocity, 574
  radius vector, logarithm of, 348
Ebonising deal sticks, 562
Ebony walking stick, polishing, 71
Eclipse, lunar, 218, 308, 349
Eclipsed moon, colour of, 349
Eclipses, relative parallax in, 530
Economy of electric light, 140
Edison: dynamo and motor, 57, 356
  lamp sockets, 570
  phonograph motor, 140
Edison's: carbon battery, 283
  method of telegraphing without wires, 525
Education, technical, 311, 332, 422
Egg-tester, 357
Egyptians, did the ancient, use steel, 268, 287
Efficiency of spectroscopes for astronomical purposes, 437, 458, 508
Electric: alarum, 270
  bath, 354
  bell, 19, 313
  — for shop, 354
  — hangers, hints for, 108
  — to clock, 117, 557, 580
  belt, 71
  condensers, 119
  fire-alarm, 247, 288
  fluid, 66, 92, 114
  lamp, portable, 92
  lamps, 559
  light fitting, practical, 165, 253, 319, 453, 519
  — installations, cost of, 182, 206, 380, 403
  lighting, 20, 72, 161, 181, 183, 204, 243, 338, 355, 357, 378, 402, 530, 556, 568
  — economy, 140, 206
  — small gas-engines and, 185
  — Tesla's experiments in, 545
  — turbine for, 515
  railway, hundred miles an hour, 570
  — motor for model, 292, 335
  sores, 140
  stress, 82
  wire, broken, 249, 269, 290
Electrical: 17, 40, 65, 72, 93, 117, 314, 471, 494
  cables, underground, 154
  candle, Wild's, 43
  cylinder machine, 306
  evaporation of metals and alloys, 13
  indicator, 515
  machine, new, 303
  motors, static, 366
  nomenclature, 314, 336
  temperature indicator, 293
  testing, 44, 95
  units, 141
Electricity: antiseptic power of, electro-microscopic slide for testing, 195
  in mining, 31
  killing rabbits by, 367
  medical, 117
  point discharge of, 12
  recovering gold and silver by, 485
  seeing by, 15
  transmission of power by, 446
Electro-bronzing, 516
Electrolysis, 162, 203
Electro-magnets, strength of, 338, 447
Electro-microscopic slide for testing the antiseptic power of electricity, 195
Electro-motor: 378, 403, 492, 535
  for boat, 21
  model, 183, 268
  one-man power, 206
  resistance in, 315
  Siemens' improved, 183
  simple form of, 195
  speed of, 315
Electrophorus, 581
Electro-photophore, 29
Electroplating: 140, 270, 271, 493, 566
  bath, 291
  practical, 366
Electro-silvering, stopping for, 249

Electrostatics, experiments in, 487, 507, 534, 576
Ellipse, 357, 396, 423, 447
Elliptic arc, length of an, 533, 574
Emergencies in the workshop, 63
Emulsifying oils, 182
Enamel: 354, 406
  oil-proof, 427
Enamelling bricks, 312, 530
Endo-skeletons, moulders', 497
Engine: Brown's rotary, 64
  compressed air, 249
  flywheel, 270, 554
  hot-air, 289, 465, 513
  increasing power o', 19, 43
  lift, 554
  new gas, 178
  query, 315
Engines: assembling parts of, 504
  gas, 355, 449, 469
  G.E.R., 137, 513,
  G.N., 313
  Midland, 246
English: debased, 485
  lever watch, 371, 391
Engraving: 130
  tools, 494
Enlarging photographs, 494
Epilepsy, 19, 43, 116
Equation to curve, 536
Equator, moon from, 226
Equatoreal, motion for, 312, 335. 354, 531
Equatorial parallax, horizontal, 176
Eruption, skin, 44, 72, 116, 226
Escape wheel, 425
Escapement, gravity, an easily constructed, 552, 555
Etching, 246
Ether: 228, 498
  surface tension of, 12
  theory, 157, 226
Eucalyptus oil: 270
  saponifying, 250
Eve, St. Martin's, 336
Evolution of the compound microscope, 571
Exo-skeletons, moulders', 541
Experiment: with incandescent lamps, 267
  with small dynamo, 352
Experimentalists, hints for, 64, 92, 118, 135, 137, 157, 177
Experiments: curious with the Wimshurst machine, 267
  electric lighting, M. Tesla's, 513
  illustrating nature of flame, 303
  in electrostatics, 487, 507, 534, 576
Expiration of the microphone patent, 1, 143
Exploration, Antarctic, 36
Explosion, 490
Explosives used in coal mines, 359
Extinguisher, fire, 269
Eye, photographic view of the human, 129
Eyepiece: astro, 206, 216, 225
  Kellner, 516, 530
Eyepieces: 38, 175, 400
  power of, 220

FAIRY: cave, 337
  lamp, lighting, 314
Falling bodies, 249, 335, 354, 581
Famine expedients, 178
Fans: 490
  weight power to drive, 93
Fast mail service, 155
Fastener, sash, Pincaver's, 154
Fastenings for boxes, corner, 145
Fat in milk, estimation of, 366, 433
Faure's regenerating battery, 28
Faust, 349, 369
Fecundity of sea-fish, 132
Feedwater, 359, 378
Fees, patent, 93
Fern, extract of male, 360
Ferns: 95
Ferro-prussiate prints, solution for writing on, 468
Field: magnets, best iron for, 293
  of telescopes, angular subtense of, 307
Filaments, carbon, of lamps, 424
Files, mechanical process for resetting blunt, 193
Filter for rain-water, 559
Fine art casting, 494, 555
Fire: balloon, 163
  alarm, electric, 247, 268
  extinguisher, 269
Fireclay, 139, 582
Fire-escape, Kiernan's, 251
Fire-irons, 357
Fire-lighters, 312
Fires, gas, 72, 95, 537
Fireworks, 140
First aid, 305
Fish: a suicidal, 91
  fecundity of, 132
Fishing nets, 139, 201
Fitting: 7, 30, 106, 128, 145, 234, 277, 326, 384, 411, 460, 523, 568
  electric light, practical, 165, 253, 319, 453, 519
  stable, 226, 268
Flame, experiments illustrating 303
Flare in telescopes, 216
Flexure in specula, 553
Flies: house, 45
  jumper, 203
Floor: contacts, 385
  dancing, 426
Flora medica, 511
Fluid: electric, 66, 92, 114
  for natural history and microscopical work, 566, 583
Fluorescence, settling a quarrel by, 305
Flirting, star, and bumptiousness, 511

Food: and drink, adulteration of, 297
  impure, 228, 385
  wasted, 67, 94, 115, 135, 156, 178, 201
Foot, artificial, 18, 43
Foot-power saws, 405, 430
Force: and pressure, 537, 556
  physical, phenomena, 65
Force-pump, 227, 247
Formula: hydraulic, 558
  Ohm's, 113, 135
  wanted, 314, 336, 380
Forty books, best, 463, 485, 511
Foundations, 554
Fountains, illuminated, 354
Four dimensions, space of, 114, 133
Four-lobed clover leaves, 118, 293
France, oyster cultivation in, 518
F.R.A.S.: and Prof. Vince, 197
  letters by, 38, 88, 133, 175, 216, 262, 307, 348, 395, 442, 485, 530, 574
Freezing machine, 246
Front-slide lathe, 518
Frosting, 180
Fruit farming, 335
Fuel, dust, 268
Fuller's: battery, 21, 515, 535, 561
  earth, 116
Furnace: casing mixture, 408
  gas, 20
  small, 116, 205
  steam blower, 20
Furniture, photographic veneering of, 288

GAFF v. spritsail, 471, 492
Galanty show, 246, 266
Galvanising castings, 358
Galvanometer: 270, 426
  multiplier, 494
  tangent, 291
  Varley's universal, 201
Garden frames, heating, 116, 158
Gas: air, 498, 514
  analysis, technical, 246
  carbon, moulding, 139, 160
  cylinders, 180
  fires, 72, 95, 537
  for lantern, 538, 556
  furnace, 20
  — atmospheric, 116
  — casing, 160, 180, 202
  generator, blower, 140, 180, 202, 225, 246
  — simplex, 366
  globe stove, new, 241, 267
  heating power of, 337
  natural, geology of petroleum and, 12
  or steam, 538
  photometer, 513
  stove, a new, 114, 135, 222, 266
  water, 328
Gas-burners: atmospheric, 116
  for lantern, 538, 556
  incandescent, 469
Gas-engine, new, 178, 201
Gas-engines: 95, 138, 337, 355, 449
  and electric lighting, 222
  compression type, 44
  small, and electric lighting, 135, 157
Gases, 355
Gasholder, contents of, 289
Gaslights, incandescent, 423, 447, 490, 535
Gauge: a telescope, 577
  screw-cutting, 283
  tide, 402
  tubes, bending, 180
  wire, English and American, 426
Gauge-glass washers, 383
Gauges: rain, 226, 530, 556, 574, 579
  steam, 515
Gear or worm, 180
Gearing: Heath's changeable speed, 195
Generator: gas, blower, 140, 180, 202, 225, 246
  — simplex, 336
  steam, Serpollet instantaneous, 431
Geographical tables, 133
Geological "sell," 176
Geology: Barbados, 176
  for students, 36, 81, 136, 137, 170, 255, 364, 408, 434, 478
  of petroleum and natural gas, 12
German polishing paste, red, 159
Germany, damage from lightning in, 196
Germ-free drinking water, 154
Gilding: bevelled mounts, 579
  ebain, 250
  china, 447
  on glass, 138, 151
  solution, 45
  steel, 96
Ginger-beer plant, 515, 579
Glacial: epocns, astronomical cause of, 530
  period, 112
Glass: blowing, 334, 400, 464
  boring holes through, 289
  cutter, American, 365
  discs, grinding edges of, 293
  gilding, 138, 151
  grinding, 395
  new optical, 94
  painting, 96, 568
  silvering, 19, 20, 138, 379
  substitute for, 159
  telescope, 333
  troughs, cement for, 71
  weather, 44
Glasses, night, 156
Glow or arc lamps, 558
Glycerine and turpentine, 294
Gold: and silver, recovering by electricity, 485
  cyanide of, 45
  lacquer, 559, 580
  precipitating, 338, 356, 377
  refining, 45, 140

Good work and good ways of doing it, 158, 536
Gouges, inside, 354
Gramme dynamo, 226
Gramophone, 73
Grape juice, 180
Gravitation, 88
Gravity: escapement easily constructed, 552, 555
  hoist, 260
Grease: 561
  cart, 271
Great: Eastern engines, 137, 513
  N.S.R. locos., 423
  Northern goods engines, 287
  — locos., 313
"Greater Britain," the, 287, 338, 447
Green ray, 14, 40, 113
Greenhouse: 337
  boilers, 408
  heating, 355
Gregorian telescope, 73
Grinding: and polishing, 347
  glass, 395
  lenses, 533, 581
  twist drills, 398
Growth after death, 449
Guericke, 111
Guignard's trainer cycle, 412
Gums receding, 425
Gunmetal castings, 271
Gut-band, hook and eye to, 378, 402
Guttapercha, bleaching, 357

HAMMERING saws, 236
Hand camera, 392
Hand-shaking battery, 356
Handy tools, 86
Hanging bookcase, 541
Hardening steel, 314
Harmonium: 116
  manual coupler to, 337
  reeds 159
Harmony: 19, 43, 138, 158
  principles of, 136, 199
Hart's sealed chloride of silver battery, 109
Harvest moon, 138, 140, 160, 175, 180, 202
Hawthorn locomotive, 466
Haydon's cutter bar, 558
Haystack, round, 471, 493
Heads, cure for injured, 504
Health, cycling and, 162
Heat: and cold, 91
  and power calculations, 183
  from the moon, radiant, 14, 216
  radiated and reflected dark rays of, 220
Heath's changeable speed gearing, 195
Heating: a house, 555
  apparatus, gas globes and, 266
  garden frames, 116, 158
  greenhouse, 355
  of cargoes, 426
  power of gas, 337
  room, 377
  — from fire below, 377
  surface of vertical boilers, 488, 553
Heavens, blue of the, 181
Heliograph, 95, 116
Heliometer, 216, 307
Herculis, 13 M, dark channels in, 574
Hicks' novel zither, 525
Hints: for bellhangers, 108, 135
  for experimentalists, 64, 92, 113, 135, 157, 177
Historical locomotives, 15
Hoist, gravity, 260
Holes: boring, in long posts, 209
  — square, 379, 402
Home-made incubator, 178
Homœopathy and influenza, 511
Hones, 86
Hook and eye to gut band, 378, 402
Horizontal equatorial parallax, 176
Horological, 46
Horology, dialling and, 134
Horse-power, 557
Hose-pipes, drying, 535
Hot: installation, 357
  iron by electricity, 493
Hot-air engine: 289, 465, 513
  pressure-gauge and thermometer for, 535
Hot-water: 163, 208
  boilers, 227
  for bath, 208
  pipes, plaster on, 558
  — separating, 378
House: flies, 45
  heating a, 555
Housekeeper's treasure, 446
Houses, dwelling, 491
Howard's telephonic apparatus, 326
Humberstone-road accident, 534, 552, 579
Hundred miles an hour electric railway, 570
Hunning's transmitter, 581
Hurricanes, 400
Hydraulic: formula, 558
  press, 554
  pump or ram, 311
Hydraulics, 180, 392, 313
Hydrochloric acid, 469
Hydrofluoric acid, and the health of workmen, 35
Hydrogen lines visible in stellar spectra, rhythmical group of, 84
Hydrometer, 204
Hysteria, 315, 336, 402

ICE: age, 66, 112, 134, 156, 486, 549, 574, 575
  — cause of an, Sir R. S. Ball's false, 505, 530, 531, 550
  cool chamber, without, 239

Ice: cream diet, 512
  machine, an improved, 460
  making, 44
Illuminated fountain, 154
Illusions, optical, 353, 375, 574
Impure food, 228, 385
Incandescent: gaslights, 423, 447, 469, 490, 535
  lamp, repairing, 162, 181
  lamps, 205, 226, 247, 298
  — experiments with, 267
  — novelties in, 236
  light, 293
  lights, 494
Incubation, artificial, 197
Incubators, 157, 178, 198, 220, 240, 264, 286, 308, 333, 352, 375, 397, 508
Index, the lathe, 233, 264, 286, 332, 333, 352, 373, 422
India: child marriage in, 114, 137
  invention in, 73
  opium in, 135
Indiarubber, cement, 94
Indicator: 355
  electrical, 289, 354, 515
  — temperature, 293, 318
  water, 556
  weather, 160, 181
Induction coil, 118, 139, 271, 291, 403, 471, 514
Inertia, 95
Influenza: 510, 523, 574
  and disease, origin of, 40, 61, 291, 332, 353
  and homœopathy, 511
Injector, steam, 557
Injured: first aid to the, 118
  heads, new cure for, 504
Ink: 292
  a perfect, 74
Insect: 555
  devil, 470
Insects: aquatic, 9
  carbolic acid and, 506
Instruments, musical, their construction and capabilites, 33, 58, 109, 130
Insulation, magnetic, 227
Intensity of negatives, method of reducing, 86
Interest, 227, 247, 268, 289, 312, 335, 356, 378
Intervals, diatonic, estimation of the, 422
Invention in India, 73
Inventors, taxation of, patent fees, 68, 93
Iodine, 96
Iris diaphragm, 288
Iron: and alumina, 19
  and steel, decomposition of, 246
  cast, soldering, 356, 402
  coating with brass, 469
  — with copper, 515, 536
  crown, in concrete, 201
  for field-magnets, best, 293
  hot, rendering by electricity, 493, [illegible]
  paint for, 205
  pipes, to keep from rusting, 554
  red heat of, 292
  section of, 180, 202
  smelting, 472
  volatilisation of, 13
Isinglass, 357
Island with a future, an, 443
Italian rifle, a new, 376
Ivory brushes, cleaning, 558

JABLOCHKOFF candles, 558
Jam, 294, 313, 354
James Kenyon Peile, the late, 566
Japanning round wire, 288
Jet, propulsion, 37
Jewellers' shops, lighting, 558
Jews, surnames of, 18
Jigs, drill, 128
Joints: brazing cycle, 45
  glass and caoutchouc, 403
  wiped, solder, cleaning, 516
Jordan's planer chuck, 237
Jovian latitudes, 230
Juice, pancreatic, 422
Jumper files, 203
Juno cycles, 545
Jupiter: 40, 88, 91, 133, 134, 239, 262, 558
  conjunction of Venus and, 506
  double belts of, 111
  red spot on, 270
  third satellite of, markings on, 574
  — transit of, 111
  satellites of, diameter of, 316
  — for verifying chronometer, 262
  — magnitudes of, 88

KALE, cauld, made het again, 17
Kellner eyepiece, 516, 530
Kettle, rusty, 293, 313
Kiernan's fire escape, 251
Kiln, 378, 423
Knot and nautical mile, 43

LABORATORY, chemical, 378
Lacquer, gold, 559, 580
Ladies' travelling basket, 116
Lady, the vanishing, 152
Lakes and canals in Mars, 111, 134, 155, 175
Lambda Ophiuchi, 220
Lamp: arc, 533, 582
  — small, 180, 536
  current for, 582
  electric, portable, 92, 515

Lamp : fairy, lighting, 314, 357
  five-candle, 238, 248
  for bicycle, electric, 449
  incandescent, reflector for, 292
  — repairing, 162, 181
  lighting, 162
  Pitkin, recharging, 436
  resistance, 358
  sockets, Edison, 570
Lamps : arc, 117, 568
  — batteries for, 292
  carbon filaments of, 434
  cement for, 292, 512, 554, 578
  electric, 559
  incandescent, 205, 226, 247, 293
  — experiments with, 267
  — novelties in, 286
  in series, dynamo to run 16c.p., 161
  sun, and semi-incandescent lamps, 141
Lantern : 408
  accessories, 299, 582
  enlarging, 288
  gas-burner for, 538, 556
  microscope, 259, 332, 557
  microscopy, 309
  optical, its construction and use, 51, 102, 122, 171, 279, 457, 542
  tank, 494
Lanternists and opticians, to, 581
Lathe : 379, 558
  centres, standard angle for, 43
  counting on the, 352
  dog, a new, 366
  engine, for, 579
  front-slide, 513
  hand-rest to, fixing, 248
  index, the, 233, 264, 286, 323, 333, 352, 378, 422
  largest, the, 389
  matters, 352, 398, 488, 511, 552
  small, 268
  treadle, 408
Lathework for amateurs, 99, 187, 297, 361, 475, 563
Latitude and longitude, lengths of a degree of, 307
Launch, electric, 357
Lead : casting in, 182, 204, 401
  extracting zinc from, 183
Leather belting, versus rubber, 554
Leaves : clover, four-lobed, 298, 336
  collecting, 188
  skeleton, 337
Leclanché : 291, 314, 469
  battery, 228, 271
  zincs, cleaning, 581
Leclanchés, driving motor by, 72
Legal, 354
Length of an elliptic arc, 533, 576
Lens : calculations concerning the, 351, 396, 418, 442, 489
  mirror, 305
  the Barlow, 33, 155, 530
Lenses, deteriorate do? 427
Lens-grinding, 583, 581
Lessons in the differential calculus, 260, 284, 367, 392, 415, 439
Letters, stamping on wood, 426
Lever watch, 140, 271, 391
Leyden jar, charging, 357
Lift, engine for, 554
Lifting-power of air-propeller, 270
Light : arc, 558
  electric, 18, 21, 182, 204, 378, 448, 537, 558
  — battery for, 380
  — cost of, 206
  — economy, 140
  — turbine for, 515
  — with small gas-engine, 250
  incandescent, 293
  obtainable from ½H.P. water motor, 378
  of comets, source of, 33
  organ, 160
  polarisation of, 182
  solar, 220, 331
  the sun's, 262
  Zodiacal, the, 216, 575
Lighters, fire, 312
Lighting : arc, 536
  electric, 20, 44, 73, 135, 157, 161, 181, 188, 227, 248, 338, 355, 357, 380, 402, 494, 448, 556, 559, 581
  — and gas engine, 222
  — cost of, 408
  — Tesla's experiments in, 545
  lamp, 162
  — fairy, 314, 357
  shops, jeweller's, 558
Lightning : 40, 88, 112, 136, 175
  in Germany, damage from, 196
  photographs, 467
Lights, arc, 338
  incandescent, 494
Lime, bisulphite of, 494, 515
Limelight, 249, 269
Limit and height of the atmosphere, 262
Limits, 206
Line : chief nebular, and Mr. Keeler, 530
  of sight, determination of terrestrial motion in the, 577
Linen, Condy's fluid stain on, 227, 248
Lines, optical duplication of, 88
Lineman's galvanometer, 355
Lining for boilers, protective, 360
Link-motion, 356
Liquid, anti-freezing, 408
Liquids, device for raising, 571
Locomotive : 96
  bed-plate, 138
  breathing of a, 185
  colours, 225, 247
  donkey pump, 20
  G.N., 313
  G.N.S.R., 423
  Hawthorn, the, 466
  historical, 15
Locomotive : London and North Western new compound, 181
  pump for, 141
  queries, 356, 377
  speed, maximum, 262
  work, 467, 489
Locomotives : 489
  L. and N.W., 95, 376, 425
  Midland, 225, 246, 268
Logarithms : 204, 226, 334, 348, 401, 468, 490
  of the distance and radii vectores of the planets, 442
London : and North Western new compound locomotive, 181
  how it could be cleared from some of its discomforts, 396, 418, 422
Longitude : and latitude, lengths of a degree of, 307
  earth's, 88
  one second of, value of, 290
Looking-glass, 580
Luminous paints in all colours, 305
Lunar : crater, new, 216
  eclipse, 218, 239, 349
  — shadow of terrestrial mountains on the moon during a, 442
  photographs, drawings from the Lick, 574
  photography, 537, 556
  radiant heat, 216
  rings and ranges capped with snow, are the? 14
  rotation and tidal action, 262
  streaks, 88
Lung protector, 289

MACHINE : alternating influence, Wimshurst's, 310
  compound, 494
  cylinder, electrical, 206, 226
  drilling, the square, and its uses, 472
  freezing, 246
  ice, an improved, 460
  magneto, 315, 337
  — defective, 161
  — electric, 45
  mitre-cutting, improved, 56
  mortising, an improved, 9
  new electrical, a, 305
  section-cutting, 262
  Voss, defective, 471
  Wimshurst : 315, 337, 426, 539
  — some curious experiments with, 267
  — theory of the, 327
Machinery, 400
Machines : drilling, notes on, 502
  milking, 182
  shaping, 507
Magic : mirrors, black, 227
  squares, 42, 70, 93, 114, 156, 161, 181, 202, 225, 244, 287, 309, 332
Magnet : construction, 20, 72
  electro, 388, 447, 554
  winding, 20, 201
Magnetic : attraction, 270
  circuit of dynamo, waste in, 357
  insulation, 227
  oxide, 183
  polarity, 44
  — and medical electricity, 117
Magnetised : plates, steel, 581
  steel wire, 227, 289
  watches, 271, 291
Magnetism : 537
  earth's, registering, 283
  in tools, 149
  terrestrial, the direct action of solar disturbances on, 40, 88
Magneto : bells, 408, 425
  electric machine, 45
  machine : 315, 337
  — defective, 161
Magnets : 20, 43
  permanent, 72
  — motor with, 588
  winding, 291
Magnifying power of microscopes, 485
Magnitudes : of Jupiter's satellites, 88
  star, 14, 38, 39, 66, 90
  — photometric and photographic, 486
Male fern, extract of, 360
Manchester dynamo, 313, 425, 583
Manganese, testing, 139
Manual coupler, 337, 555
Manufacture : of ozone, the commercial, 60
  sulphuric acid, 448
Manufactured silver, price of, 506
Maquay battery, 423
Marble : artificial, 554
  slab, 512
  turning and polishing serpentine, 472, 498
Marine, telescope, 75
Mariner's compass, 62, 115
Markings on Jupiter's third satellite, 574
Mars : 443
  canal of, 66
  lakes and canals in, 111, 134, 155, 175
  markings on, 83
Martial waterworks, 88
Mathematical, 558
Maximum locomotive speed, 262
Measuring glasses : enlarged, 580
  rain-gauge, 530, 537, 556, 574, 579
Meats, roast and baked, 285
Mechanical : motion, 514
  process for resetting blunt files, 192
  telephone, 469
Mechanics, textbooks on, 180
Medica, flora, 511
Medical : battery, altering Halse's, 268
Medical : coil, 19, 44, 494
  — batteries for, 557
  electricity, and magnetic polarity, 117
Medicine, water as a, 208
Memorial, the Draper, 442
Memoriam, in, "J. K. P.," 577
Mercury : and Saturn, 91
  and Venus, 443
Mesmeric sailor, 314
Messier's nebulæ, 350
Metal : cast, softening, 378
  casting, moulds for, 205
  glass and, cementing, 556
  slotting, 139, 160
Metallic : compound, 239, 335
  mirrors, silvering, 379
Metallochromy, 376
Meteor : 240, 330, 531
  brilliant, 220, 239, 263, 286, 308, 371
  display of Aug. 10, 90
  radiants, 90
  remarkable, a, 177, 197
Meteoric dustfall on the moon, 61, 112
Meteorite, ascending, 574
Meteors, 14
  August, 61
  splendid, 549
Micro-erector, extempore, 201
Micrometer : reticle, 262
  ring, 216
Micrometrical measurements of the planets, 240
Microphone : 515, 535, 581
  patent, the expiration of the, 1, 77, 143
Micro-photography, 118, 293
Microscope : compound evolution of the, 571
  lantern, the, 259, 332, 557
  tube-length and resolving power, 489
  work, and natural history, new fluid for, 370
Microscopic : objects, mounting, 326
  optics, 133, 141
Microscopical : 298
  sections, the cutting of simple, 243
Microscopy : lantern, 309
  practical, for students, 126, 146, 167, 178, 191, 232, 257, 277, 299, 322, 348, 363, 387, 410, 431, 455, 477, 499, 521, 546, 567
  recreative, 17
Midland locomotives, 225, 246, 268
Mile, nautical and knot, 43
Milk : fat in, the estimation of, 366
  — — apparatus for, 438
  keeping, 44, 72
Milking machines, 182
Milky way, the structure of the, 220, 348
Milling cutters, speed of, 268
Milling machine dog, a new, 571
Mines, coal, explosives used in, 359
Mining : electricity in, 31
  in New Zealand, wolfram, 75
  query, 357
Mirror : and scale, galvanometer, 250
  lens, 305
Mirrors : flexure of, 578
  magic, black, 227
  metallic, silvering, 379
  silvering, 397, 446, 463, 512, 531, 576
Mitre-cutting machine, improved, 56
Mnemonics, 188, 226
Model : electric railway, motor for, 292, 335
  electro-motor, 183, 368
  steam port, 180
  yacht, 159, 248
Modelling wax, 249
Molecular and atomic volumes, 468
Monocycle, 172
Moon : 575
  eclipsed, colour of the, 349
  from equator, 228
  harvest, the, 133, 140, 160, 175, 180, 202
  meteoric dustfall on the, 61, 112
  radiant heat from the, 14
  recent eclipse of the, 308
  shadow of terrestrial mountains on the, during a lunar eclipse, 442
  volcanoes in the, 216, 227, 248
Moonlight, Arctic, 227
Moon's : heat, 442
  mean distance of the, 216
  rotation, causes of the, 14
Meor's improved blowpipe, 215
Mortising machine, an improved, 9
Motion : 117, 189
  for equatoreal, 270, 312, 335, 354, 395
  mechanical, 514
  solar, in space, 175
  terrestrial in the line of sight, determination of, 577
Motions : cam, 483
  parallel, 193
  stars, the proper, 486
Motor : and dynamo, the Edison, 57, 449
  driving by Leclanchés, 72
  electric, a simple form of, 195
  — model, 403
  electro, small, 96, 117, 535
  for boat, 161, 202, 425
  for model electric railway, 292, 335
  phonograph, 188
  small battery for, 227, 248
  water, 43, 537, 580
  — light obtainable from ½H.P., 378
  — transmission of power, 559
  with permanent magnets, 588
Motors : alternating current, condenser for, 9
  static, electrical, 366
Mould, 204
Moulder's : endo-skeletons, 497
  exo-skeleton, 341
Moulding : celluloid, 559
  gas-carbon, 139, 160
Moulds : for metal casting, 205
  powder for coating, 238
Mountains and valleys, 504
Mounting : microscopic objects, 326
  parasites, 517
Mounts : cutting, 536
  photo, gilding bevelled, 579
Mullein, 182, 228
Multiplier, galvanometer, 494
Muscæ volitantes, 348
Music, physical basis of, 15, 41, 241
Musical : box, 325
  instruments, their construction and capabilities, 33, 5 , 109, 130

NASIK squares, 161, 181, 202, 225, 246
Natural : drinks, 288, 294, 313, 332, 397
  history, and microscope work, new fluid for, 370
  phenomena, 494
Nature of flame, some new experiments illustrating the, 308
Nautical : almanac, 216, 574
  mile and knot, 43
Naval observatory, United States, 530
Nebula, the great Andromeda, the variable nucleus, and an anomalous star near it, 238, 263
Nebular line, Mr. Keeler and the chief, 530
Negatives : 20, 44
  broken, to repair, 208
  intensity of, method of reducing, 86
Neighbours' pianos, 471, 579
Neptune : 558, 574, 580
  and Uranus, 216
  path of, 176, 227
Nets, fishing, 139
Newspaper science, 395
Niagara, 87
Nickel : plating, 44, 270, 290, 357
  — bath, sediment in, 249
Nicotine, 267
Night-glasses, 156
Nist's planing device, 35
Nitrogen in sulphuric acid, 181
Noise of steam, 516
Nomenclature, electrical, 314, 336
Notes : astronomical, 4, 104, 210, 300, 406, 501
  on drilling machines, 502
  shop, 69
Novel zither, Hicks', 525
Novelties in incandescent lamps, 286
Novelty in violin construction, 310
Nu² Scorpionis, 220, 330
Numbers, curiosities of high, 70

OAK posts, preserving, 270
Oars, 96
Object in a refractor, distortion of, 83
Object-glass : achromatic, on the new form of the, 67
  divided, a, 365
  double-image, a, 177
  misty, 362
Object-glasses : for celestial and terrestrial observation, 133
  powers of, 463
  spotted, and speckled tubes, 530
Objects : microscopic, mounting, 326
  test, 350
Observations, unpublished, 307
Observatory : "annuaire" of the Belgian Royal, 530, 574
  companion to the, 348
  United States naval, 530
Observing, 395
Ocarina, 579
Ohm's formula, 94, 113, 135
Oil : colour for, red, 96, 116
  eucalyptus, 250, 270
  paraffin, 434
  test, 138
Oil-gas, 581
Oil-proof enamel, elastic, 427
Oil-stove cookery, 471
Oils, emulsifying, by tartaric acid, 182
Omnibuses, warming, 394
Onyx, 494, 535
Opium in India, 135
Optical : duplication of lines, 88
  glass, the new, 94, 555
  illusions, 353, 375, 574
  lantern, its construction and use, 51, 102, 122, 171, 279, 457, 542
Opticians and lanternists, to, 581
Optics : microscopic, 133, 141
  photographic, 18, 42, 67
  telescopic, 88
Orbital velocity, terrestrial, 485, 535, 574
Orbits of the planets, 175
Organ : 434, 579
  American, 71, 95, 96, 115, 116, 137, 138, 158, 159, 180, 184, 201, 204, 225, 226, 246, 247, 249, 289, 311
  blower for, 491
  light, 160
  matters, 468
  pipe, paint for, 348
  pneumatic action, 65
  reeds, 518
  swell in the, 150, 218, 346, 418
  temperament, 446
Organnettes : 224
  and pianistas, 331, 372, 398, 420
Organ-pipe, a new, 240
Origin of influenza and disease, 40, 61, 291, 333, 358
Orionis : 371, 443
  numbering of Pi, 197
Orrery, Philip's patent revolving, 182
Osbo-premier battery, 17
Overtaxed brain, 350, 395, 396, 442, 445, 464, 490

Oxide: of copper battery, De Lalande's new, 32
  plumbous, 537
Oxidising silver, 182
Oxychloride and other cements, 516, 536, 555
Oyster cultivation in France, artificial, 518
Ozone, the commercial manufacture of, 60

PAD, drill, a useful, 418
Paint: for boiler, 271
  for iron, 205
  for organ pipe, 348
  on glass, 558
Painting: glass, 96
  outside, 180
Paints, luminous in all colours, 305
Pancreatic juice, 423
Paper: burnt, 20
  chemically prepared, 348
  wood, 73
Papering a ceiling, 18
Papier mache, 116
Papyroxyline, 370
Paquelin's benzine blowpipe, 414
Paraffin: oil, 424
  spray for boiler, 447
Parallax: horizontal equatorial, 176
  relative, in eclipses, 580
  solar, 296
  sun's distance and, 442
Parallel motions, 193
Parasites, mounting, 518
Past, future, and space, 70
Patent: fees, taxation of inventors, 68, 93
  improved air-pump ventilator, Boyle's, 568
  microphone, expiration of the, 1, 77, 143
  revolving orrery, Philip's, 132
  sash fastener, Piceaver's, 154
  staple driver, "W. and R.," 257
Path: of Neptune, 176, 237
  of Uranus, 549
Patterns, punching sheet-brass, 315
Peculiar rainbows, 157
Pedal, swell, balanced, 313, 335, 376, 401
Pedals: 528
  piano, 96, 116, 180
Pelle, James Kenyon, the late, 567
Pendulum, compensated, 535
Peptones, the analysis of, 502
Period, the glacial, 112
Periphery of an ellipse, 396
Permanent magnets, 72
Periodic comet, Wolf's, 66, 88, 111, 134, 155, 177, 197, 240
Perseids, the August, 112, 134, 156, 177
Phenomena: natural, 494
  "physical" force, 65
  sunset, 113
Philip's patent revolving orrery, 132
Phonograph: 161, 205, 236, 249, 314, 378, 426, 448, 492, 516, 536
  how to construct a, 78, 168
  motor, 183
Phosphor bronze, 236
Photographers, amateur, 66
Photographic: blue prints, 288
  enlargements, stand, 245
  magnitudes of stars, 486
  optics, 18, 42, 67
  veneering of furniture, 238
  view, and the human eye, 129
Photographing, diagrams, 44, 72
Photographs: enlarging, 494
  lighting, 467
  the Lick lunar, drawings from, 574
  the solar-prominence spectrum, 88
Photography: 19, 293, 403, 425
  lunar, 537, 556
  on a black ground, 129
  practical, for amateurs, 3, 50, 144, 234, 281, 324
  suggestions in, 368
Photometer, 116
Photometric and photographic magnitudes of stars, 486
Photo-micrography, 293
Physical: basis of music, 15, 41, 241
  force phenomena, 65
  "sciences," the connection of the, 485
Physiological, 380
Physiology of tears, 369
Pianistes and organettes, 331, 372, 398, 4.0
Piano: 43, 72
  trichord, 238
  hammers, riveting felts on, 403
  pedals, 96, 116, 180
  sound subduer, 204
Pianoforte: choosing a, 288, 402
  playing, 44
  tuning, 498
Pianofortes, 338
Pianos, neighbours', 471, 579
Piceaver's patent sash fastener, 154
Pin, ruby, in English lever, 20, 43
Pin-hole camera, 305
Pink streamers after sunset, 421
Pipe: Kenyon, the, 334
  chafing, 427
  steam, centring short lengths of, 392, 312
Pipe-organ, chamber, 358
Pipes: iron, to keep from rusting, 554
  pressure through, 557
  sink, cleaning, 314
Piping, 579
Pitkin lamp, recharging, 426
Pivot drills, watch, 45
Planer chuck, Jordan's, 237
Planets: logarithms of the distances and radii vectores of the, 442
  micrometrical measurements of the, 240
Planets: orbits of the, 175
Planing device, Nist's, 35
Planing-up thin stuff, 312
Plank, the largest in the world, 47
Plant: barometer, artificial, 559, 580
  castor-oil, 294
  ginger-beer, 515, 579
Plaster on hot-water pipes, 558
Plate, division, 447
Plates: accumulator, forming, 328
  iron, enamelled, 313
  steel, magnetised, 581
  striking out, 160
  Wimshurst, fixing, 357
Plating: dynamo, 403
  electro, 140, 270, 271, 493, 566
  nickel, 44, 270, 290, 357
  solution, 228, 248, 294
Playing-cards, antique press for, 509
Plumbous oxide, 537
Pneumatic: action, organ, 65
  tires, 137, 156, 200
Poison, extermination of rats without, 71
Polarisation of light, 182
Polarity: magnetic, 44
  — medical electricity, 117
Polishing: and grinding, 347
  celluloid, 516, 536
  ebony walking stick, 71
  paste, red German, for metals, 159
  steel, 354
Polygons, 558
Portable electric lamp, 92, 515
Poster writing, 270
Posts: boring holes in long, 209
  oak, preserving, 270
Pots, stoneware, 315, 337
Potsdam spectrography, 485
Powder for coating moulds, 238
Power: and heat calculation, 183
  antiseptic, of electricity, electro-microscopic slide for testing the, 195
  heating, of gas, 337
  magnifying, of microscopes, 485
  of engine, increasing, 19, 48, 338
  of eyepieces, 220
  resolving, and microscope tube-length, 489
  transmission of, by electricity, 446
  water, 269
Powers of object-glasses, 463
Practical: electric-light fitting, 165, 258, 319, 366, 453, 519
  hints in boiler design, 30, 80, 147, 213, 302, 384, 432, 483
  microscopy for students, 125, 146, 167, 178, 191, 232, 257, 277, 299, 323, 343, 363, 387, 410, 431, 455, 477, 499, 521, 546, 567
  photography for amateurs, 3, 50, 144, 234, 281, 324, 348
Practice and theory, 64
Precipitating gold, 338, 356, 377
Preservation of arachnids, fluid for, 533
Press: antique, for playing cards, 509
  hydraulic, 180, 554
  screws, 247
Pressure: and force, 537, 556
  atmospheric, and gaseous expansion, 92
  gauge and thermometer for hot air, 535
  through pipes, 557, 580
  water, 19
Price of manufactured silver, 506, 533
Principle compound, 559, 580
Principles of harmony, 136, 199
Printer's roller composition, 311
Printing without silver, 182
Prints: blue, photographic, 288
  ferro-prussiate, solution for writing on, 468
Prismatic compass, 442
Problem: 337, 403, 424
  electrical, 227
Process: blue copying, 45, 72
  new mechanical, for resetting blunt files, 192
Products, injurious combustion, 491
Progress of astronomy in 1891, 429
Projectiles: 424
  and the rotation of the earth, 307, 333, 348, 351, 375, 421, 446, 487, 532, 551, 577
  deviation in the flight of, 352, 395, 422
Prolapsus ani, 494, 514, 535, 555, 579
Prolonged sleep, 554
Proportions of cylinders, 469
Propulsion, jet, 37
Pugh's cushioned tires for cycles, 81
Pulley, 203, 556
Pump: Abyssinian, 162
  air, Boyle's patent improved ventilator, 568
  donkey, locomotive, 20
  for locomotive, 141
  force, 246
  hydraulic, 311
  steam, 403, 515, 535
Punching sheet-brass patterns, 315
Punt, river, 95, 159, 201, 226
Puzzle: 376
  subtraction, 516
Pyrometers, 71, 94
Pyrotechny, 268

QUADRANTIDS, the January 2, 463, 486
Quarrel, settling a, by fluoresceine, 305
Queries: locomotive, 356, 377
  violin, 377
Query, engine, 153, 315, 579
Question in arithmetic, 490, 534, 554

RABBITS, killing by electricity, 357
Radial axle-boxes, 43
Radiant points, the observation of stationary, 371
Radiants: long enduring, 330
  meteor, 90
Radiated and reflected dark rays of heat, 200, 262
Railway: electric, motor for model, 292
  Great Eastern, 513
  hundred miles an hour, electric, 570
  South Eastern, 289
  trains, bumping of, 538
Railway's engine, L. and N. W. Greater Britain, 287
Rain: gauge, measuring glasses, 530, 537, 556, 574, 579
  gauges, recording, 226, 247
  water, filter for, 559
  without clouds, 506
Rainbows, peculiar, 157, 197
Rain-bringing, 375
Rain-making, artificial, 173, 348, 395, 462
Ramie culture, 164
Rats, extermination of, without poison, 71
Ray, a green, 14, 40, 113
Rays: and a volcanic surfacing inconsistent with lunar tides, 219
  of heat, dark, radiated and reflected, 220, 262
Reagents, 516
Receding gums, 425
Receivers, telephone, clicking noise in, 357, 402
Recharging Pitkin lamp, 426
Recreative microscopy, 17
Red: colour for oil, 96, 116
  German polishing paste for metal, 159
  spot on Jupiter, 270
Reed-voicing, 249, 290, 335, 376
Refining: copper, 505
  gold, 45, 140
Reflector: 379
  for incandescent lamp, 292
Refraction of sound-waves, 68, 94
Refractor, distortion of object in a, 88
Refrigeration, 78
Regenerating battery, Faure's, 29
Regulating damper, 338
Regulator for incubators, 352, 508
Relacquering chandeliers, 380
Relative parallax in eclipses, 580
Repairing incandescent lamp, 162, 181
Resetting blunt files, new mechanical process for, 192
Resistance: 558
  adjustable, 250, 270, 315, 577
  internal, of battery, testing, 494, 515, 539, 557, 579
  lamp, 358
Retina, detached, 312
Retort carbons, cutting, 558
Retouching, 246

Reviews:
  Annandale's Concise Dictionary of the English Language, 565
  Electric Light Cables, by Stuart A. Russell, 565
  Engineering Chemistry, by H. Joshua Phillips, 167
  Light, by Sir H. Trueman Wood, 321
  Miscellaneous, 167, 321, 565
  Optical Projection, by Lewis Wright, 321
  Pictorial Astronomy for General Readers, by G. F. Chambers, 166
  Solutions, by W. Oswald, 166
  Star Groups, a Student's Guide to the Constellations, by J. E. Gore, 321
  The Adjustment and Testing of Telescopic Objectives, 167
  The Electro-magnet and Electro-magnetic Mechanism, by Silvanus P. Thomson, 167
  The Metallurgy of Argentiferous Lead, by M. Eissler, 565
  The Optics of Photography and Photographic Lenses, by J. Traill Taylor, 565
  The Practical Telephone Handbook, by Joseph Poole, 321

Rhythmical group of hydrogen lines visible in many stellar spectra, 84
Ribbons, typewriter, 71, 492
Rifle: Italian, the new, 376
  new automatic, 185
Rigel, 486, 530, 575
Ring: armature, 494
  micrometer, 216
  signet, stone from, 271
Ringing all bells but your own, 557
Rings and ranges, lunar, capped with snow, 14
River punt, 95, 159, 201, 226
Riveting felts on piano hammers, 403
Roast and baked meats, 285
Rock, Gibraltar, 537
Roller composition, printer's, 311
Rome, 335
Roof: 578
  pitch of, 116
Room: heating, 377
  resounding, 205
Rope-gear, 554
Rose-vase, 18
Rotary engine, Brown's, 64
Rotation: lunar, and tidal action, 262
  of the earth, and projectiles, 307, 333, 348, 351, 375, 421, 446, 487, 532, 551, 577
Rotation: the moon's, causes of the, 14
Rouge, 336, 402
Round haystack, 471, 492
Rubber: borax solutions of, 94
  hard, a natural, 414
  substitute, 87
  versus leather belting, 554
  washers, softening, 206, 312
Running circular saws, 391
Russia, vineyards in, 174
Rusting, to keep iron pipes from, 554
Rusty kettle, 293, 313

SAFETY: bicycle, 469
  drill and tapholder, 328
Safety-valve, steam boiler, 379
Sailing, 248
Sailor, mesmeric, 314
Salt bath, 182, 289
Satellite, Jupiter's third: markings on, 574
  transit of, 111
Satellites: extraordinary, 575
  Jupiter's, diameter of, 216
  — for verifying chronometer, 363
  — magnitudes of, 88
Saturation, 205
Saturn: 286, 574
  and Mercury, 91
Saturnian system, dimensions of the, 574
Saturn's rings through the sun, passage of the plane of, 485
Saws: band, 356, 378
  circular, running, 391
  foot-power, 405, 430
  hammering, 286
Scarfpin, 294
Science, newspaper, 395
Scientific advertising, 88, 137, 175, 201, 222, 238

SCIENTIFIC NEWS: 13, 38, 60, 88, 110, 132, 154, 174, 196, 216, 238, 261, 285, 306, 330, 347, 370, 394, 416, 441, 462, 484, 504, 528, 548, 573

Scientific Societies:
  British Astronomical Association, 237, 329, 440, 527
  Lantern Society, 237, 285, 394
  Quekett Microscopical Club, 196, 306
  Royal Astronomical, 305, 393, 461, 573
  Royal Meteorological, 393, 527
  Western Microscopical Club, 461

Scotia toolholder, 98
Scrap copper, 183
Screw, an automatic, 526
Screw-cutting: 117, 162, 182, 203, 271, 313
  gauge, 283
Screw-propulsion, 581
Screws: leading pitch of, 289
  press, 247
Scribing block, a, 375
Scurvy, prevention of, 110
Sea: error of chronometer, 498
  fish, fecundity of, 182
  sounds at, 335, 352
Seat attachment for bicycles, 284
Section of iron, 180, 202
Section-cutting machine, 262
Sections, the cutting of simple microscopical, 243
Seeing by electricity, 15
Selenographical, 111, 396, 464
Series-wound dynamo, 159
Serpollet instantaneous steam generator, 481
Service, fast mail, 155
Shafting, pipe, 437
Shaping: attachment, a, 301
  machines, 507
Sharpening: drills, 439
  wire, 180
Ship: and shore, communication with, 308, 332
  reflection of, 375
Shop: bell, electric, 318, 336, 354
  notes, 69
Shops, jewellers', lighting, 558
Shrubs and telescopic definition, 216
Shrunken woollen goods, 315, 336, 468, 534
Shunt, 96
Shunt-winding a Gramme dynamo, 315
Siberia, inhabitants of, 280
Sidereal: universe, the structure of the, 38
  watch, 216
  — time, 506
Siemens's: drum armature, winding, 250
  dynamo, to give shocks, 379
  improved electro-motor, 198
Sight, line of, determination of terrestria motion in the, 577
Signal wires, adjusting, 71
Signet ring, stone from, 271
Signwriting, 289
Silica, 204
Silicate of soda, 246
Silk, waterproofing, 580
Silver: and gold, recovering by electricity, 485
  casting, 472
  manufactured, price of, 506, 533
  oxidising, 182
  printing without, 182
Silvering: glass, 19, 20, 138
  metallic mirrors, 379
  mirrors, 397, 446, 463, 512, 531, 576

Silvering : solution for glass, 379
  specula, 461
Simplex gas generator, 366
Single-needle telegraph, 290
Single-stroke bell, 292
Sink pipe, cleaning, 314
Siphon, 402, 423, 434, 447
Skates, 493, 514
Skeleton leaves, 337
Skin eruption, 44, 72, 116, 228
Slab, marble, 512
Slate trick, the "spirit," 439
Sledges, 401
Sleep, prolonged, 554
Slide-valve setting, 182, 208, 235
Slotting metal, 139, 160
Sloyd work, 268, 288
Small boxes, 49, 121
Smelting iron, 472
Smoke, 580
Smokeless coal, 161
Smoking and teeth, 470, 578
Smoky chimney, 379
Snakes, 226, 249
Snow, volcanic rock, or, 88
Soap bubbles, 416
Societies, amateur astronomical, 88
Soda, silicate of, 246
Sodium amalgam, 515
Solar : altitude, 18, 38
  disturbances, 40, 88
  light, 220, 331
  motion in space, 175
  parallax, 395
Solder : 138
  analysing, 559
  brass colour for, 379
Soldering : 356, 402,
  and brazing, 139, 160
  cast iron, 356, 402
Solution : borax, of rubber, 94
  for glass silvering, 379
  for writing on ferro-prussiate prints, 468
  gilding, 45, 139, 160
  of dextrine, 378
  plating, 228, 248, 294
Sores, electric, 140
Sounder, Thomson's, 306
Sounds at sea, 335, 353
Sound-waves, refraction of, 68, 94
South-Eastern railway, 289
Space : 112
  of four dimensions, 88, 93, 114, 133, 138
  past, future, and, 70
  solar motion in, 175
Spark coil, 588
Sparking dynamo, 117, 162
Spectrography, Potsdam, 486
Spectroscope, diffraction, 447
Spectroscopes, elementary principles governing the efficiency of, for astronomical purposes, 437, 458, 502
Spectrum, solar-prominence, photographing the, 88
Specula : flexure in, prevention of, 552
  silvering, 491
Speed : 554
  armature, 515
  calculating, 161
  gearing, Heath's changeable, 195
  indicator, 182
  maximum locomotive, 262
  of milling cutters, 268
Spiral springs, 71
Spontaneous combustion, 472
Springs : spiral, 71
  strength of, 45
Spritsail v. gaff and boom, 471, 492
Square hole, boring, 379, 402
Squares : magic, 42, 70, 98, 114, 156, 161, 181, 202, 225, 244, 287, 309, 332
  nasik, 161, 181, 202, 225, 246
St. Martin's eve, 336
St. Paul's cathedral clock, 505
Stable fittings, 226, 268
Stain on linen, Condy's fluid, 227, 248
Stamping letters on wood, 425
Stand : for telescope, 18, 71, 115
  photographic enlargements, 245
Standard angle for lathe centres, 43
Staple driver, "W. and R." patent, 267
Star : fluting and bumptiousness, 511
  magnitudes, 14, 38, 39, 66, 90
  new, in Auriga, 574
  of 1890, in the Andromeda nebula, 350
  tests, 308, 349, 395
Stars : 205, 226
  anomalous, and other variable nebulæ, 258
  brightest, the twelve, 216
  double, 14
  evolution, and age of the, 348
  faint, 506, 549
  fixed, proper motions of the, 417
  magnitudes of, photometric and photographic, 486
  motions of the, proper, 486, 531
  shooting, 574, 581
  talking with the, 56
  test, 330
  variable, 220
Star-tests wanted, 263
Static electrical motors, 366
Statuary, 498
Steam : blower, furnace, 20
  boiler, small, 492
  boiling, 78
  gauge, 515
  generator, Serpollet instantaneous, 431
  injector, 557
  noise of, 516
  or gas, 538
  pipe, centring short lengths of, 292, 312
  port, model, 180
  pump, 403, 434, 515, 535
  steering gear, 377
  tramway engines, 95
Steam : tricycle, 289
Steamboats, Thames, 137
Steam-boiler safety-valve, 379
Steam-engine, condensing, 312
Steamers, Atlantic, coal burnt on the, 306
Steam-jet cupola, 554
Steamships, Bristol, 471
Steel : ancient Egyptians, did they use? 266, 287
  and iron, decomposition of, 246
  articles, blueing small, 338
  colouring, 159
  cutting, 21
  gilding, 96
  hardening, 314
  plates, magnetising, 581
  polishing, 354
  softening, 208
  wire, magnetised, 227, 289
Stellar : cluster, Persei, 38
  spectra, rhythmical group of hydrogen lines visible in many, 34
Sticks, deal, ebonising, 582
Stomach, cancer in the, 72
Stone, artificial, 354
Stonehenge, 114, 133, 157
Stoneware pots, 315, 337
Storage : batteries, switch for charging, from arc circuit, 483
  cells, 117
Stove : draught, 378
  gas, a new, 114, 222, 341, 267
  slow-combustion, 116
Strain of engine belt, 469
Strasburg turpentine, 246
Strength : of electro-magnets, 338, 447
  of springs, 45
Stress, on electric, 32
Strophanthus, 403
Students : chemistry for, 54, 190, 308, 344, 386, 543
  geology for, 26, 81, 126, 137, 170, 212, 255, 364, 408, 434, 478
  microscopy for, practical, 125, 146, 167, 178, 191, 232, 257, 277, 299, 322, 343, 363, 387, 410, 431, 455, 477, 499, 521, 546, 567
Substitute : for glass, 150
  rubber, 87
Subtraction puzzle, 516
Sulphur in coal gas, 472, 492
Sulphuric acid : for accumulator, 162
  manufacture, 448
  nitrogen in, 181
Sun : 91
  bodies crossing the, 88
  comet crossing the, 38
  earth, and the, 574, 580
  lamps, and semi-incandescent lamps, 141
  passage of the plane of Saturn's rings through the, 485
  throwing an image of the, on to a screen, 530, 538
Sundial : 175, 314, 418, 533
  to make a, gnomon included, out of a single piece of paper, 309
  traveller's, the, 418
Sun's : distance and parallax, 442
  light, 262, 307
Sunset : on Chimborazo, 485
  phenomena, 118
  pink streamers after, 421
Sunspots : 531
  swarm of, 506
  visible to the naked eye, 308
Surfacing for wood engraver's blocks, 228
Surnames of Jews, 18
Surveying, 396
Swell : in the organ, 150, 218, 346, 413
  pedal, balanced, 313, 335, 376, 401
Switch for charging storage batteries from arc circuits, 483

TABLES, geographical, 133
Tainted beer, 246
Talking with the stars, 56
Tamarind wine, 288, 402
Tangent galvanometer, 291
Tank, lantern, 494
Tanks, creasote, fastening covers of, 180
Tap, water, buzzing, 312
Tapers and cone fitting, 532
Tapholder, safety drill and, 328
Taunton dynamo, 493
Taxation of inventors, patent fees, 68, 93
Taxidermy, 315
Tea drinking, 204
Teak, 539
Tears, the physiology of, 369
Technical : education, 311, 332, 422
  gas analysis, 246
Teeth : 403
  and smoking, 470, 578
  artificial, from a hygienic point of view, 517
Telegraph, single-needle, 290
Telegraphing without wires, Edison's method of, 514
Telephone : 21, 315, 356, 494, 536
  and bell connections, 269, 271, 290
  mechanical, 469
  receivers, clicking noise in, 357, 402
Telephones, 402
Telephonic apparatus, Howard's improved, 326
Telescope : 91, 133, 177, 263, 271, 313, 348, 355, 377, 581
  angle view of, 336, 354
  astronomical, 307
  field of, angular subtense of, 307
Telescope : flare in, 216
  gauge, 577
  glass, 332
  marine, 175
  stand for, 18, 71, 115
  street, 333
Telescopes : 216, 349
  and troopships, 91, 133, 506
  astro, 72, 88, 138
  correction of, 155
  suitable, and Tempel-Swift comet, 350
  tests for, 395, 531
Telescopic : definition, and shrubs, 216
  field, 316
  optics, 88
Tempel-Swift comet : a search for, 91
  and suitable telescopes, 350
Temperament, organ, 446
Temperature indicator, electrical, 293, 313
Tempering clay, 269
Terebene driers, 72, 159, 180, 333
Terrestrial : crater-rings, 220
  eyepiece, 138
  magnetism, the direct action of solar disturbances on, 40, 88
  motion in the line of sight, determination of, 577
  mountains on the moon, during a lunar eclipse, the shadow of, 442
  observation, object-glasses for celestial and, 133
  orbital velocity, 485, 535, 574
Tesla's experiments in electric lighting, 345
Test : objects, 350
  oil, 136
  stars, 330
Testing : battery, 45
  electrical, 44, 95
  for tin, 428
  internal resistance of battery, 494, 515, 539, 557, 579
  manganese, 139
Tests : star, 308, 349, 395
  telescopes, 395, 531
Test-stars wanted, 220
Textbooks on mechanics, 180
Thames steamboats, 137
Theory : and practice, 64
  ether, 157
  of the Wimshurst machine, 327
Theopathy, 204, 312
Theosophy, 93, 134, 175
  and ether, 112
Thermo-dynamics, 536
Thermometer : for hot-air and pressure gauge, 535
  minimum, 472
Thermopile, 249, 471
Thermostats, 371
Thomson's sounder, 306
Throat, 270, 291, 312
Tidal action and lunar rotation, 262
Tide gauge, 402
Tight-lacing, effects of, 534
Tiles, hip and valley, 116
Time : equation of, 442
  watch, a sidereal, 506
Tin : recovering, from waste tinplate, 215
  tests for, 428
Tinning copper utensils, 425
Tinplate, waste, recovering tin from, 215
Tires : bicycle, 137, 156
  for cycles, Pugh's cushioned, 81
  pneumatic, 137, 156, 200
  welding, 460, 512
Toad, the venom of the, 133
Toes, distorted, 116
Tool-chest, a, and how to make it, 383
Toolholder, the Scotia, 93
Tools : a few handy, 86
  magnetism in, 149
Torsion : 293
  balance, 449, 492, 518, 535, 555, 575
Tourmaline in the Shan States, 35
Tractive resistance on inclines, 139
"Trainer" cycle, Guignard's, 412
Trains, railway, bumping of, 538
Tramway : engines, steam, 95
  extensions, 462
Tramways, cable, 200
Transformer, 73, 315, 357
Transmitter, Hunnings, 581
Transit of Jupiter's third satellite, 111
Transit-taking, personal equation in, 262
Transmission of power by electricity, 446
Trapezium of Orionis, 350
Traveller's sundial, the, 418
Travelling baskets, ladies', 116
Treadle, lathe, 408
Treasure, the "housekeeper's," 446
Tree, a remarkable Californian, 145
Trick, the "spirit slate," 439
Tricycle : 403
  steam, 289
Trigonometry, distance by, 530, 537
Triple-expansion engines, 138
Troopships, and telescopes, 91, 133, 506
Tropics, astronomy in the, 91
Troughs, cement for glass, 71
Truffles, 73, 116
Tube-length, microscope, and resolving power, 489
Tubes : gauge, bending, 180
  pulse, 73
  speckled, and spotted object-glasses, 530
  vacuum, 337, 400, 588
Tuning pianoforte, 498
Tunnel, St. Clair, the, 158
Turbine : 225
  for electric light, 515
Turning : and boring engine cylinders, 448, 518
  and polishing serpentine marble, 472, 493
Turpentine : and glycerine, 294
  Strasburg, 246
Twist-drill : 557
  grinding, 398
Type gas-engine, compression, 44
Type-metal and cores, casting in, 579
Typewriter ribbons, 71, 493

UNDERGROUND, electrical cable, 154
Unfermented wine, 96, 333
United States : cutlery exports to, 184
  naval observatory, 580
Units, electrical, 141
Universal galvanometer, Varley's, 201
Universe, sidereal, the structure of the, 38
Upright writing, 138
Uranus : and Neptune, 216
  path of, 549
Useful clamp for wheelwrights, 484
Utensils, copper : cleaning, 291, 313
  — tinning, 425

VACCINATION, 551
Vacuum : 223
  re the, 200
  tubes, 337, 400, 538
Valley and hip tiles, 116
Valleys and mountains, 504
Valves, noisy, 20
Vanishing lady, the, 152
Varicose veins, 72
Varley's universal galvanometer, 201
Varnish : copal, 314, 336
  violin, 353
Vat, wood, 117
Vegetation, growth of, 91
Veins, varicose, 72
Velocities of falling bodies, 581
Velocity : of dynamos, 516, 536
  orbital, terrestrial, 485, 535, 574
Vendelinus, 464
Veneering of furniture, photographic, 238
Venom of the toad, the, 133
Ventilator, Boyle's patent improved air-pump, 568
Venus : 133, 175, 180
  and Jupiter, conjunction of, 506
  and Mercury, 443
Verbascum, 226
Vermin, body, 204, 334
Vertical boilers, heating surface of small, 488, 558
Vince, Prof., "F.R.A.S." and, 197
Vineyards in Russia, 174
Violin : 376
  construction, novelty in, 310
  how to make a, 5, 52, 107, 148, 189, 267, 268, 282, 325, 397
  making, 68, 197, 228, 353, 378, 419, 510, 532, 551, 578
  matters, 446, 465, 468, 486, 510, 550
  queries, 377
  varnish, 353
Violins, "Berliner" and "Fiddler," 463
Voice culture, 116
Volatilisation of iron, 18
Volcanic rock, or snow, 88
Volcanoes in the moon, 216, 227, 248
Voltmeter : 271, 426, 581
  and ammeter combined, 71, 117
Voss, machine, defective, 471

WALKING-STICK, polishing ebony, 71
Wall diagrams, 225
Warming : house, 515
  omnibuses, 394
Washers : gauge-glass, 280
  softening rubber, 206, 312
Wasted food : 67, 94, 115, 135, 156, 201
  and famine expedients, 178
Watch : astro, 205
  lever, 140, 271, 291
  pivot drills, 45
  sidereal, 216
  — time, 506
Watches, magnetised, 271, 291
Water : as a medicine, 206
  colours, preserving, 270
  distilled, for domestic use, 425, 448, 485
  fresh, from sea-water, 493
  germ-free drinking, 154
  hot, 208
  indicator, 556
  motor, 43, 537, 580
  — light obtainable from ⅛H.P., 378
  — transmission of power, 559
  power, 269
  pressure, 19
  rain, filter for, 559
  raising, 139, 201
  supply, 176
  support in, 160
  tap, buzzing, 312
Water-gas, 388
Water-motor : 246
  an improved, 432
Waterproof, 205
Waterproofing silk, 580
Water-wheel, overshot, 554
Waterworks, Martial, 88
Watery comet, a, 574
Wax, modelling, 249
Weather : cyclone, 440
  glass, 44
  indicator, 160, 181
Weight-power to drive fans, &c., 98
Welding tires, 460, 512
Wheatstone's bridge, 496, 514
Wheel, 'scape, 428

Wheel-cutting, 470
Wheel-making, 270
Wheel-valve, 512, 535, 554
Wheelwrights, useful clamp for, 484
Wild's electrical candle, 48
Wimshurst : machine, 315, 337, 425, 539
  — some curious experiments with the, 267
  — theory of the, 337
  plates, fixing, 357
Wimshurst's alternating influence machine, 310
Wine : tamarind, 268, 402
  unfermented, 96, 338
Winding : armature, 205, 558, 580
  dynamo, 31, 206, 237, 356
  magnet, 20, 201
  motor for boat, 471
  Siemens' drum armature, 250
Windmill, an improved, 547
Wiped solder joints, cleaning, 517

Wire : and electro-magnets, relation between, 293
  battery for incandescing, 45, 139
  electric, broken, 249, 269, 290
  gauge, English and American, 436
  iron, resistance of, 183
  japanning round, 288
  sharpening, 180
  steel, magnetised, 227, 289
Wires : adjusting signal, 71
  telegraphing without, Edison's method of, 524
Wolfram mining in New Zealand, 75
Wolf's periodic comet, 66, 88, 111, 134, 155, 177, 197, 240
Wood : engravers' blocks, surfacing for, 228
  paper, 73
  preservative for, 270
  saws, device for cleaning, 139
  stamping letters on, 425
  vats, 117

Wood-bending, 379
Wool, carbonising, 96, 116, 139, 159, 160, 201, 225, 246
Woollen goods, shrunken, 315, 336, 469, 584
Work : burnt-wood, 160
  good, and good ways of doing it, 158, 526
  locomotive, 467, 489
  microscope, and natural history, new fluid for, 370
  sloyd, 268, 288
Workmen, health of, and hydrofluoric acid, 85
Workshop : 569
  emergencies in the, 63
  floor, 377
  heating, 290
World, the largest plank in the, 47
Worm, gear on, 180
Worry, brain, 463

Writing : poster, 270
  upright, 138

XYLOPHONE, 268

YACHT, model, 189, 248
Yeast, 73, 95

ZINC: 559
  blacking, 357
  chloride of, and chromic acid, battery with, 117
  extracting lead from, 183
Zincs : and carbons, best arrangement of, 183
  Leclanché, cleaning, 581
Zither, Hick's novel, 525
Zodiacal light, the, 216, 575

ILLUSTRATIONS.

ACCESSORIES, lantern, 299
Accumulators : 269
  charging, 556
  dynamo for charging, suggested, 553
Achromatic object-glass, new form of, 67
Air-pump ventilator, Boyle's improved, 568
Alarms, burglar, annunciator for, 327
Alternating current motors, condenser for, 9
Altitude, solar, 18
Amateurs : glass blowing for, 400, 465
  lathework for, 100, 188, 298, 361, 475, 568
  practical photography for, 284, 382
Anal ysis of beeswax, 458
Ani, prolapsus, 579
Annunciator for burglar alarms 327
Antique press for playing cards, 509
Arc : elliptic, length of, 576
  lamp, how to make, 533
  — small, 536
  of contact, 290
Assembling parts of engines, 504
Astronomical driving clock, 312
Attachment, shaping, 301
Attraction, magnetic, 250
Auriga, new star in, 575
Automatic screw, 526
Axle-boxes, radial, 43

BALANCED swell pedal, 313, 335
Band saws, brazing, 378
Bars in organ, steel, 424
Batteries : switch for charging storage from arc circuits, 484
Battery : Edison's carbon, 283
  Faure's regenerating, 29
  Hart's sealed chloride of silver, 109
  Lalande's oxide of copper, 38
  testing internal resistance of, 557
Beauchene's boring bit, 110
Beeswax, analysis of, 458
Bell : electric, for shop, 336
  — to clock, 117, 580
  telephone connections and, 229, 269, 290
Bellphone, 17
Bells : electric, 229, 269, 290
  — hints for hangers of, 108
Bench, carpenter's, 456
Bicycles, seat attachment for, 284
Black ground, photography on a, 129
Block, scribing, 375
Blowpipe : Moor's improved, 215
  Paquelin's benzoline, 415
Boats, sailing, 248
Boiler : design, practical hints in, 31, 80 147, 213, 302, 433
  Serpollet, 431
Bolt-holder, handy, 548
Bookcase, a hanging, 541
Boring : and turning engine, 513
  bit, Beanchene's, 110
  tools in long posts, 209
Boxes : corner fastenings for, 145
  making small, 49, 121
Boyle's improved air-pump ventilator, 568
Brazing : bandsaws, 378
Breaking weight of spar, 449
Brickmaking, 365
Bridge, Wheatstone, 473
Broken line, finding a fault in, 269
Bubbles, soap, 416
Burglar alarms, annunciator for, 327

CAILLETET'S cryogen, 198
Calculations respecting the lens, 351
Calculus, lessons in the, 284, 392
Cam, one kind of, 389
Cams : designing, 109
  method of cutting, 437
  motions of, 483
Carbon filaments in lamps, 424
Cards, antique press for playing, 509
Carpenter's bench, 456
Carriage wrench, champion, 129
Casting : in lead, 204, 229
  steel tube and, 340
Centring short lengths of pipe, 312
Charging accumulators, 556
Chemistry for students, 54, 190, 308, 344, 386, 544
Chess-board, pocket, 576
Chiming clock, how to construct a quarter, 25
Chuck, Jordan's planer, 287
Clamp for wheelwrights, 484
Cleaning wood saws, 129
Clock : astronomical driving, 312
  electric bell to, 117, 580
  how to construct a quarter chiming, 25
Clockmaking, 275
Comet : Tempel-Swift, 350
  Wolf's, path of, 5, 106
Condenser for alternating current motors, 9
Connections : bell and telephone, 229, 269, 290
  for compound wound dynamo, 580
  of magneto-electric machine, 181
Contacts, floor, 355
Copper oxide battery, 38
Corner fastenings for boxes, 145
Crane, size of bars for, 97
Crank without a dead-point, 482
Cryogen, Cailletet's, 198
Curve, equation to, 536
Cutter-bar, Haydon's, 540
Cutting corns, 437
Cycle, Guignard's trainer, 413
Cycles : Juno, 545
  Pugh's cushioned tires for, 81
Cyclostat, the, 345
Cylinders, boring and turning engine, 513

DEAD-POINT, crank without a, 482
Design, boiler, hints in, 31, 80, 147, 213, 302, 433
Designing cams, 109
Dialling, 444, 467
Differential calculus, 560
Distance by trigonometry, 530
Dividing system for wheel-cutting, 470
Dog, new lathe, 366
Dialling : and the ellipse, 228, 309
  Stephenson's sundial, 358
Dog, milling machine, 571
Drawing : geometrical, 160
Drill : jigs, 128
  pad, useful, 418
  safety and tap-holder, 329
Drilling machines, notes on, 502
Drills, twist, grinding, 398, 502
Driving clock, astronomical, 312
Dynamo : 43
  and motor, Edison, 58
  connections for compound wound, 580
  suggestion for a small for accumulator charging, 553

EARTH : projectiles and the rotation of the, 487
Eclipse, lunar, 219
Edison : carbon battery, 283
  dynamo and motor, 58
  lamp sockets, 570
Edison's method of telegraphing without wires, 525
Electric : bell, for shop, 356
  bell hangers, hints for, 108
  — clock, 117, 580
  fire alarm, 247, 268
  lamp, portable, 92
  light fitting, practical, 165, 253, 319, 453, 519
  railway, hundred miles an hour, 570
Electrical : motors, static, 367
  nomenclature, 336
  temperature indicator, 318
Electricity, antiseptic power of, electro microscopic slide for testing, 195
Electro-plating, practical, 566
Electro-magnet, 316
Electro-microscopic slide for testing antiseptic power of electricity, 195
Electro-motor : Siemen's improved, 198
  simple form of, 195
Electrophotophore, 29
Electrostatics, experiments in, 487, 576
Ellipse, dialling and the, 228
Elliptic arc, length of, 576
Endo-skeletons, moulders', 497
Engine : cylinders, boring and turning, 513
  gas, new, 178
  — tinplate gas bag for, 469
  hot-air, 465
Engines, assembling parts of, 504
Equation curve, 536
Equatoreal, motion for, 312, 385
Escapement, gravity, easily constructed, 552
Exo-skeletons, moulders', 341
Experiments : in electrostatics, 487, 576
  with the Wimshurst machine, curious 267
Eye, photographic view and the human, 129

FAT in milk, estimating, 438
Faure's regenerating battery, 29
Files, mechanical process for resetting blunt, 192
Fire : alarm, electric, 247, 268
  extinguisher, 259
Fitting : 7, 106, 124, 234, 278, 326, 385, 411, 480, 521, 569
  electric light, practical, 165, 253, 319, 453, 519
Flame, new experiments illustrating the nature of, 303
Floor contacts, 355
Foot-power saws, 405, 430
Force pump, 247
Frame, heating garden, 158

GALVANOMETER, lineman's, 355
Garden frame, heating, 158
Gas : engine, new, 179
  — gas-bag for, 469
  generator, simplex, 366
Gauge : screw-cutting, 283
  telescope, 577
Gearing, changeable speed, Heath's, 195
Generator, simplex gas, 336
Geology for students, 26, 82, 136, 170, 212, 255, 364, 408, 478
Geometrical drawing, 160
Glass, substitute for, 150
Glass-blowing, amateur, 400, 465
Gold, precipitating, 377
Good work and good ways of doing it, 153, 527
Gouges, inside, 354
Gravity : escapement, easily constructed, 552
  hoist, simple and efficient, 260
Great Eastern locos., 188, 513
Grinding : polishing and, 347
  twist drills, 398
Guarnerius violin, dimensions of a, 466
Guericke, 111
Guignard's "trainer" cycle, 413

HAND-REST to lathe, fixing, 248
Handy tools, a few, 87
Hanging bookcase, 541
Harmony : 20
  principles of, 136, 199
Hart's chloride of silver battery, 109
Hawthorn locomotive, 467
Haydon's cutter-bar, 540
Heath's changeable speed gearing, 195
Heating : garden frame, 158
  hotwater, 142, 203
Hicks's novel zither, 525
Historical locomotives, 15
Hoist, gravity, 260
Holes in long posts, boring, 209
Hot-air engine, 465
Hotwater heating, 142, 203
Howard's improved telephonic apparatus, 326
Hundred miles an hour electric railway, 570
Hydrogen : lines in stellar spectra, rhythmical group of, 85
  preparation of, 548

ICE MACHINE, improved 460
Incandescent lamps : 181
  novelties in, 236
Incubators : 179, 198, 221, 240, 264
  regulators for, 352, 508
Index, lathe, 283, 323, 383, 373, 422
Indicator, electrical temperature, 318
Indicators, electrical, 355
Influence machine, Wimshurst's alternating, 310
Inside gouges, 354

JIGS, drill, 128
Jordan's planer chuck, 287
Juno cycles, 545
Jupiter, conjunction of Venus and, 506
Jupiter's satellites, 89

KENYON pipe, 325
Kiln, 428

LADY, the vanishing, 152
Lalande's oxide of copper battery, 38
Lamp, arc : how to make, 533
  small, 536
  sockets, Edison, 570
Lamps : incandescent, 181, 424
  — novelties in, 236
  portable electric, 92
Lantern : accessories, 299
  optical, construction and use, 51, 103, 122, 171, 279, 543
Lathe : dog, new, 366
  fixing hand-rest to, 248
  index, 283, 323, 333, 373, 422
  rest, motion for, 495
Lathework for amateurs, 100, 188, 298, 361, 475. 563
Lead, casting in, 204, 229
Lens : calculations respecting the, 351
  mirror, 305
Lightning photographs, 467
Lineman's galvanometer, 355
Link motion, 316
Liquids, device for raising, 571
Locomotive, the Hawthorn, 467
Locomotives : G.E.R., 188, 513
  historical, 15
  S.E , 289
Lunar eclipse, 219
Lyræ, epsilon ^{1} and ^{2}, 349

MACHINE : ice, improved, 460
  mitre cutting, 56
  mortising, 9
  Wimshurst, theory of, 327
  Wimshurst's alternating influence, 310
Machines : drilling, notes on, 502
Magic squares, 42, 70, 114, 156, 202, 244, 247, 287, 309, 332
Magnet, electro, 316,
Magnetic attraction, 250
Magneto-electric machines, connections of, 181
Mars, 448
Mechanical motion, 473, 514
Metal for moulding into glass, 495
Microphone : 536
  patent, expiration of, 77, 143
Microscopical sections, cutting, 243
Microscopy for students, practical, 125, 146, 167, 191, 232, 257, 277, 299, 322, 343, 363, 387, 410, 432, 455, 477, 499, 521, 547 567
Milk, estimating fat in, 438
Milling machine dog, 571
Mirror lens, 505
Mirrors, silvering, 532, 576
Mitre-cutting machine, 56
Monocycle : 173

Moor's : improved blowpipe, 215
  self-locking retort stand, 436
Mortising machine, 9
Motion : for equatoreal, 312, 335
  link, 316
  mechanical, 473, 514
Motions : cam, 483
  parallel, 194
Motor : and dynamo, Edison, 581
  water, improved, 482
Motors : condenser for alternating current, 9
  static electrical, 367
Moulders' : endo-skeletons, 497
  exo-skeletons, 341
Music bands for organettes, cutting, 399

NASIK squares, 163, 181
Nature of flame, experiments illustrating, 303
Neptune, path of, 177
Nist's planing device, 35
Nomenclature, electrical, 336
Notes : on drilling machines, 502
  shop, 69

OBJECT-GLASS, new form of achromatic, 67
Optical lantern, construction and use, 51, 103, 132, 171, 279, 543
Organ : pipe, new, 240
  pneumatic action, 65
  steel bars in, 424
Organettes : 224, 243, 265, 331, 373, 399, 420
  cutting music for, 399
Oxygen, preparation of, 543
Ozone, commercial manufacture of, 60

PAD, drill, useful, 413
Paquelin's benzoline blowpipe, 415
Parallel motions, 194
Path : of Neptune, 177
  of Uranus, 549
  of Wolf's Comet, 5, 105
Pedal, balanced swell, 313, 335
Phonograph : 226
  how to construct a, 79, 169
Photographic view, and the human eye, 129
Photographs, lightning, 467
Photography : on a black ground, 129
  practical, for amateurs, 234 262
  suggestions in, 368
Pianistas, 331, 373
Piccaver's sash fastener, 154
Pipe : centring short lengths of, 312
  Kenyon, 325
  new organ, 240
Planer chuck, Jordan's, 237
Planing device, Nist's, 35
Plates, striking out, 118, 160
Plating, electro, practical, 566
Pneumatic : action for organ, 65
  tires, 200
Pocket chess-board, 576
Polishing and grinding, 347
Precipitating gold, 377
Press : antique for playing cards, 509
  screws, 247
Projectiles and the rotation of the earth, 487
Prolapsus ani, 579
Pugh's cushioned tires for cycles, 81
Pulley, 203, 517
Pump : force, 247
  vacuum, 200
Punt, river, 95, 159, 201, 225

RADIAL axle-boxes, 43
Railway, electric, hundred miles an hour, 570
Raising liquids, device for, 571
Refraction of sound waves, 68
Regulators for incubators, 353, 508
Resetting blunt files, mechanical process for, 192
Resistance : adjustable, 270, 377
  of battery, testing internal, 557
Retort stand, Moor's self-locking, 436
River punt, 95, 159, 201, 225
Roof, 426

SAILING boats, 248
Sash fastener, Piccaver's, 154
Satellites of Jupiter, 89
Saws : brazing band, 378
  device for cleaning wood, 129
  foot-power, 405, 430
Scotia tool-holder, 93
Screw, an automatic, 526
Screw-cutting gauge, 288
Screws, press, 247
Scribing block, 375
Sections, cutting microscopical, 248
Serpollet boiler, 431
Shaping attachment, 301
Shop : bell, electric, 336
  notes, 69
Siemens' improved electro-motor, 193
Silvering mirrors, 532, 576
Sledges, 402
Soap bubbles, 416
Sockets, lamp, Edison, 570
Solar altitude, 18
Sound-waves, refraction of, 68
South Eastern engines, 289
Spar, breaking weight of, 449
Spectra, rhythmical group of hydrogen lines in stellar, 85
"Spirit" slate trick, 439
Squares : magic, 42, 70, 114, 156, 202, 244, 287, 309, 332
  nasik, 162, 181, 202
Stand for telescope, 115
Staple-driver, W. and R., 257
Star in Auriga, new, 575
Static electrical motors, 367
Stephenson's sundial, 358
Students : chemistry for, 54, 190, 303, 344, 386, 544
  geology for, 26, 83, 126, 170, 212, 255, 277, 364, 408, 478
  microscopy for, 125, 146 167, 191, 232, 257, 299, 322, 343, 363, 387, 410, 432, 455, 477, 499, 531, 547, 567
Sundial : 418
  making out of a single piece of paper, 309
  Stephenson's, 358
Swell pedal, balanced, 313, 335
Switch for charging storage batteries from arc circuits, 484

TAP-HOLDER, safety drill and, 329
Telegraph, single needle, 291
Telegraphing without wires, Edison's method of, 525
Telephone and bell connections, 229, 269, 290
Telephonic apparatus, Howard's improved, 326
Telescope : angle of view of, 318
  gauge, 577
Telescope : stand for, 115
Tempel-Swift comet, 350
Temperature indicator, electrical, 313
Theory of Wimshurst machine, 327
Tiles, valley and hip, 116
Tin, recovering from waste, 215
Tires : for cycles, Pugh's cushioned, 81
  pneumatic, 200
  welding, 460, 512
Tool-chest and how to make it, 368
Toolholder, Scotia, 93

Tools, handy, 87
Triangle, 339
Trick, "spirit" slate, 439
Trigonometry, distance by, 530
Tube, steel, and casting, 340
Twist drills, grinding, 396

URANUS, path of, 549

VACUUM pump, 200
Valley and hip tiles, 116
Vendelinus, by T. G. Elger, 465
Ventilator, Boyle's improved air-pump, 568
Venus and Jupiter, conjunction of, 506
Violin : dimensions of a Guarnerius, 466
  how to make a, 6, 52, 107, 149
  making, 419, 510, 550
  novelty in construction of, 310

WATER indicator, 556
Water-motor, improved, 482
Welding tires, 460, 512
Wheatstone bridge, 473
Wheel-cutting, 470
Wheelwrights, clamp for, 484
Wimshurst : alternating influence machine 310
  machine, curious experiments with the, 267
Windmill, improved, 547
Wire, broken electric, 269
Wires, Edison's method of telegraphing without, 525
Wolf's comet, path of, 5, 105
Work, good, and good ways of doing it, 153, 587
Wrench, carriage, champion, 129

ZITHER, Hicks' novel, 526

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August 28, 1891.

THE ENGLISH MECHANIC

AND WORLD OF SCIENCE.

THE EXPIRATION OF THE MICROPHONE PATENT.

By F. C. ALLSOP.

Author of "Telephones: their Construction and Fitting," "Practical Electric-Bell Fitting," "Electric-Bell Construction," &c.

ON July 30th last expired (no doubt deeply lamented by certain members of the legal profession) our old friend the Edison patent No. 2909, 1877, the plaintiff in so many actions for infringement during the last ten or twelve years. This patent ets free the microphone transmitter, and knocks away the last support of the telephone monopoly. Not that the expiration of this atent can be considered of so much importance as that of its companion on Dec. 9 f last year, for although the microphone onsiderably increases the loudness of the peech, yet the speaking of two *well-made* eceivers (such as the Ader or double-pole ell) is all that is required for short lines up two or three miles, and the majority of rivate telephone lines are considerably horter than this. We can transmit speech etween two places by means of receivers; ut not so with microphones only. A icrophone, moreover, introduces additional mplications into a telephone instrument, ore points at which faults are likely to ppear, besides increasing the cost, so that is exceedingly doubtful if much advantage gained by employing one except on long nes.

The Edison patent, just expired, can ightly be called *the* microphone patent, eing that it liberates all the different parts essary to make an efficient microphone nsmitter; and though there are three maining unexpired patents (the Blake, Hunnings, and Crossley) to which importance is usually attached, yet these have erence almost wholly to special forms of, and methods of supporting, certain parts. The recent advertisement inserted in the chnical papers by the National Telephone Co. with reference to the expiration of Edison's patent must have appeared inapplicable to many. The advertisement parently "pooh-poohed" the expiration Edison's patent, and placed undue importance on the Blake, Hunnings, and ossley, a statement which, considering the mpany have fought all actions for infringement on the former patent, is somewhat tradictory. The professed desire of the ectors to warn the public from the use of se instruments, or "instruments constructed in colourable imitation thereof" (to ote the advertisement), had apparently the different object of attempting to frighten by a game of bluff those not versed in telephone matters from using instruments other than the company's make. The impression obtained by a perusal of Edison's specification scarcely accords with that given by the advertisement, and it is the intention of the writer to submit this specification, together with those still in force (the Blake, Hunnings, and Crossley) to some analysis, with a view to point out what is open for and what is barred from public use, and afterwards to describe the construction of an efficient form of microphone that is quite clear of, and may be used without fear of infringing, these last-mentioned patents.

Edison's Specification, No. 2909, July 30th, 1877.

The most important points liberated by the expiration of this patent are contained in the second claim, which runs as follows:—"In an instrument for transmitting electric impulses by sound, the combination with a diaphragm or tympan of an electric tension regulator for varying the resistance in a closed circuit substantially as set forth." The term "electric tension" regulator the inventor tell us he applies to "the small bunches, tufts, or discs of semi-conducting elastic fibre and an intermediate conducting or semi-conducting material, which is more or less compressed by the vibrations of the diaphragm, and the electric current rises in tension as it is compressed or lessens as the fibre expands." The inventor further adds that "the fibre is rendered semi-conducting by being rubbed with plumbago, soft metal, or similar material." It was this claim for the combination with a diaphragm of electric tension regulators that made it impossible to devise a battery transmitter free from infringements while this patent was in force, since this is the very essence of the instrument, and with the very wide definition of a diaphragm, practically covered the whole field. In the specification various forms of the tension regulator are shown, some being mounted on rigid backstops, and others on adjustable springs. Reference is made to the importance of the circuit not being broken to get satisfactory results, for, on page 5, the inventor says: "I find it is not practicable to open and close the line circuit in instruments for transmitting the human voice; the circuit to line must be always closed, and the transmission be produced by a rise and fall of electric tension resulting from more or less resistance in the line." In cases where an induction coil is used, of course, the words local circuit must be substituted for "circuit to line."

Speaking of the construction of the diaphragm, Edison mentions that he uses many materials, such as metals, horn, vellum, celluloid, ivory, &c., but gives the preference to mica, in that it is almost entirely free from any resonant action, and will respond, "when secured at its edges," with the greatest accuracy to the sound vibrations. This, therefore, frees all forms of diaphragms fixed at their edges.

The Edison specification contains numerous illustrations, but perhaps the most important one is Fig. 10, which shows a transmitter with a diaphragm coated with platina foil, against which presses a spring, the point of which is faced with compressed plumbago, the spring being fitted with an adjusting screw. One connection is made to the diaphragm, and the other to the spring with the plumbago point. When the diaphragm vibrates, says the inventor, it causes a greater or lesser pressure on the plumbago point, and "as the tension regulator of plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak." Two springs are shown in the figure in conjunction with a special way of connecting the battery; but take away the second superfluous spring (the instrument will act equally as well), and we have a combination very much resembling the Blake microphone.

Fig. 24 of the specification shows the method of connecting up the transmitter with an induction coil, the transmitter being in the primary and receiver in the secondary windings after the manner now almost universally employed.

At the foot of p. 5 reference is made to a multiplicity of contacts, for, says Mr. Edison, "if there are several electrodes opposite to each other, and insulated except at their ends, and the circuit be led from one to the other, so that the current passes through all the electrodes in succession, the rise and fall of electric tension will be promoted because the smallest vibration of one set of electrodes is multiplied by the number of places at which the metallic circuit is interrupted or varied." Here we have substantially the "compound" or Crossley microphone.

It is interesting to note that on p. 4, Edison makes mention of the well-known difficulty in getting a satisfactory reproduction of the sibilants, and suggests as the cause that hissing sounds are projected downwards after leaving the mouth, and thus, by escaping the mouthpiece, fail to take full effect on the diaphragm. As a remedy he proposes a special form of mouthpiece, in the bottom lip of which is a hole

VOL. LIV.—No. 1879.

against the edges of which the downward sound-waves are directed. It seems more probable to the writer, however, that the bad transmission of the sibilants is due more to the complexity and rapidity of their vibrations, seeing that the microphone of to-day fails to satisfactorily transmit them.

To sum up, then, the various parts of the battery transmitter set free by the expiration of Edison's patent may be recapitulated as follows:—

1. The ordinary microphone diaphragm, whether of metal, wood, &c., so long as it is secured at its *edges*.

2. The use of a variable resistance, acting by the variation of pressure between two contact surfaces, either conducting or semi-conducting, one contact of which is mounted on the diaphragm, and the other attached to an adjustable back-stop, or, better still, mounted on the end of a spring the pressure of which can be adjusted by a set-screw.

3. The combination of microphone, battery, and induction coil, the one circuit consisting of the microphone, battery, and primary windings, and the other of the receivers, line, and secondary windings.

Prof. Hughes's Discoveries.

In May, 1878, some ten months after the filing of Edison's patent, Prof. Hughes made public certain facts which were the means of bringing about a vast improvement in telephone transmitters. These were the discovery of the microphonic principle and the excellent results to be obtained by the use of *hard* carbons. It was considered, however, that Edison in his patent had anticipated the discoveries of Hughes, seeing that mention was made in his specification of variable contacts and lampblack, or soft carbon. Thus by the expiration of Edison's patent, all the discoveries made by Hughes (and from his various papers, it would appear that he had experimented with the microphone in innumerable forms) are thrown open free for public use. Although the action of Hughes' microphone is commonly held to be somewhat different from that of Edison's carbon transmitter, yet at first sight it is exceedingly difficult to see where the one begins and the other ends, the two instruments having so much in common. The microphone is a loose contact in a circuit which is subjected to great variation in resistance when set into vibration; but what is Edison's transmitter but a loose or imperfect contact? True in the Edison specification the variation of the resistance of the tension regulator is pointed out as being due more to the compression of the semi-conductive substance, but nevertheless it is at the point of contact that the greatest variation takes place. As we have seen, Edison was fully alive to the necessity of the circuit not being broken while speech is being transmitted, and this is also of vital importance in respect to the microphone. In both instruments the transmission of speech to be satisfactory must be produced by a rise and fall of electric tension brought about by more or less resistance in the circuit, resulting from greater or lesser intimacy of contact.

Hughes, in his papers, makes mention of a "multiplication of transmitting contacts both in series or parallel"—a fact that cannot but have a serious bearing on the validity of all patents for a multiple contact microphone.

By Prof. Hughes' disclosures, then, we have thrown open for public use (in addition to the points released by the Edison patent) his discoveries with regard to the microphone and the use of hard carbon and multiple transmitting contacts in parallel, and one is, of course, at liberty to combine and interchange Hughes' and Edison's ideas. This gives ample material for the construction of an efficient microphone transmitter that will not infringe the three patents (owned by the National Telephone Co.) still in force—viz., the Blake, Hunnings, and Crossley, and which patents we will now proceed to investigate.

Hunnings' Specification (No. 3647), Sept. 16th, 1878.

This patent, the first in order to expire, has not nearly so voluminous a specification as the Edison. The inventor first proceeds to describe in detail, with reference to a very clear illustration, his well-known form of microphone, consisting of powdered carbon between two thin metal diaphragms. After drawing attention to the fact that he wishes it to be understood that he lays no claim to carbon in the solid or consolidated form, "as exemplified in the well-known Hughes microphone or Edison carbon telephone," he concludes by indicating the new features of his invention, which are summed up in two claims, as follows:—

1. "The use of finely-powdered carbon or like conductor (preferably oven-made coke prepared as described) in a loose and free state (not compressed or consolidated in any way or combined with foreign material) as a means of varying the resistance of a telephonic circuit by the vibrations of a thin metallic or metal-covered diaphragm inclosing it, controlled by the sound-waves impinging upon it."

Fig. 2. "A telephone transmitter consisting of a layer of finely-divided carbon or similar conducting material, preferably oven-made engine coke placed in a loose and free state between the thin metallic or metal-covered diaphragms in a suitable case, as, and for, the purposes described."

Now, although there appears very little reason to doubt that the Hunnings microphone in its most efficient form is effectually covered by this patent, and the patent is good, yet it is worthy of note that the inventor only mentions (and this most persistently) *thin* diaphragms. These diaphragms, he further says, are *metallic* or *metal-covered*. Now the Hunnings transmitter will work almost as well with a *thick wooden* diaphragm, the inner surface of which is pasted with tinfoil. This would therefore seem to evade the patent, or, at least, raise another hard nut for the legal profession to crack—viz., What is a *thin* diaphragm? The metal-covered diaphragm can also be eluded by using instead of the metallic covering a short pillar with a large, flat head projecting from the centre of the diaphragm into the powdered carbon. It is true, however, that in line 25 Hunnings says, in describing his diaphragm, "or other material," but it has frequently been pointed out that the other material he had in view must have been metallic in its nature, since he makes no mention of a special form of electrode (as described above) such as is necessary for a non-conducting diaphragm.

What strikes one most on first glancing at at Hunnings' illustration, is that the shape he has given his transmitter scarcely accords with that which in actual practice has been found to give the best results. He shows a large diaphragm with but little depth of powdered carbon, whereas a smaller diaphragm and considerable thickness of powdered carbon will be found more effectual. Carbon in the form of small balls with highly-polished surfaces has also been found to be the best material to use between the diaphragms, the mixture described by Hunnings having a tendency to "cake."

Blake (No. 229, Jan. 20, 1879).

The Blake transmitter is protected in this country in the name of William Robert Lake, it being a communication from abroad, and although the instrument gives evidence of much originality, yet a combination of Edison's ideas with Hughes's discoveries is clearly traceable; in fact, on close investigation it bears, it will be seen, a remarkable resemblance to Edison's, Fig. 10. Its novel points are the supporting of the diaphragm by spring pressure, the affixing of the second electrode—not as Edison does on the diaphragm, but to a small independent spring—and a special form of adjusting lever. A fourth claim is made for supporting the back electrode, or carbon button, on a spring; but in the face of Edison's specification it is difficult to see how such a claim could be substantiated.

Commencing with a statement as regards his method of supporting the diaphragm, the inventor passes on to the transmitting contacts, and remarks: "As heretofore constructed, one of the electrodes is held in a fixed position, while the other, being free to move to some extent, is pressed against it with greater or less force by the vibrations of the diaphragm to which it is connected." Such a state of things, the inventor avers, is not conducive to obtaining the best results, for the instrument must be adjusted with great care and delicacy, and when so adjusted is liable to lose its adjustment on the first abnormal vibration of the diaphragm. This statement, although true in regard to some forms shown in Edison's specification, does not apply to Fig. 10, where the back contact is supported on a spring. Continuing, the inventor proceeds to describe his well-known microphone with reference to three illustrations which, as indicating that the instrument must have been pretty well perfected before being patented, differ but slightly from the Blake transmitter of to-day. The method of supporting the diaphragm is explained, it being kept in position merely by the pressure of two "gloved" springs from the back. Passing on to the mounting of the first electrode or platinum contact, the inventor says that this may be attached directly to the diaphragm, but that he prefers to support it independently on a light spring, "for it not unfrequently happens when the intermediate electrode is attached directly to the diaphragm, that a too rapid vibration of the diaphragm or some other disturbance in its vibrations will throw the outer electrode out of contact with the intermediate electrode, and thus break the circuit; but in my construction such irregular vibrations of the diaphragm will separate the diaphragm from the intermediate electrode rather than separate the two electrodes from each other, and the circuit would not be broken." The supporting of the carbon electrode is next described, which, we are told, is weighted for the purpose of resisting by its inertia the vibrations of the diaphragm. This second electrode, the inventor says, may be of metal, but better results are obtained from hard-pressed carbon, such as is used for electric-lighting.

After describing the special form of adjustment, the specification concludes with the following claims:—

1. "The method herein described for holding the diaphragm of a telephone by means of springs pressing against one of its surfaces."

2. "A spring forming or carrying one electrode of the circuit of a telephone, and constantly pressing against the other electrode and diaphragm to maintain the required initial pressure between the electrodes, and yield to the movements of the diaphragm substantially as described."

3. "The adjusting lever for regulating the tension of the spring which carries one of the electrodes, and the initial pressure between the two electrodes and against the diaphragm substantially as described."

4. "The combination of the two electrodes by means of springs acting against each other substantially as described, to maintain the electrodes in contact when forced away from the diaphragm."

5. "The yielding weight connected with the movable electrode to resist the movement of the diaphragm, and modify by its

inertia the variation of pressure between the two electrodes substantially as described."

As regards the first of these claims, this, of course, covers the mounting of the diaphragm by springs; but since diaphragms held at their edges are just as efficient, it is of no consequence. The second is apparently intended to cover the form of microphone with one electrode on a spring and the other attached to the diaphragm; but this form is released by the expiration of Edison's patent. So far as this claim relates to the second electrode being also on a spring, it is undoubtedly new. The third is for the special form of adjusting lever, which is certainly novel and efficacious. Nevertheless, the mechanic who could not devise a dozen others equally as good may reasonably be adjudged to have mistaken his vocation. Claim 4, for the combination of the two electrodes on springs, Blake is undoubtedly entitled to, this being one of the main features of his invention. In the 5th claim, however, exception must be taken, for although Edison does not make mention of specially weighting his spring carrying the plumbago button, nevertheless it follows, as a matter of course, for the simple reason that it would be impossible to construct such a button without weight. Edison makes no limit as to the size of the button, and the bigger the button the more weight it must necessarily have, and it does not require a button of very large size to give the requisite weight to get satisfactory results.

Crossley (No. 412, Feb. 1st, 1879).

Crossley's claim is for a compound microphone, which he defines as one having three, four, or more carbon pencils, with six, eight, or more points of contact, as differing from the ordinary microphone with only one pencil and two points of contact, to which he graciously lays no claim.

In the body of the specification he describes the construction with reference to several figures of his well-known and excellent four-pencil microphone, and concludes with two claims. The second of these is for "the arrangement, construction, and employment of compound microphones" . . . . "substantially as described with reference to the accompanying drawing," a claim to which no one can take exception, and to which the inventor is justly entitled. Claim No. 1, however, is of a very wholesale character, and covers all forms of compound microphones "having three, four, or *more* carbon pencils, with six, eight, or *more* surfaces touching each other," and also compound microphones with thin metal plates instead of carbon pencils, and whether mounted on parchment, wood, or any other suitable substance." In the face of what Edison has shown in his specification and Hughes makes mention of in his papers with regard to multiple contacts, it is somewhat surprising that such a claim should have been made.

The specification itself is very far from being a masterpiece, for matter is introduced into the final specification that is not even foreshadowed in the provisional—a fact which alone is liable to invalidate the patent. To quote Crossley's own words, he says, "I employ an ordinary microphone," and throughout the entire provisional not one word is mentioned about compound microphones, nor so much as a hint let drop that he employs anything but an ordinary microphone. The "ordinary" microphone had been devised by Edison and by Hughes a year or two before. It is only in the complete or final specification that any light is thrown on the matter, when the inventor substitutes the word "compound" for "ordinary." He then proceeds to define a compound microphone and also an ordinary, to which latter he repudiates all claim, which, to say the least of it, is somewhat contradictory.

Taking into consideration, therefore, this extraordinary want of sympathy between the provisional and complete specifications, with the fact that a multiplication of transmitting contacts had been previously mentioned by both Edison and Hughes, it is extremely doubtful if the Crossley specification would "hold water." Even were this not so, however, all claim to a two-pencil microphone is repudiated, and with two carbon pencils we shall now proceed to show how a microphone transmitter can be constructed of the speaking capabilities of which no one need be ashamed.

(*To be continued.*)

PRACTICAL PHOTOGRAPHY FOR AMATEURS.*

By S. R. Bottone.

§ 33. The process about to be described, although very much more sensitive than any previously noticed, is not by any means one of the most sensitive. My reason for describing it here is because it closely resembles in manipulatory details the simple "printing" processes already considered, and leads us in a gradual and natural manner to the study of that most interesting department of photography known as *development.* This process is known as the "Calotype," and was published by Fox Talbot in 1840, and soon received improvement in the hands of Sir John Herschel, Mr. Cundell, Robert Bingham, and Gustave Le Gray. The student will need, for this process, the following articles—viz.:—Nitrate of silver (crystallised), glacial acetic acid, iodide of potassium, bromide of potassium, gallic acid, white wax, and hyposulphite of soda.

The paper on which he prepares the sensitive medium should be as before mentioned (§ 7), that known by photographic dealers as *plain unsalted paper.* This is sold in sheets about 22in. by 18in. On examining carefully one of these sheets before a well-lighted window, it will be noticed that one side is smoother than the other, and shows the wire marks less. *This* is the right side, and the wrong side should be lightly marked with a pencil, to distinguish it. The operator should then cut a sheet into square pieces, a little smaller than the opening in the carrier of the dark frame of his camera, which, if he has procured a ¼-plate instrument, will be 4¼in. by 3¼in. He will also procure a sheet of perfectly flat glass to fit into the carrier, which will serve as a support for the paper at a later stage of the process. The next step will be to "iodise" the paper. To this end the student will make up the following solution, which can be kept in a stoppered bottle in a dark cupboard, when not in use, labelled "Iodising solution for calotypes."

Water	2oz.	or 1,000 parts.
Iodide of potassium	48¾gr. or	50 parts.
Bromide of potassium ..	24gr. or	25 parts.

When the salts have dissolved, he will pour the solution into a square, shallow, porcelain dish (procurable from any dealer in photographic goods) to the depth of about ½in., and will float as many sheets of the plain paper (right side downwards) on the surface of the solution as he may require. The same precautions as to avoidance of air-bubbles, &c., must be taken, as in the preparation of the paper described at § 7, and the operator will be wise if, before floating the sheets on the liquid, he mark the wrong side of each sheet with a cross at one corner. As each sheet shows by its curling and uncurling that it is saturated with the solution, it must be removed from the dish and hung up by one corner to dry. The operation of iodising and drying the paper may be performed in full daylight, as at this point the paper is not sensitive. When the sheets of paper are dry they should be placed between the leaves of a book made of clean unused blotting paper, until wanted for use. If stored in a dry place they will keep for any length of time, and improve, rather than deteriorate, by keeping.

§ 34. The next operation is to convert the insensitive mixture of potassium iodide and bromide into the sensitive silver haloid salts; and as the sensibility of the paper is greatly enhanced by the presence of free nitrate of silver, it is necessary that this salt shall be in excess. For this purpose, the operator makes up, in a perfectly clean, stoppered bottle, which he will label "Sensitising Solution for Calotypes," the following mixture:—

Crystallised nitrate of silver	80 grains, or	88 parts.
Water, rain or distilled....	2oz.,	or 1,000 parts.
Glacial acetic acid........	1½drms., or	93 parts.

The mixing can be performed in daylight, but the mixture should afterwards be kept in a dark place; otherwise it blackens round the sides of the bottle very considerably. This mixture having been made up, the operator will proceed to make up in another bottle a saturated solution of gallic acid; this means gallic acid, dissolved in water (rain or distilled), as much as the water can take up. It is well, indeed, to always have an excess of gallic acid; and only pour off the clear solution for use. As the solution of gallic acid does not keep well, it is not advisable to make up a large quantity at a time, and unless large pictures are to be taken, more than two ounces need not be prepared at one time.

§ 35. This solution of gallic acid, which should be labelled "Developing solution for calotypes," consists of:—

Gallic acid..............	4½gr. or	10 parts.
Distilled (or rain) water..	1oz.	or 1,000 parts.

§ 36. When the above solutions have been prepared, the operator proceeds into his dark room (see § 29), and having closed all the doors, and left only the yellow screen over the window, he proceeds to sensitise a sheet of paper in the following mode: Pouring out the sensitising solution in a perfectly clean square glazed dish, he floats a sheet of iodised paper on it, unmarked side downwards. The greatest care must be taken that none of the fluid touch the paper, as it would inevitably produce a stain. Whilst the paper is on the solution he takes a sheet of clean blotting paper of the same size as the sheet of glass which fits into the carrier of the dark frame of his camera, and having placed it on this said piece of glass, he wets it all over with clean water, so as to cause it to adhere to the glass, and leave the surface quite wet. He then returns to the dish, in which lies the sheet of paper being sensitised, and taking up the sheet of paper cautiously, by means of a perfectly clean pair of whalebone forceps (kept for this purpose alone), he draws it along the edge of the dish, to remove superfluous moisture; and having held it for a few seconds over the dish to drain, he places it, with its dry side downwards, squarely on the wet blotting-paper which is adhering to the square of glass. The square of glass, with its blotting-paper pad and sensitive paper adhering to it, should now be raised on edge, and allowed to drain on a piece of blotting-paper, and when drained, placed with its sensitive side facing the sliding shutter in the dark frame, or "back" of the camera; the lifting lid of the back having been closed and fastened down by the side-clips, the operator leaves the dark frame in the operating room, and proceeds to focus some suitable view with his camera.

§ 37. Let us suppose that he elects to take a view of the church opposite his window. He places his camera in a horizontal position, and, having uncovered the lens, he selects that portion of the church (or other view) to which he desires to give greater prominence, and by moving his camera on the stand, gets *that* portion on the centre of the ground-glass screen. Covering his head, as indicated at § 31, he proceeds to rack the lens, or slide the body of his camera, until the image shows with the greatest possible distinctness and sharpness—every brick, every tile, every leaf being perfectly crisp and distinct. He then screws the camera body firm, so that no alteration in his focus should take place. Returning now to the dark room, he takes the dark frame containing his sensitive paper, and proceeding to the camera he examines for the last time the picture on the screen, to insure that all is properly in focus. He then replaces the cap on the lens, lifts out the ground-glass screen, being most careful in so doing not to derange the position of the camera, and places in its stead the dark frame with the *sliding shutter facing the lens.* Holding the frame firmly in position with his left hand, he draws up the sliding-shutter with his right until it reaches the top of its travel, and bends it over at its hinged portion. The prepared paper is therefore now uncovered, with its sensitive surface facing the lens. Now comes the critical portion of the operation, the *exposure,* the success of which depends so much on the judgment of the operator.

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* All rights reserved.

§ 38. The exposure proper consists simply in removing the cover from the lens, so as to allow the rays of light proceeding from the objects to be copied to enter the lens and fall upon the sensitive surface, and then closing the lens, when the light has had sufficient time to effect its work. To secure a good exposure, the student will notice the aspect of the view to be copied. If the sun is shining on the object, an exposure of 50 or 60 seconds will be sufficient; if there is no sun, but the objects are light in colour and well lighted, the exposure should be about two minutes (120 seconds); but if the weather be at all dull, or the view of a dark or sombre character, as much as twenty minutes' exposure may safely be given before the cap be replaced on the lens.

§ 39. The exposure having been duly given, and the cup replaced on the lens, the operator closes the sliding shutter of the dark frame, being careful that it goes right home, and withdrawing the dark frame from the camera, returns to the dark room, where, having shut off all light except the deep yellow, he proceeds to develop the picture. For this purpose he pours into a perfectly clean glass measure 2dr. of the gallic acid developing solution (§ 35). He then opens the dark frame by the hinged lid, and takes up the glass sheet with adhering papers, and lays it, paper side uppermost, on the rim of a wineglass standing level on the table. He then proceeds to pour sufficient developing solution from the glass measure over the surface of the sensitised paper to cover it, and if he finds any difficulty in getting it to flow equally all over, he must coax it by means of a piece of perfectly clean glass tube, drawn over the surface. He will notice that, although little or no trace of a picture was visible on the surface of the paper when removed from the dark frame, yet very soon, under the influence of the developer, an image begins to show itself, and the sky depicting itself in *black*, the dark portion of the view remaining quite light, and, in fact, the whole picture appearing with the lights and shades just the reverse to what they appear in nature. When it is seen that every detail is fully out, and that the sky and other fully-lighted objects appear quite dark (nearly black), the development may be considered at an end; when the action of the developing solution should be stopped by removing the picture from the pad and glass, and throwing it into a basin of clean cold water. Here the back of the paper may be gently rubbed to remove any adhering gallic-acid stains, and then the picture must be finally *fixed* by immersion in the ordinary *fixing solution*, as described for ordinary silver prints. At this point ordinary white light may be admitted into the dark room. The fixing must be continued until all traces of yellowness in the light portion of the picture (due to the mixed iodide and bromide of silver) be entirely removed. The picture must then be allowed to stand in running water until all the hyposulphite has been eliminated.

ASTRONOMICAL NOTES FOR SEPTEMBER, 1891.

The Sun.

Day of Month.	Souths.	At Greenwich Mean Noon.		
		Right Ascension.	Declination.	Sidereal Time.
	h. m. s.	h. m. s.	° ′ ″	h. m. s.
1	11 59 56·11 A.M.	10 41 23	8 18 9 N	10 41 27·06
6	11 58 19·13 ,,	10 59 29	6 27 39 ,,	11 1 9·83
11	11 56 36·73 ,,	11 17 29	4 34 30 ,,	11 20 52·60
16	11 54 51·07 ,,	11 35 26	2 39 25 ,,	11 40 35·37
21	11 53 4·78 ,,	11 53 23	0 43 4 ,,	12 0 18·14
26	11 51 20·94 ,,	12 11 22	1 13 54 S	12 20 0·90

The method of finding the Sidereal Time at Mean Noon at any other station will be found on p. 367 of Vol. LII.

The Sun should be watched for spots, faculæ, &c., on every clear day, as they are now becoming both fine and numerous.

At 8h. 13m. a.m., on September 23rd, the sun is said to enter Libra, and Autumn is supposed to commence. He is really at this instant between β and η Virginis, about one-third of the whole distance from the last-named star. This is the theoretical date of the Equinox; but the closest approximation to the equality of day and night in London will occur on the 25th, when the Sun will be above the horizon for 11h. 59m., and, of course, 12h. 1m. below it. Late in the month the Zodiacal light may be seen in the East before sunrise.

Occultations of (and Near Approaches to) Fixed Stars by the Moon.

Day of Month.	Star's Name.	Magnitude.	Disappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.	Reappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.
			h. m.		°	°	h. m.		°	°
11	B A C 5907	6½	5 19 p.m.	Dark	114	121	6 38 p.m.	Bright	269	264
15	B A C 7550	6	†10 29 ,,	NNW	335	330				
17	τ^1 Aquarii	6	12 39 a.m.	Dark	106	90	1 23 a.m.	Bright	191	168
17	τ^2 Aquarii	4	1 42 ,,	Dark	69	44	2 43 ,,	Bright	230	198
22	53 Tauri	6	10 9 p.m.	Bright	93	133	11 0 p.m.	Dark	224	266
23	κ^2 Tauri	6½	†1 44 a.m.	NNW	337	12				
24	118 Tauri	6	†4 36 ,,	N by W	347	359				
27	λ Cancri	6	4 56 ,,	Bright	21	60	5 14 a.m.	Dark	354	32

† Near approaches. An illustrated explanation of the above table will be found on page 367 of Vol. LII.

Jupiter's Satellites.

Day of Month.	Satellite.	Phenomenon.	H.	M.	S.	Day of Month.	Satellite.	Phenomenon.	H.	M.	S.	Day of Month.	Satellite.	Phenomenon.	H.	M.	S.
1	II	Sh E	8	20	P.M.	10	III	Tr E	10	51	P.M.	21	I	Oc D	11	53	P.M.
1	II	Tr E	8	31	,,	10	III	Sh E	11	25	,,	22	I	Ec R	2	33	45A.M.
3	*IV*	*Tr I*	6	58	,,	12	IV	Oc D	12	23	A.M.	22	I	Tr I	9	2	P.M.
3	*III*	*Sh E*	7	25	,,	13	I	Oc D	3	42	,,	22	I	Sh I	9	28	,,
3	*III*	*Tr E*	7	35	,,	14	I	Tr I	12	52	,,	22	I	Tr E	11	20	,,
3	IV	Sh E	10	19	,,	14	I	Sh I	1	5	,,	22	I	Sh E	11	47	,,
3	IV	Tr E	10	33	,,	14	I	Tr E	3	10	,,	23	II	Tr I	12	30	A.M.
5	*I*	*Sh I*	4	42	A.M.	14	I	Sh E	3	24	,,	23	II	Sh I	1	22	,,
5	*I*	*Tr I*	4	43	,,	14	II	Oc D	3	24	,,	23	*II*	*Tr E*	3	21	,,
6	I	Oc D	1	58	,,	14	I	Oc D	10	8	P.M.	23	*I*	*Oc D*	6	19	P.M.
6	I	Oc R	4	16	,,	15	I	Ec R	12	38	32A.M.	23	I	Ec R	9	2	37,,
6	I	Tr I	11	9	P.M.	15	I	Tr I	7	18	P.M.	24	*I*	*Sh E*	6	16	,,
6	I	Sh I	11	10	P.M.	15	I	Sh I	7	34	,,	24	II	Oc D	6	45	,,
7	II	Oc D	1	11	A.M.	15	I	Tr E	9	36	,,	24	II	Ec R	10	31	51,,
7	I	Tr E	1	27	,,	15	I	Sh E	9	52	,,	25	III	Tr I	2	5	A.M.
7	I	Sh E	1	29	,,	15	II	Tr I	10	13	P.M.	28	*IV*	*Oc R*	6	26	P.M.
7	II	Ec R	4	3	27,,	15	II	Sh I	10	43	,,	28	IV	Ec D	8	6	53,,
7	I	Oc D	8	24	P.M.	16	II	Tr E	1	4	A.M.	28	III	Ec R	9	20	7,,
7	I	Ec R	10	43	25,,	16	II	Sh E	1	36	,,	28	IV	Ec R	11	48	19,,
8	I	Tr E	7	53		16	I	Ec R	7	7	22P.M.	29	I	Oc D	1	38	A.M.
8	II	Tr I	7	57		17	II	Ec R	7	56	20,,	29	I	Tr I	10	47	P.M.
8	I	Sh E	7	58	P.M.	17	III	Tr I	10	47	,,	29	I	Sh I	11	23	,,
8	II	Sh I	8	5	,,	17	III	Sh I	12	0	,,	30	I	Tr E	1	5	A.M.
8	II	Tr E	10	48	,,	18	III	Tr E	2	8	A.M.	30	I	Sh E	1	42	,,
8	II	Sh E	10	58	,,	18	III	Sh E	3	26	,,	30	*II*	*Tr I*	2	47	,,
10	III	Tr I	7	31	,,	21	I	Tr I	2	36	,,	30	I	Oc D	8	4	P.M.
10	III	Sh I	7	59	,,	21	I	Sh I	3	0	,,	30	I	Ec R	10	57	57,,

Ec, Eclipse; Oc, Occultation; Tr, Transit of Satellite; Sh, Transit of Shadow; D, Disappearance; R, Reappearance; I, Ingress; E, Egress. The printing of a phenomenon in *italics* indicates that its visibility is rendered doubtful, either by the brightness of the twilight, or by Jupiter's proximity to the horizon.

The Moon

Is New at 8h. 16·0m. in the morning of the 3rd, and enters her First Quarter at 52·9 minutes before Noon on the 11th. She will be Full at 5h. 3·9m. a.m. on the 18th, and enter her Last Quarter at 11h. 7·2m. on the night of the 24th. High Tides (notably in the neighbourhood of the Equator) may be looked for at and about the time of Full Moon.

Day of Month.	Moon's Age at Noon.	Souths.
	Days.	h. m.
1	27·8	10 46·1 a.m.
6	3·2	2 13·6 p.m.
11	8·2	6 3·3 ,,
16	13·2	10 55·5 ,,
21	18·2	2 28·3 a.m.
26	23·2	7 3·2 ,,

The Moon will be in conjunction with Mars (4° 5′ N. of him) at 5h. a.m. on the 2nd; with Venus at 8 o'clock the same night (Venus 3° 54′ S.); with Saturn at 11h. p.m. on the 3rd (Saturn 3° 6′ S.); with Mercury at 11h. a.m. on the 4th (Mercury 9° 42′ S.); with Jupiter at 6h. a.m. on the 17th (Jupiter 3° 45′ N.); and once more with Mars at midnight on the 30th (Mars 4° 1′ S.)

When our notes open, the Moon has not lo entered Leo, and she is travelling through th constellation until 6 a.m. on the 4th, when s quits it for Virgo. Her journey through Vir terminates at 11h. p.m. on the 7th, at whi hour she enters Libra. 48 hours later—*i.e.*, 11h. p.m. on the 9th—she has crossed Libra, a arrived at the western edge of the narrow no thern spike of Scorpio. She traverses this 13 hours, and at noon on the 10th emerges Ophiuchus. Here she remains until 11h. 30 p.m. on the 11th, when she enters Sagittari She quits Sagittarius for Capricornus at noon the 14th, and Capricornus, in turn, for Aquari at 3h. a.m. on the 16th. She completes h passage through Aquarius at 1h. 30m. a.m. the 18th. She then enters Pisces, and as s traverses that constellation arrives, at 4 p.m. the 18th, at an outlying part of Cetus, which s enters and travels through until 11h. 30m. a on the 19th, and then re-enters Pisces. Thi however, is only to plunge for the second ti into another outlying portion of Cetus at 10 a.m. on the 20th. When she finally quits Cet at 2 o'clock that afternoon, it is to emerge Aries. It takes her until 1h. a.m. on the 22 to cross Aries and enter Taurus, and she co tinues in Taurus until 6.30 p.m. on the 24th. Then she passes in Gemini, and is in Gemini until 7h. p.m. on the 26th, when she passes into Cancer. Quitting Cancer at 11h. a.m. on the 28th, she enters Leo, and is still in Leo at midnight on the 30th.

Mercury

Is an evening star at the beginning of September, but comes into Inferior Conjunction with the sun at 5h. a.m. on the 13th, after which, of course, he becomes a morning star, and, as a matter of fact, attains his greatest elongation west of the sun (17° 51′) at 9 p.m. on the 28th. He is but indifferently placed for the observer, whose best chance of detecting him with the naked eye will be before sunrise at the end of the month. His angular diameter increases from 9·6″ on the 1st to 10·4″ for a few days about the time of his inferior conjunction. After which, it diminishes again to 6·8″ by the end of September.

Day of Month.	Right Ascension.		Declination.			Souths.		
	h.	m.	°	′		h.	m.	
1	11	47·6	3	14·3	S	1	6·0	p.m.
6	11	39·5	2	28·4	,,	0	38·2	,,
11	11	24·3	0	11·2	,,	0	3·4	,,
16	11	8·4	2	56·0	N	11	27·9	a.m.
21	11	1·2	5	27·7	,,	11	1·1	,,
26	11	8·0	6	16·8	,,	10	48·2	,,

The looped path indicated in the above ephemeris lies in the confines of Leo and Virgo; but in a part of the sky destitute of any conspicuous stars.

Venus

Is nominally a morning star during the first three-quarters of September, and an evening star for the remaining quarter of the month, coming as she does into superior conjunction with the Sun at 4h. p.m. on the 18th; but she is practically invisible during the whole of September. For the benefit, however, of such possessors of powerful telescopes as may care to scrutinise a sensibly circular disc 9·6″ in diam., we give an Ephemeris of the planet.

Day of Month.	Right Ascension.		Declination			Souths.		
	h.	m.	°	′		h.	m.	
1	10	25·8	11	16·7	N.	11	44·4	a.m.
6	10	49·3	9	0·5	,,	11	48·2	,,
11	11	12·5	6	38·1	,,	11	51·7	,,
16	11	30·9	4	40·6	,,	11	54·9	,,
21	11	53 8	2	11·0	,,	11	58·0	,,
26	12	21·1	0	51·3	S.	0	1·1	p.m.

Hence it will be seen that starting from a point to the North and a little to West of ρ Leonis, Venus will traverse a considerable part of the constellation Leo, and terminate her path in Virgo. On the morning of the 8th she will be somewhat to the N. of χ Leonis, as she will be of τ Leonis on the 14th. She will be between 1° and 2° S. of γ Virginis on the 29th. Venus will be in conjunction with Saturn (of course below our horizon) at midnight on the 14th.

Mars is invisible, as, for the observer's purpose, are Uranus and Neptune. Most unfortunately, too, Saturn comes into conjunction with the Sun at 1h. p.m. on the 13th. We say "unfortunately" very emphatically, inasmuch as on the 22nd his ring disappears, and in all but the largest telescopes, the planet, were he visible, would be seen shorn of that appendage, of which the only trace left would be a narrow dark line coincident with his equator.

Minima of the Variable Star Algol

Will occur at 2h. 37m. a.m. on the 18th, at 11h. 16m. p.m. on the 20th, and at 8h. 5m. p.m. on the 23rd, as well as on other occasions when sunlight will render the phenomenon invisible.

Jupiter

Is visible during the greater part of the working hours of the night, and, but for his South Declination, would be well situated for the observer, coming as he does into opposition to the sun at 11h. p.m. on the 5th. His angular equatorial diameter decreases quite insensibly from 49·2″ at the beginning of September to 48·2″ at the end of it.

Day of Month.	Right Ascension.		Declination South.		Souths.		
	h.	m.	°	′	h.	m.	
1	23	2·1	7	46·5	12	22·6	a.m.
6	22	59·2	8	5·2	11	56·1	p.m.
11	22	56·7	8	20·5	11	34·0	,,
16	22	54·3	8	35·3	11	11·9	,,
21	22	52·0	8	49·2	10	50·0	,,
26	22	49·9	9	2·1	10	28·1	,,

It will be seen from this ephemeris that Jupiter during September will describe a short retrograde arc in Aquarius, terminating a little to the east and south of the 6th-magnitude star λ in that constellation.

Shooting Stars

May be watched for from the 3rd to the 7th inclusive; on the 15th; from the 19th to the 22nd, and again at the end of the month.

Greenwich Mean Time of Southing of Ten of the Principal Fixed Stars on the Night of September 1st, 1891.

Star.	Souths. h.	m.	s.	
Vega	7	50	32·06	p.m.
ζ Aquilæ	8	17	37·00	,,
Altair	9	2	33·77	,,
α² Capricorni	9	29	2·24	,,
α Cygni..	9	54	40·33	,,
α Cephei	10	32	50·24	,,
ε Pegasi..	10	55	37·53	,,
α Aquarii	11	16	55·29	,,
Fomalhaut	*12	8	13·84	a.m.
Markab	*12	15	54·27	,,

* Early morning of the 2nd.

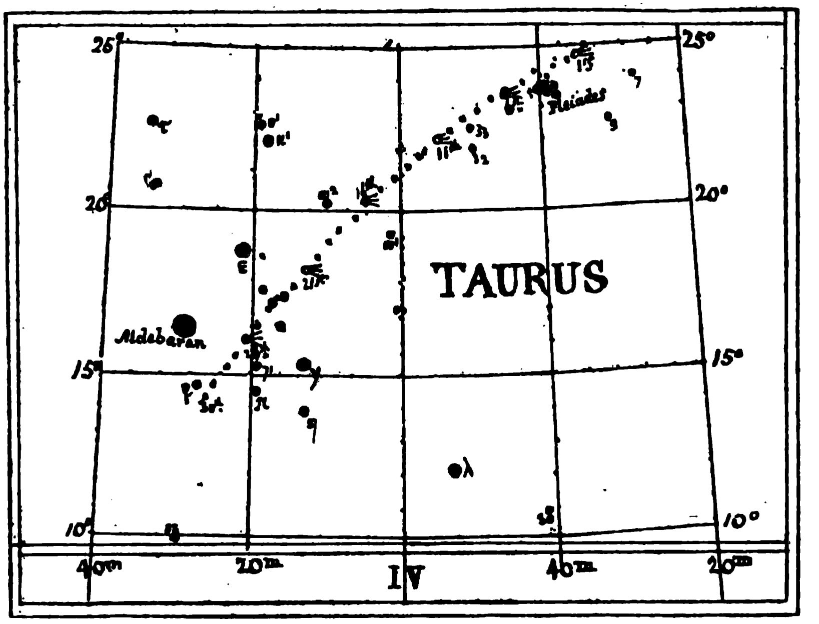
The method of finding the Greenwich mean time of Southing of either of the stars in the above list, for any other night in September, as also that of determining the local instant of its transit at any other station, will be found on p. 368 of Vol. LII.

Wolf's Comet

Continues to increase in brightness, and, as will be seen from our appended map, has now reached a region of the sky in which its proximity to fairly conspicuous stars will render its detection more easy. On the night of September 4th it will cross the Pleiades. Happily there will be no Moon, so that, if the sky be clear, this most interesting phenomenon may be watched, with sufficiently powerful instruments, to the greatest advantage. On the 24th it will enter the Hyades, and here again moonlight will not interfere with its observation. Calling its brightness at the date of its discovery 1, it will be represented by 7·83 on September 1st, and by 11·08 on the last night of the month.

Day of Month.	At Berlin Mean Midnight.			
	Right Ascension.		Declination. North.	
	h.	m.	°	′
1	3	33·7	24	51·4
6	3	44·8	23	32·4
11	3	55·1	22	0·3
16	4	4·6	20	15·3
21	4	13·1	18	17·7
26	4	20·6	16	8·2

Path of Wolf's Comet during September 1891



HOW TO MAKE A VIOLIN.*

By W. Pickering.

Introductory.

It is with considerable pleasure that I recently received a request from the Editor of the English Mechanic to contribute a series of articles on violin construction. In back volumes of "our" journal, there have been a number of fragmentary queries and answers on the subject of violins, and some years ago the Rev. W. Blow, and several others, wrote frequently on the adjustment of bridges and soundposts, on varnish, and other similar points which were very interesting to the amateur. Nothing, however, of a connected character has appeared in the pages of the English Mechanic, and I, therefore, readily agreed to give such hints as a love of the subject, and a somewhat close study, coupled with a great number of experiments, might inspire.

In these studies it was a natural consequence that I should annex as much as possible of the literature of the subject; but from a perusal of the somewhat numerous collection of works "On the Violin" it was apparent that the bulk of them related less to the constructive than to the historical and descriptive. The latter branches are, of course, exceedingly interesting to all who are smitten with the fascinating fancy for old fiddles, and are indispensable to those who wish to conduct the study from a connoisseur's point of view. They are, however, but of slight use in acquiring skill in judging, or naming at sight the almost innumerable makers, and also *manufacturers*, of the instrument. Good books, attractively written, and accompanied by the best illustrations which the draughtsman or photographer can supply, would be of little value without actual observation. The handling and minute inspection of authenticated instruments—supposing the individual to be possessed of fairly good perceptive faculties and a retentive memory for contour, outline, and colour—is absolutely necessary for arriving at a condition of being able to recognise a particular make or school when one sees it, and an inspection of a dozen or twenty good instruments has a greater educational result than the perusal of a thousand treatises.

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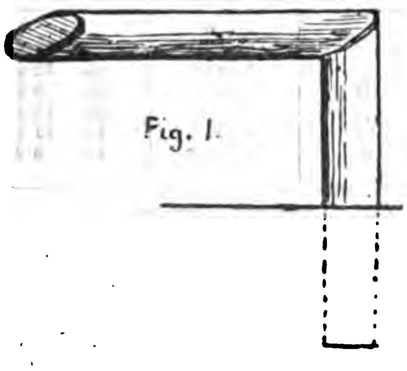


Fig. 1.

But there is another factor, and it is far above all the rest, which tends to perfect the amateur in the desired skill in judging, and that is the experience gained by *making a few fiddles himself.* Books, study, or even handling and observation, are all far in the background as compared with the practical tuition gained in the actual handiwork of construction. The intelligent tyro will learn more in his first efforts—even from his own mistakes—than he will with years of reading, and although he will not be able at the onset to realise the innocence of his own crude curves and outlines, he will gradually and surely find that he is learning more than all the written instruction in the world could teach him. New light will dawn upon him at every step, and the reason for this turn, or that deflection, will appear, and will become his own, in a manner and with a fixity that no oral or written effort could impart.

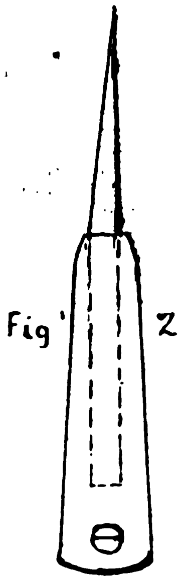


Fig 2

It is, therefore, with the hope of assisting the tyro in his desire for knowledge that I will attempt to give a few hints on "How to Make a Violin," in a plain and simple manner, with some possibly original methods in the use and manufacture of tools, and for the production of tone, and likewise with as small an outlay in the matter of appliances as is practicable. The "instructions" I have met with all seem to follow the same beaten track, and if there is one thing I like to avoid, it is that of running in a particular rut, because our grandfathers and great-grandfathers did so.

Without further preface, I will give a list of the tools required. These are:—Small carpenter's bench, with vice, handsaw, tenon saw, bow saw, smoothing plane, trying plane, a couple of chisels, 1in. and ¼in., two or three knives, as indicated hereafter, two spokeshaves of different degrees of curvature, a couple of bradawls, bending iron, several scrapers, rat-tail file ⅜in. in the thickest part, bevelled Washita sharpening-stone, one dozen wooden screws or cramps, two or three iron cramps, steel 2ft. rule (in one piece, so as to act as a straight-edge), two dozen clips, calipers made as indicated, T-square, glue-pot. Other minor, but at the same time indispensable, requisites, such as glue, glass-paper, &c., will be referred to hereafter in the proper places.

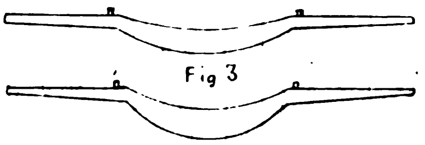


Fig 3

It is, of course, unnecessary to give diagrams of such well-known auxiliaries as saws, planes, files, chisels, and bradawls; but several of the tools in the list are special and peculiar to violin-making, and of these it is desirable to give illustrations.

The Bending Iron, though so-called, is preferably made of brass or copper. A piece of metal about 18in. in length, the section of which is a long oval thus: ⬭, will meet every requirement. It should be about 2½in. in its longest diameter, and may be bent or cast at a right angle, as Fig. 1. A hole should be cut in the top of the bench for it to be sunk into when in use, and it can be kept elsewhere when not wanted. The usual plan is to heat the iron on the top of a stove, and then place it in position; but I prefer putting a small gas-jet underneath it, as by this means a steady and uniform degree of heat can be maintained, without the trouble of frequently removing and reheating. That old-fashioned implement, the Italian iron, used for getting up frills, makes a very fair substitute; but even in this case a gas-jet will be found the most satisfactory method of heating. The surface of the iron should be kept smooth and bright.

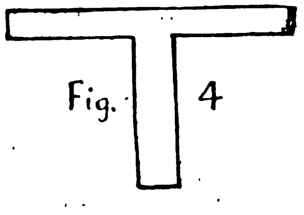


Fig. 4

The Knives.—Fig. 2 gives the most useful form of knife. Get a cutler to make you half a dozen blades of the shape indicated, with a sharp edge all the length. Then take a piece of hard wood, saw it in two lengthwise. Sink the blade into one-half, and glue the other half on the top of it, and when the glue has set run a small screw through the lower end of the handle. This form of knife admits of the wood of the handle being cut away, as the blade is ground down in sharpening, and at the same time is a tool very firm in the grip. The part of the blade exposed should be ground off to a fine point, as in diagram, and it will then be found to be remarkably easy to work with.

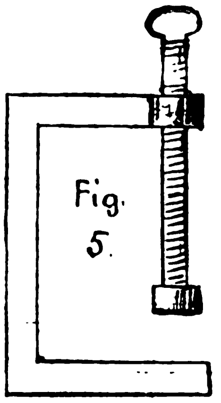


Fig. 5.

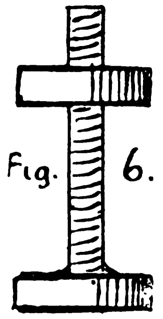


Fig. 6.

The Spokeshaves (Fig. 3) are most usef implements. The "instructions" aforesaid a speak of the use of *gouges* for cutting away th superfluous wood, and getting the instrume into shape, and this old-fashioned and very slo system is still adopted by nearly all the fiddl makers of the present day, than which hard anything can be more tedious and absurd. Pe sonally, I should never have had the patience t make a fiddle on such a method; but by the u of a couple of spokeshaves, of different degrees o curvature in the blades, the work can be g through so expeditiously that it is surprising th spokeshaves have not come into general use.

T-*square.*—A small T-square in brass or ir will be found very useful as the work proceeds.

Iron Cramps.—Fig. 5 shows a form of cram useful for a variety of purposes. Two or thr of these, about 6in. by 4in., will be sufficien They may be frequently picked up for a fe pence.

Wooden Cramps.—Fig. 6 shows a simple form of wooden screw, or cramp, used for holding the top and bottom tables to the sides, until the glue sets. About a dozen will be required, and will be made by a turner for about half-a-crown.

Scrapers (Fig. 7).—The scraper is certainly not a tool peculiar to fiddle-making, excepting with regard to the shape of its cutting-edge. It is hardly necessary to *buy* scrapers. Most of my readers will have at least one female friend who wears stays, and who will present him with a broken busk occasionally, if solicited in a becoming manner. These stay busks make excellent scrapers. Get some pieces, and file, grind, or otherwise shape them something after the manner of the diagrams—that is, irregularly, in order to meet the varied curves, corners, and declivities you will have to operate upon and produce. When you have got the metal to the desired curve, grind or file a slight bevel on the curved side. Then on your Washita sharpener (referred to hereafter) get a keen edge. Now place it in your vice, and draw a smooth piece of steel—a large bradawl will answer the purpose—firmly once or twice along the sharpened edge, and the tool is ready for use. The following diagram shows the position of the sharpener on the edge of the scraper.

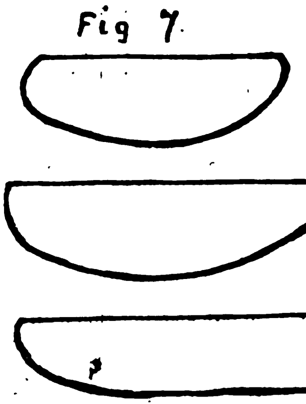


Fig 7.

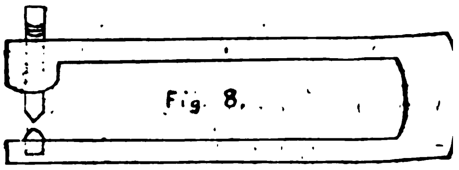
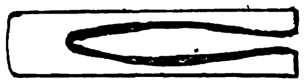


Fig. 8.

It is desirable to have a number of scrapers ready sharpened before you begin, so that as one becomes blunted another may be taken up without having to leave your work to resharpen. A scraper may be "set" by laying it flat at the corner of the bench and drawing the steel (bradawl) smartly along the *flat* surface, so as to turn back the burr given to it by the first process. Having turned back this burr, again put the scraper in the vice, and proceed as at first. A scraper may often be reset a dozen or twenty times without it being necessary to put it on the hone. The variety of the curved edges of, say, three scrapers enables you to do anything you require in fiddle-making, and if you have not previously used a scraper, you will be agreeably surprised to find what a lot of excellent work can be done with so modest an implement. Therefore, do not neglect to contract with your lady friends for all the broken busks.

Calipers.—A number of intricate and mysterious-looking apparatus have been devised for ascertaining the thicknesses of the wood, either in the making of new or the inspection of old fiddles, and some of them are awkward and unreliable, and therefore worse than useless because actually deceiving. The simplest and most effective that I know of may be made by any amateur, and there is always an additional pleasure in being able to make one's own appliances. It is shown in Fig. 8. Take a piece of beech or mahogany about 10in. by 4in., and ½in. thick. With your bow-saw cut it out in shape like the diagram. Bore a clean round hole near the extremity of the upper arm, in which an ivory pin will loosely play. This pin should have a smooth point at the lower end. Immediately under this point—that is, in the lower arm—insert another little ivory pin, also having a smooth point, and fix it there immovably. Let the loose pin drop to touch the fixed pin, and then mark a circle on the loose pin just where it appears above the upper arm. This mark you may call zero. Take out the loose pin, and make a few divisions of 16ths and 32nds of an inch downwards, towards the point. Replace the loose pin in position, and you can then run the instrument over the wood to be gauged, and by watching the scale on the loose pin as it rises and falls, see exactly what the thicknesses are—always being careful that the lower or fixed pin is in *contact* with the under side of the wood.

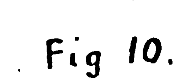
Fig. 9.



Clips.—The small clips, used for keeping the side-linings in position until the glue sets, can be made by the amateur himself out of bits of beech or similar wood. They should be about 3in. in length and ⅜in. square. Make a saw-cut down the centre for two-thirds the length, and then with your knife cut away the inner portion until you get the form in Fig. 9.

The Sharpening Hone.—In my opinion there is nothing to beat a piece of Washita-stone for sharpening. No oil is required—in fact, oil *must not* be used, only clean water. It is generally sold in bevelled form (see Fig. 10), and the rounded edges will be found an advantage in sharpening the blades of the spokeshaves.

Fig 10.



The Purfling Tool (Fig. 11).—I should advise the amateur *not* to give half a sovereign for a purfling tool, but to make one himself at a cost of three-halfpence. Some of these purfling tools are fearfully and wonderfully made. I was once presented with one upon which a great deal of labour and ingenuity had been expended, but it was unworkable; whereas one which I devised—a combination of a bradawl and a cotton-reel—has done all that was required of it. This simple instrument may be made in the following manner:—Take a cotton-reel, in which the axle is thick in wood, and cut one end away, as in B (Fig. 11). If you possess a lathe this may be done in two minutes; if not, it can be reduced with a file, and rounded smooth with glass-paper. Bore five or six small holes in a line with the axis *outside* the smaller spindle, and at slightly different distances from the centre of the reel. Next grind down the point of a small bradawl, till it takes the form as at A (Fig. 11), and get it very sharp. The bradawl is placed in one of the small holes (in which it should fit tightly), according to the distance you wish to scribe from the edge of the work. If after a time the bradawl gets slack in the reel, wet it, and on placing it in position, the wood will swell sufficiently to grip again. The mode of using the purfler will be described hereafter.

Tool Sharpening.—The grinding of plane-irons and chisels and the setting of saws is an art of itself, and I would recommend the amateur to pay a few pence to have these duties performed for him. He would, by doing so, save considerable time, and avoid the risk of spoiling his tools. The blades of the spokeshaves he can manage easily. The mode is to hold the Washita stone firmly down on its narrowest edge at the corner of the bench. Hang the iron across it, so that the thick part, as well as the cutting edge, touches the stone, and move to and fro with a firm and steady pressure. The following little diagram will show the mode of performing this operation, which will have to be done frequently, as the blade must be kept very keen. On no account must you grind the *convex* side of the blade, but only the concave side. It is almost needless to remark on the desirability of keeping all your cutting tools as sharp as possible. No one can do decent work with blunt instruments, and the ease and comfort with which an operation is performed with a sharp tool repays you for all the time and labour taken up in maintaining keen edges.

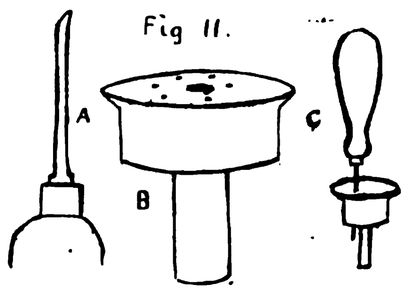


Fig 11.

Having said all that is necessary at present respecting tools, I will next deal with the different woods used in fiddle-making.

FITTING.—III.

THE rule used by fitters is generally 1ft. long, and of steel. Joint rules of any kind are not suitable, especially those which are made of wood. When a 2ft. rule is used that also is of steel, and unjointed. Two, or four edges are usually divided. For the ordinary purposes of the workman two edges are quite sufficient. There is no advantage either in having such fine divisions as 100th of an inch; 64th is quite fine enough, and one inch so divided is sufficient. Three or six inches may be divided into 32nd's, and the whole of one edge into 16th's. I think it is always best that one entire edge shall be left divided no finer than 8th's of an inch. It saves confusion when taking coarse measurements. There is seldom any advantage in having a rule divided into 10th's, or 20th's, or 50th's. Nor are millimètres divisions of any use in a general shop. If French measures have to be adopted, as they have on some jobs, it is better to keep a separate rule for them. Besides the 1ft. or 2ft. rule, one rule 6in. long is very useful to carry in the pocket. It is well to have all rules nickel-plated.

The straight-edges, squares, and calipers are very important tools. As a rule, fitters make these for themselves. It is scarcely necessary to occupy valuable space in a detailed description of the methods by which these are made, because every apprentice of a year or two years standing has made them all for himself; and, of course, everybody knows that to originate a perfectly true parallel straightedge, it is necessary to make three such. But for workshop use, a straight-edge is made from a standard already in existence, or from a shop surface plate. So also it is known that to make a square true, the edges must be done by trial on straight-edge or surface plate, and then the blade made true with the stock by turning its stock to right and left alternately against the true edge of a plate, correcting the blade until each edge coincides with a line squared up from that edge upon the surface of the plate. It is also well known that caliper joints must fit closely, that pins must fit their holes exactly, without slop, and that to prevent spring the metal near the pivot end must be much wider and stiffer than at the points, thence tapering well down to the latter; and also that the points should be thin, but spread very slightly.

Small squares are made with stock and blade separately, the blade being fitted tightly within a saw groove cut in the stock, and so riveted in. The stock is purposely made heavy, in order that the square shall stand steadily upright upon the stock when being used as a set-square. But large squares are forged from a solid flat bar of iron or steel bent round by the smith. The edges are afterwards planed or filed true. Small squares are as short as 2in. or 3in. in the blade for carrying in the waistcoat pocket. For bench use, they range from 6in. to 8in. or 10in. in the blade. Large squares may be from 15in. or 18in. to 2ft. 6in. or 3ft. in length. Lines over that length are better raised by geometrical methods. The length of the blade of a square may be about twice that of the stock.

The various forms of calipers are shown in the figures—Fig. 12. There are the outside calipers A, the inside B, the compass caliper C (used for scribing work), and the combination D, where external and internal legs give the same dimensions.

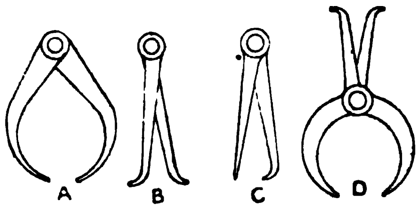
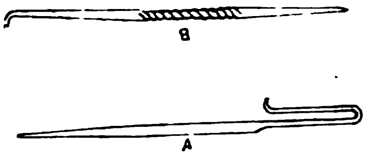


FIG 12

Lines are invariably marked with pointed instruments. The common scriber is used for lines not marked with other instruments. One end is straight, the other is often curved. This instrument is shown in Fig. 13. It is made in two forms. One, A, with one point only; the other end being frequently bent round; the other, B, with one point straight, and the opposite point turned round for marking the under surfaces of work. In B is shown a twist often given to the body to enable the hand to grip it better.

A tool in constant use is the scribing block, or surface gauge. It is also one that is always made by workmen for their own use. It occurs in perhaps a dozen different modified types. I give scaled views of two forms in Fig. 14, so that gauges can be made from the figures.

The value of the scribing block consists in the facility with which its movable point can be adjusted for height, and made to move in parallel lines with the face of the marking-off table, no matter how irregular the faces upon which the parallel lines have to be scribed. With no other tool would it be possible to scribe parallel lines upon faces in various planes.



FIC 13

In Fig. 14, both in A and B, the base C consists of a disc of wrought iron, supporting the rod D. In the first figure, A, upon the rod slides freely, yet closely, the spherical head E. The head is drilled at right angles to take the circular pin F, which is drilled in turn at right angles with its length to slide loosely upon the pillar. The tail of the pin is screwed to take the wing-nut G. Between the wing-nut and the hemispherical body the actual scriber H is slid over the screw. The hemispherical body E is flattened at the spot where the scriber has its bearing. The shoulder of F stands slightly within this flat face. When

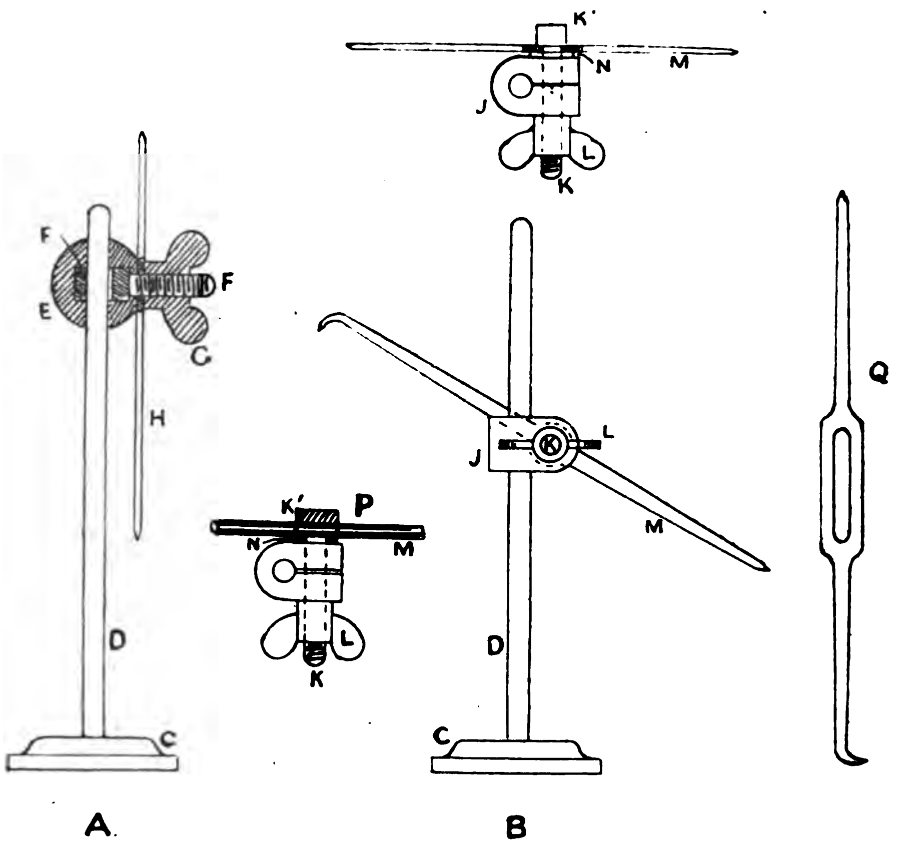


FIG 14

therefore, the nut G is tightened against the scriber, the pin F and the hemispherical body E are pulled towards each other, so tightening around the pillar D, and upon the scriber H, and all is fast.

The scriber shown at B is tightened in a different manner. Upon the pillar D slides a split-block, J, divided on one side as far as the pillar. Through a hole drilled in this portion, the screwed pin K, is passed and pulled up against the block J, with the wing-nut L. The pin K is furnished with a head, K¹. When the nut is screwed up tightly it pulls the head K¹ against the scriber M, and not only sets the block J in position on the pillar; but also pulls the scriber M fast against the washer N.

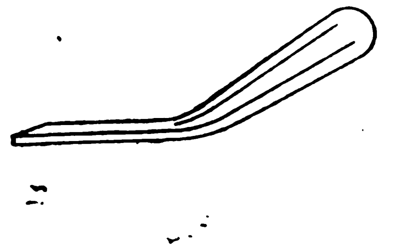


FIG 15

In scribing blocks fitted with a split block like J, an alternative plan is to drill a hole through K¹, and making M of round steel wire, let it pass through the drilled hole. By filing shallow grooves in the washer N, the scriber can be clamped fast against these grooves. This is shown at P. These indispensable tools are modified in many ways in the shops.

Properly, the scriber should have means of end-long adjustment, as well as adjustment for height. The usual form given to it is that shown at Q, the long slot permitting of movement endwise. At P the same object is secured by the movement of the round rod M, through the hole drilled in the head K¹ of the pinching-screw.

A scriber-block should not be made in a flimsy fashion, for it will then be unsteady, and mark untrue lines. The base should be stout and massive, and the stem also stout. The lightest portion should be the sliding block and screw.

The key-drift, Fig. 15, is a tool in frequent use. It is of steel, and is employed for driving out keys from their seatings. It is cranked to clear the body of the shaft in which the key-way is cut.

Two pairs of trammels are required, a small light pair, and a larger pair. For the small ones, the beam is sometimes of metal, for the larger ones it is of wood. A good type of trammel head is shown in Fig. 16. The proportions to which the figure is drawn are suitable for large or small heads. The length should not be relatively much less than that shown, or the head will be unsteady upon the rod. The cross-section of a small rod may be $\frac{3}{4}$in. by $\frac{5}{16}$in., of a large one $2\frac{1}{4}$in. by $\frac{3}{4}$in., and others will come between these sizes. The figure is almost self-explanatory of the method of construction. Trammel heads usually are made on the general pattern there shown. A is a casting of gun-metal or brass, filed to slide smoothly, and with as little slop as possible on the staff; B is the pointed leg, fitted either with a screw, or by tight driving into the hole drilled in its boss; C is a set-screw of brass or steel tapped into its boss, and pressing upon the thin washer D, which is shouldered in plan to prevent it from slipping out endwise. The washer then bears fast upon the rod, and the head is fixed in position.

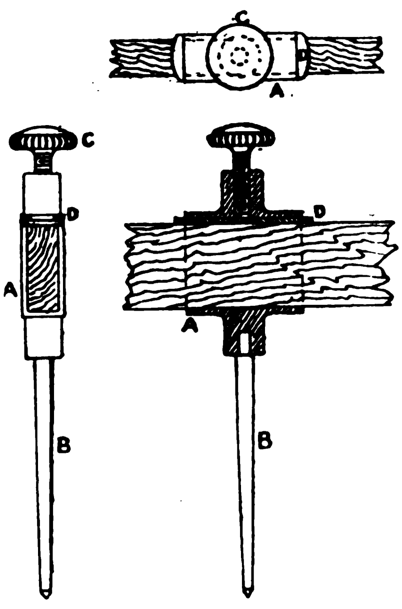


FIG 16

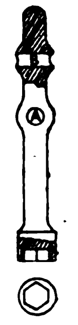


FIG 17

The ordinary wing compasses and spring dividers are used by fitters; but they are ground to a more obtuse angle then when employed for wood. The points of all fitters' marking instruments must be ground to a larger angle than those for marking on wood, otherwise they will not preserve their edges; and they should be sharpened on an oilstone as often as they begin to get dulled.

Spanners should be cranked at an angle of 15° with the shank. Then they will turn square nuts in 45°, and hexagon nuts in 30°. The length of shank should be eight or nine times the width between the jaws. I need not illustrate these, nor the screw wrenches. Fig. 17 shows a box spanner, used where nuts are in a position so confined that the ordinary spanners cannot be turned round. A podger, or any suitable piece of round bar, is inserted in one or other of the holes A B, as most convenient, and gives the necessary leverage for turning the spanner round.

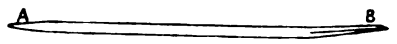


FIG 18

Fig. 18 shows a podger, employed for two purposes. The tapered end A, of round section, is used for pulling drilled or punched holes into line, so that their bolts or rivets can be inserted. The flattened end B is used like the end of a crowbar for lifting up and slipping along a casting or forging into position, or for prising open flanges or plates that are in close contact.

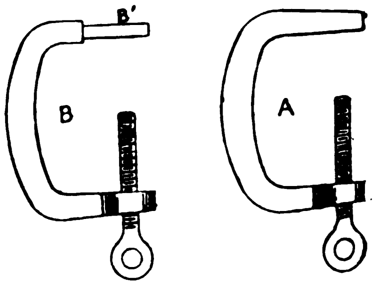


FIG 19

Two or three centre-punches, light and heavy, are always kept at hand. They are made from old round files, or forged from rod. It is better to make the body of hexagenal form, as the tool can be grasped and rotated better in the fingers than if left smooth.

Cramps of almost all sizes are used by fitters of the types and general proportions shown in Fig. 19. They are forged in wrought iron or steel. A is that in most request, B being a special form used in cases where there are not two flat surfaces in opposition. Thus, in pinching two plates standing at right angles, united with angle iron or other attachments, the round part B_1 would enter into punched or drilled hole, and offer the necessary resistance to the pressure of the screw.

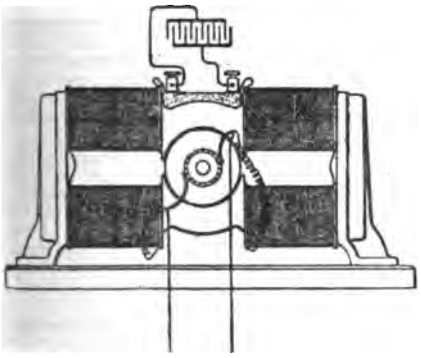
A small surface-plate, about 10in. or 12in. square or in diameter, is a necessary equipment of the general working-fitter's bench.

Drills and screwing tackle are too important to be passed lightly over. I shall, therefore, defer my remarks on these until I treat specially about the methods of union adopted by fitters.

J. H.

CONDENSER FOR ALTERNATING CURRENT MOTORS.

THE low efficiency of alternating current motors is known to be due to the large self-induction due to the iron. This self-induction, by creating a greater amount of current lag in the field-magnet than in the armature circuit, changes the times of magnetisation of field and armature respectively, resulting in an inefficient operation. With a view to decreasing the amount of lag and bringing the instant of field magnetisation more nearly into coincidence with that of the armature, William Stanley, jun., of Pittsfield, Mass., and John F. Kelly, of New York, propose to insert in the field-magnet circuit a condenser. The improvement is illustrated in the accompanying engraving, which represents an ordinary shunt-wound motor, provided with laminated field-magnet and armature cores, a condenser, D, being interposed in the shunt or field-magnet circuit. The condenser has the property of neutralising or counteracting the effects of self-induction in the circuit with which it is connected. The high self-induction of the field is thereby lowered, and its time of magnetisation brought more nearly into coincidence with that of the armature. It would seem at first sight that the enormous resistance added to the field-magnet circuit by the condenser would reduce the field magnetisation to a very low value.

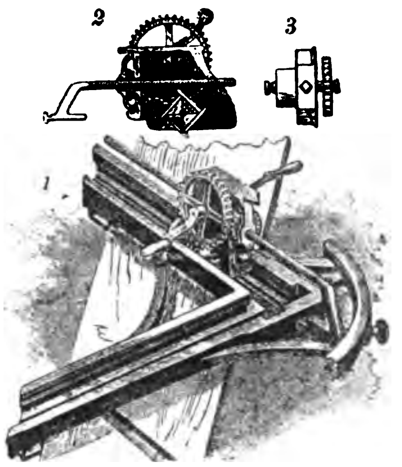


AQUATIC INSECTS.

THE Friday evening discourse before the British Association was delivered by Prof. L. C. Miall, who took for his subject "Some Difficulties in the Life of Aquatic Insects," showing how they lay their eggs, sink and rise in the water, and obtain their food. He said that we understand insects to be animals of small size furnished with a hard skin and six legs, breathing air by branch air tubes, and commonly provided in the adult condition with wings. The animals thus organised are pre-eminently a dominant group, as shown by the vast number of the species, the great numbers of the individuals, their wide distribution, and their various habitat. The insect type, like some of the fruitful inventions of man—paper or lithography, for instance—has proved so successful that it has been found profitable to adapt it to countless distinct purposes. He proposed to consider only one of its infinitely varied adaptations—namely, its adaptation to aquatic life. There are some insects which can live in the water—not as the mammal, bird, or reptile does, coming up from time to time to breathe — but constantly immersed like a fish. Nearly every order of insects contains aquatic forms, and the total number of such forms is very large. All are believed to be modifications of terrestrial types, and it is probable that members of different families have often betaken themselves to the water independently of one another. The difficulties which aquatic insects have to encounter begin with the egg. It is in most cases convenient that the egg should be laid in the water, though this is not indispensable to the winged or breathing fly, which is, as a rule, ill fitted for entering the water. Some insect eggs hatch if they are merely scattered like grains of sand over the bottom of a stream; but others must be laid at the surface of the water, where they can gain a sufficient supply of oxygen. If the water is stagnant, it will suffice if the eggs are buoyant, like those which compose the eggraft of the gnat; but this plan would hardly answer in running streams, which would carry light floating eggs to great distances, or even sweep them out to sea. Moreover, floating eggs are exposed to the attacks of hungry creatures of various kinds, such as birds or predatory insects. These difficulties have been met in the cases of a number of insects by laying the eggs in chains or strings and mooring them at the surface of the water. The eggs are invested by a gelatinous envelope, which swells at the moment it reaches the water into an abundant transparent mucilage. This mucilage answers more than one purpose. It makes the eggs so slippery that birds or insects cannot grasp them. It also spaces the eggs, and enables each to get its fair share of air and sunlight. The gelatinous substance appears to possess some antiseptic property, which prevents water moulds from attacking the eggs, for long after the eggs have hatched out the transparent envelope remains unchanged. Some insects, too, lay their eggs in the form of an adhesive band. In several cases the egg chain is moored to the bank by a slender cord. The common two-winged fly Cheronomous lays its eggs in transparent cylindrical ropes, which float on the surface of the water. The eggs of the caddis fly are laid in large ropes, which in some species are very beautiful objects, owing to the grass-green colour of the eggs. The eggraft of the gnat, which has often been described, is well suited to float in stagnant water, and is freely exposed to the air—a point of unusual importance in the case of an insect which in all stages of growth seems to need the most efficient means of respiration, and whose eggs are usually laid in water of very doubtful purity. The lower, or submerged, end of each egg opens by a lid, through which the larva at length escapes. When the larvæ are hatched and escaped into the water new difficulties arise. Some have to seek their food at the surface of the water, and must yet be always immersed. Others live upon food which is only to be found in rapid streams, and thus run serious risk of being swept away by the rush of water. All need a good supply of oxygen, which has either to be drawn from the air at the surface or extracted from the water by special organs. The difficulty of breathing is, of course, greatly increased when the larvæ seeks its food at the bottom of foul streams, as is the case with certain diptera. After describing various other difficulties encountered by insects, the lecturer said that many insects run and skip on the surface-film of the water. They are able to do this by their small size, the great spread of their legs, and the fine hairs on the legs. The multiplication of the points of contact may indefinitely increase the support afforded by the surface of the water. It is possible for many not only to run on the surface of the water, but even to leap upon it, as on a table. The minute and hairy body of the black podura is incapable of being wetted, and it frisks about on the silvery surface of a pond as a house fly might on a surface of quicksilver. But the podura must descend for food. On a leaf of dockweed it pulls itself forcibly through the surface film and climbs down the long root. Once below, though buoyant, it is enabled by muscular exertion to swim downwards to any depth. Other aquatic insects not quite so minute have similar difficulties to cope with. Creeping on the under surface of the film is often practised by leeches, snails, cyclas, &c. It is sometimes erroneously described as creeping on the air. The body of the animal is wholly immersed, and it does not displace particles of lycopodium powder sprinkled on the water. Thus the film is a ceiling to the water chamber below. The body of the leech is of higher gravity than water, and when it loses its hold of the surplus film it falls to the bottom. Pond snails, however, actually float at the surface, and if disturbed or made to release their hold merely turn over in the water. Air-breathing insects, by overcoming the difficulties of living in water, have gained access to new and ample stores of food which abound in our fresh waters, and they have multiplied exceedingly, so that the number of individuals in a species is sometimes surprisingly high. The head of the larva degenerates, and in extreme cases is reduced to a simplo shell, not inclosing a brain, and devoid of eyes, antennæ, and jaws. Some aquatic, as well as some non-aquatic, species, which have found an unlimited supply of food, manage to produce offspring from unfertilised eggs, and to have these eggs laid by wingless pupæ, or hatched within the bodies of wingless larvæ. The development of the winged fly, the whole business of mating, and even the development of the embryo within the egg, have thus in particular insects been abbreviated to the point of suppression. Abundant food, needing no exertion to discover or appropriate it, has led in a few instances to the most complete atrophy of those higher functions which alone make life interesting.

AN IMPROVED MORTISING MACHINE.

A PORTABLE machine especially adapted for mortising wall strings to receive the risers and treads of steps is shown in the accompanying illustration, and has been patented by Mr. Paul Swieter, of No. 24, Howard-street, Allegheny, Pa. Fig. 1 is a perspective view of the machine, Fig. 2 representing a vertical section through the carriage, while Fig. 3 shows the cutter detached. The base of the machine consists of two parallel angular sections, the members of which are at a right angle to each other, and each of which has a lower horizontal slotted flange, and also an undercut T-shaped recess. Opposite the angle of the outside section a segmental plate is secured by radial arms, the plate having a T-shaped undercut recess and a downwardly extending central lug through which a set screw passes. The members of the two sections are united by diagonally located collecting-plates, by means of adjustable bolts extending up through the slots of the base flanges, whereby the width of space between the sections may be regulated; and in operation the base is attached to the wall string by bringing one side edge of the connecting-plates against a face of the string piece and causing the set screw of the segmental plate to engage the other side edge. The carriage is adapted to travel in the space between the sections, and consists of a box-like casing, through which passes the feed-screw, having a downward and outward extremity terminating in a horizontal foot, with a button at one end adapted to enter the undercut recess of the segmental plate. At one end of the casing is a vertical bracket, and in the bracket and an aperture in the end of the casing is the hub of a pinion, the bore of the hub being threaded and the pinion turning upon the feed-screw. On a shaft near the top of the casing is journalled a crown wheel meshing with the pinion, the shaft being rotated by a crank arm on each side; the crown wheel also, through connecting gears, operating the cutters, which revolve between the sides of the casing in its lower open face. The cutter head is made in two sections, one of which is nominally fixed and the other held to slide, producing a mortise cut of any desired width; or such adjustment may be made that the mortise will be wider at one end than it is at the other. When one mortise groove or channel has been completed, the position of the carriage is reversed, it being then placed at the other channel of the base, the foot of the feed-screw being correspondingly adjusted in the segmental plate.



THE respiration of insects has been the subject of study by M. Contejean, who has found that, contrary to what takes place in vertebrates, the movement of inspiration is passive and that of expiration active. The air is driven from the body by a contractile effort. Hence, when the insect is wounded, the flow of blood occurs at each expiration. The respiratory movement is not interrupted by cutting off the head, nor by the absorption of curare, which produces an immediate cessation in man.

BRITISH ASSOCIATION.

THE ADDRESS IN MATHEMATICS AND PHYSICS.

THE Address in Section A was delivered by Prof. Oliver J. Lodge, D.Sc., F.R.S., who referred in commencing to the fact that this year is Faraday's centenary, and then proceeded to talk about colour photography, which subject led on to the main point of his address—the fact that the further progress of physical science was becoming increasingly difficult. The quantitative portion of the work should be undertaken in a permanent and publicly-supported physical laboratory on a large scale. It would relieve the private worker of much of what he could undertake only with great difficulty, sacrifice, and expense. Long-continued consecutive observations did not require leaders of science; but could be done equally well by a professional observer or computer. The ohm had been determined with 4-figure, perhaps 5-figure, accuracy, but at the cost of severe labour to eminent men. The question of the fifth or sixth decimal was a work to be undertaken by the rank and file as workers in a national laboratory. Paris had one in the Conservatoire des Arts et Métiers, and had in consequence been able to impose the metric system on the civilised world. Other examples were the new Electric Standardising Laboratory of the Board of Trade and the Meteorological and Magnetic Observatory at Kew. The work and appliances of mechanical engineers eclipsed those of the physical in point of accuracy. Yet discoveries lie along the path of extreme accuracy. The aberration of light would not have been discovered had not Bradley been able to measure to less than 1 part in 10,000; and what a brilliant and momentous discovery it was! With good work being done at head-quarters the army of outside physicists would cease from peddling with taking transits or altitudes, and would be free to discover comets, invent the spectroscope, watch solar phenomena, chemically analyse the stars, devise celestial photography, and elaborate still more celestial theories. The National Laboratory would be also the natural custodian of our standards, in a state fit for use and for comparison with copies sent to be certified. Else perhaps some day our standard ohm may be buried in a brick wall at Westminster, and no one living may be able to recall precisely where it is. In the course of his address, the President also mentioned that in the early days of the Copernican theory, Galileo for some years refrained from teaching it, because he considered that he had better get more fully settled in his University chair before evoking the storm of controversy which the abandonment of the Ptolemaic system would arouse. The same thing in very minor degree is going on to-day. Men hesitate to avow interest in new investigations (not credence, but interest) until they have settled down more securely and made a name for themselves in other lines. The field is the borderland of physics and psychology, the connection between life and energy, or the connection between mind and matter. It is an intermediate region, bounded on the north by psychology, on the south by physics, on the east by physiology, and on the west by pathology and medicine. An occasional psychologist has groped down into it and become a metaphysician. An occasional physicist has wandered up into it and lost his base, to the horror of his quondam brethren. Biologists mostly look at it askance, or deny its existence. A few medical practitioners, after long maintenance of a similar attitude, have begun to annex a portion of its western frontier. The whole region seems to be inhabited mainly by savages, many of them, so far as we can judge from a distance, given to gross superstition. "Why not leave it to the metaphysicians?" It has been left to them long enough. They have explored it with sufficient equipment. The physical knowledge of the great philosophers has been necessarily scanty. They appear to have guessed far more than they saw. The scientific method is different; it creeps slowly from the base of physical knowledge. A vulnerable spot seems to be the connexion between life and energy. The conservation of energy has been so long established as to have become a commonplace. The relation of life to energy is not understood. Life is not energy, and the death of an animal affects the amount of energy no whit; yet a live animal exerts control over energy which a dead one cannot. Life is a guiding or directing principle, disturbing to the physical world, but not yet given a place in the scheme of physics. The transfer of energy is accounted for by the performance of work; the guidance of energy needs no work, but demands force only. What is force, and how can living beings exert it in the way they do? As automata, worked by preceding conditions—that is, by the past—say the materialists. Are we so sure that they are not worked by the future, too? In other words, that the totality of things, by which everyone must admit that actions are guided, includes the future as well as the past, and that to attempt to deduce those actions from the past only will prove impossible. In some way matter can be moved, guided, disturbed by the agency of living beings; in some way there is a control, a directing-agency active, and events are caused at its choice and will that would not otherwise happen. A luminous and helpful idea is that time is but a relative mode of regarding things. We progress through phenomena at a certain definite pace, and this subjective advance we interpret in an objective manner, as if events necessarily happened in this order and at this precise rate. But that may be only one mode of regarding them. The events may be in some sense existent always, both past and future, and it may be we who are arriving at them, not they which are happening. The analogy of a traveller in a railway train is useful. If he could never leave the train nor alter its pace he would probably consider the landscapes as necessarily successive, and be unable to conceive their co-existence. The analogy of a solid cut into sections is closer. We recognise the universe in sections, and each section we call the present. It is like the string of slices cut by a micrometer; it is our way of studying the whole. But we may err in supposing that the body only exists in the slices which pass before our microscope in regular order and succession. We perceive, therefore, a possible fourth-dimensional aspect about time, the inexorableness of whose flow may be a natural part of our present limitations. And if once we grasp the idea that past and future may be actually existing, we can recognise that they may have a controlling influence on all present action, and the two together may constitute "the higher plane," or the totality of things, after which, as it seems to me, we are impelled to seek, in connection with the directing of force or determinism, and the action of living beings consciously directed to a definite and preconceived end. By what means is force exerted, and what, definitely, is force? There is here something not provided for in the orthodox scheme of physics; modern physics is not complete, and a line of possible advance lies in this direction. Given that force can be exerted by an act of will, do we understand the mechanism by which this is done? And if there is a gap in our knowledge between the conscious idea of a motion and the liberation of muscular energy needed to accomplish it, how do we know that a body may not be moved without ordinary material contact by an act of will? We require more knowledge before we can deny the possibility. If the conservation of energy were upset by the process, we should have grounds for denying it; but nothing that we know is upset by the discovery of a novel medium of communication, perhaps some more immediate action through the ether. It is no use theorising; it is unwise to decline to examine phenomena because we feel too sure of their impossibility. We ought to know the universe very thoroughly and completely before we take up that attitude. Again, it is familiar that a thought may be excited in the brain of another person, transferred thither from our brain, by pulling a suitable trigger; by liberating energy in the form of sound, for instance, or by the mechanical act of writing, or in other ways. A prearranged code called language, and a material medium of communication are the recognised methods. May there not also be an immaterial (perhaps an ethereal) medium of communication? Is it possible that an idea can be transferred from one person to another by a process such as we have not yet grown accustomed to, and know practically nothing about? In this case I have evidence. I assert that I have seen it done, and am perfectly convinced of the fact. Many others are satisfied of the truth of it too. Why must we speak of it with bated breath, as of a thing of which we are ashamed? What right have we to be ashamed of a truth? And, after all, when we have grown accustomed to it, it will not seem altogether strange. It is, perhaps, a natural consequence of the community of life or family relationship running through all living beings. The transmission of life may be likened in some ways to the transmission of magnetism, and all magnets are sympathetically connected, so that if suitably suspended, a vibration from one disturbs others, even though they be distant ninety-two million miles. It is sometimes objected that, granting thought-transference or telepathy to be a fact, it belongs more especially to lower forms of life, and that as the cerebral hemispheres develop we become independent of it; that what we notice is the relic of a decaying faculty, not the germ of a new and fruitful sense; and that progress is not to be made by studying or attending to it. It may be that it is an immature mode of communication, adapted to lower stages of consciousness than ours. But how much can we not learn by studying immature stages? As well might the objection be urged against a study of embryology. It may, on the other hand, be an indication of a higher mode of communication, which shall survive our temporary connection with ordinary matter. I have spoken of the apparently direct action of mind on mind, and of a possible action of mind on matter. But the whole region is unexplored territory, and it is conceivable that matter may react on a mind in a way we can at present only dimly imagine. In fact, the barrier between the two may gradually melt away, as so many other barriers have done, and we may end in a wider perception of the unity of nature, such as philosophers have already dreamt of.

In the discussion which followed, Prof. Carey Foster thought the suggestion for the establishment of a national physical observatory was of importance; while Dr. Johnstone Stoney, who also welcomed the suggestion, thought the subject mooted was hardly connected with the section of Mathematics and Physics, but was more intimately connected with the mental physiology of the brain.

THE ADDRESS IN CHEMISTRY.

The Address in Section B was delivered by Prof. Roberts-Austen, F.R.S., who naturally, the meeting being in South Wales, referred to the connection of metallurgy with chemistry, and the important work the chemist or scientific worker did for the practical man. The principal feature of the address was the reference to the investigations of Mr. Ludwig Mond on the action of carbonic oxide on nickel and on iron. Berthelot's work in the same direction was described at some length with a view to show that our knowledge of the mechanism of reduction and carburisation, which are of vast importance in the metallurgy of iron and steel, has received remarkable development during the last two years. As to the modern aspects of metallurgical practice, the whole range of the metallurgist's field of study was changing. It is no longer possible for him to devise a series of operations on the evidence afforded by a set of equations which indicate the completion of an operation; he has to consider the complicated problems which have been introduced into chemistry from the sciences of physics and mechanics. He has, in fact, no longer to deal merely with atoms and molecules, but with the influence of mass. The time has come when the principles of dynamic chemistry must be applied to the study of metallurgical problems if they are to be correctly understood, and it is, moreover, necessary to remember the part played by the surface separating the different aggregates in contact with one another. It is often urged that metallurgical practice depends upon the application of chemical principles which are well taught in every large centre of instruction in this country, but a long series of chemical reactions exist which are of vital importance to the metallurgist, though they are not set forth in any British manual of chemistry, nor are dealt with in courses of purely chemical lectures. As examiner in metallurgy for the Science and Art Department, Prof. Austin found that purely analytical and laboratory methods are often given in the belief that they are applicable to processes conducted on a large scale and at high temperatures. It was held that technical instruction should be kept apart from scientific education, which consists in preparing the student to apply the results of past experience in dealing with entirely new sets of conditions; but it can be shown that there is a whole side of metallurgical teaching which is truly educational, and leads students to acquire the habit of scientific thought as surely as the investigation of any other branch of knowledge. The illustrations in proof of this were borrowed from the smelting of copper and the extraction of silver from copper ores in the great district of Swansea. The President pointed out that it is a grave mistake to suppose that in industry, any more than in art, national advance takes place always under the guidance of a master possessed of some new gift of invention. The way for any great technical advance is prepared by the patient acquisition of facts by investigators of pure science. A genius whose practical order of mind enables him to make some great invention suddenly arises, apparently by chance; but his coming will, in most cases, be found to have "followed hard upon" the discovery by some scientific worker of an important fact, or even the accurate determination of a set of physical constants. Concluding a most interesting address, Prof. Roberts-Austen said: I would ask those to whom the direction of the metallurgical works of this country is intrusted to remember that we have to deal both with metals and with men, and have reason to be grateful to all who extend the boundaries, not only of our knowledge, but also of our sympathy.

THE ADDRESS IN GEOLOGY.

The Address in Section C was delivered by Prof. T. Rupert Jones, F.R.S., who, like his confrère in Section B, naturally referred to a subject of local interest—Coal. After giving some statistics showing the importance of the Welsh coal-fields, the president said:—Coal is now generally accepted as being a compressed and chemically altered mass of ancient vegetables. The tissue of some of the trees and other plants may be detected in the substance more or less distinctly by fracture, by burning, and in thin sections. In some cases trees occur rooted in the attitude of growth, their stems rising upwards and their roots remaining in or below the coal. The accumulation of coals as seams of varying thicknesses, in very numerous parallel beds, can be explained by the gradual and long-continued subsidence of long and wide tracts of old marginal sea-beds, estuaries, and lagoons, with adjoining lands, all more or less invested with vegetation. At the same time limited, isolated, and lenticular patches and nests of pure coal, usually in sandstone, have been probably due to floating masses of vegetation, matted plants and trees, becoming waterlogged and sinking in estuaries and shallow seas. Some highly bituminous coal, like cannel and torbanite, may have been due to limited accumulations of macerated plants rotting in water; or to the bursting of those natural reservoirs, like peat-bogs, and a local arrangement of the resulting flow of carbonaceous mud. The valuable coal-field of South Wales (estimated by some to occupy 640,000 acres, and stated by others to be 906 square miles in extent) forms an irregular coal basin or trough lying east and west (about 56 miles long, from Pontypool to Carmarthen Bay), with a narrow extension westward beyond Carmarthen Bay, through Pembrokeshire to St. Bride's Bay (about 17 miles long.) The greatest width is about 16 miles. In 1881 there were 662 collieries at work. Looking at these coal-measures alone, and considering that slow depression accompanied their formation, the mind is strained in estimating the time required for the gradual subsidence to 10,000ft., with shallow water always in place, and jungle growing steadily after jungle, inundation following inundation at intervals—and is somewhat confused in reasoning on the possible causes and the exact processes by which not only the sinking of this region of the earth's crust was brought about, but how, in turn, the 10,000ft. of new accumulations and deposits were raised into the great undulations which Prof. Ramsay has described and depicted in his memoir, and how and when they were slowly worn down day by day into the present beautifully varied surface of South Wales and adjacent country. The analogous coalfield of Nova Scotia, investigated by Sir W. E. Logan, Sir J. W. Dawson, and others, has a thickness of 14,570ft., including seventy-six seams of coal and ninety distinct stigmarian underclays. The coal of the British coalfields exhibits every variety of composition between anthracite, which is nearly pure carbon, and the so-called bituminous coals, such as ordinary coal and cannel coal (hydrocarbons), rich in hydrogen. Anthracitic beds are rarely seen, except in districts where the strata have been much disturbed, or peculiarly affected by other circumstances. Heat, whether direct or induced by pressure, vertical or lateral, has probably been the important agent in depriving coal of its hydrogen with some of its carbon, and thus changing it into anthracite. Neither in this latter nor in the compact cannel coal are the laminar structure and symmetrical jointing so distinct as in the ordinary coals. The last lose their volatile hydrocarbons also by exposure to the air, at outcrops and in open faults; hence they are not nearly so good for burning as those got at a greater depth. In the Franco-Belgian coalfield the coals become more and more anthracitic as they pass down to greater depths: both kinds, therefore, were of the same age in formation; in South Wales also, as already stated, the anthracite and the other coals are all of one age. The squeezing, faulting, and inversions in the former field are accompanied by an alteration of the highly bituminous coals into dry coals and anthracite. The geologist, chemist, and botanist, seeking out the composition of the various coals, their local position and extent, their special natural history, the mode of passage from dead plants to first-rate fuel—in fact, aiming at a complete mastery over all the mazy events and complicated results of the coal formation—not only find a useful exercise of their cultivated intelligence and accumulated knowledge, benefiting all by the practical results, but they widen the mental culture of others, and show how the study of nature is an indispensable element in good education, and necessarily productive of lasting benefit to society at large. Light, heat, motion, fragrance, and colour are all now obtainable from coal. What more could the sun himself do for us? Nevertheless, a great deal has yet to be learnt about the natural history of the coal-measures, the order and extent of the special kinds of their animals and plants, the time occupied in formation, and the geographical and hydrographical conditions. At all events, we know that all their strata have been arranged in order, have been buried under circumstances favourable to production of the various coaly fuels, and then turned up in orderly disorder, ready to the hand of man, and well adapted for his use in this passage-stage of his civilisation and development, helping him, when intelligent, active, careful, and persevering, to higher ends. For we cannot doubt that all things here are arranged for his better being, his progress towards more and more useful arts, wider ranges of science, and fitter aptitudes of life, of which as yet we have but little conception. We are still the early settlers in a beautiful world, whose capabilities, imperfectly known as yet, wait until higher developments of man can understand them fully, and apply the results to the general good.

THE ADDRESS IN BIOLOGY.

The Address in Section D was delivered by Mr. Francis Darwin, F.R.S., and had the merit of offering plenty of food for thought. The president of the section said:—A seedling plant, such as a young sunflower when growing in a state of nature, grows straight up towards the open sky, while its main root grows straight down towards the centre of the earth. When it is artificially displaced, for instance, by laying the flower-pot on its side, both root and stem execute certain curvatures by which they reach the vertical once more. Curvatures such as these, whether executed in relation to light, gravitation, or other influences, may be grouped together as growth-curvatures, and it is with the history of our knowledge on this subject that I shall be occupied to-day. I shall principally deal with geotropic curvatures, or those executed in relation to gravitation; but the phenomena in question form a natural group, and it will be necessary to refer to heliotropism, and, indeed, to other growth-curvatures. The history of the subject divides into two branches, which it will be convenient to study separately. When a displaced apogeotropic organ curves so as to become once more vertical, two distinct questions arise, which may be briefly expressed thus:—(1) How does the plant recognise the vertical line—how does it know where the centre of the earth is? (2) In what way are the curvatures which bring it into the line executed? The first is a question of irritability, the second of the mechanism of movement. Sachs has well pointed out that these two very different questions have been confused together. They should be kept as distinct as the kindred questions how, by what nervous apparatus, does an animal perceive changes in the external world; and how, by what muscular machinery, does it move in relation to such changes? The President dealt separately with "irritability" and "mechanism," and then treated of "circumnutation," expressing his continued belief in the views put forward in the "Power of Movement in Plants," that circumnutation is a widely-spread phenomenon, even though it may not be so widely spread as he and his father had supposed. In conclusion, he said:—The relation between rectipetality and circumnutation may be exemplified by an illustration which I have sometimes made use of in lecturing on this point. A skilful bicycle-rider runs very straight: the deviations from the desired course are comparatively small, whereas a beginner "wobbles" or deviates much. But the deviations are of the same nature; both are symptoms of the regulating power of the rider. We may carry the analogy one step further; just as growth-curvature is the continuance or exaggeration of a nutation in a definite direction, so when the rider curves in his course he does so by wilful exaggeration of a "wobble." It may be said that circumnutation is here reduced to the rank of an accidental deviation from a right line. But this does not seem necessarily the case. A bicycle cannot be ridden at all unless it can "wobble," as every rider knows who has allowed his wheel to run into a frozen rut. In the same way it is possible that some degree of circumnutation is correlated with growth in the manner suggested above, owing to the need of regular pauses in growth. Rectipetality would thus be a power by which irregularities, inherent in growth, are reduced to order and made subservient to rectilinear growth. Circumnutation would be the outward and visible sign of the process. I feel that some apology is due from me to my hearers for the introduction of so much speculative matter. It may, however, have one good result, for it shows how difficult is the problem of growth-curvature, and how much room there still is for work in this field of research.

THE ADDRESS IN GEOGRAPHY.

The Address in Section E was delivered by Mr. E. G. Ravenstein, the president, who gave a lucid account of the development of cartography, and then spoke of the influence of geographical features on the human race. After a concise history of map-making the president proceeded:—Now, at the close of the 19th century, he thought that they might fairly boast that the combined science and skill of surveyors and cartographers, aided as they were by the great advance of the graphic arts, were fully equal to the production of a map which should be a faithful image of the earth's surface. Let them imagine for one moment that an ideal map of the kind were before them, a map exhibiting not merely the features of the land and the depth of the sea, but also the extent of forests and of pasture lands, the distribution of human habitations, and all those features the representation of which had become familiar to them through physical and statistical atlas. Let them then analyse the vast mass of facts thus placed before them, and they would find that they formed quite naturally two well-defined divisions, those of physical and political geography, whilst the third department of the science, mathematical geography, dealt with the measurement and survey of the earth, the ultimate outcome of which was the production of a perfect map. He would abstain from giving a laboured definition of what he considered geography should embrace, for definitions of the kind helped practical workers but little, and would never deter anyone who felt disposed and capable from straying into fields which an abuse of logic had clearly demonstrated to lie outside his proper domain. But he wished to enforce the fact that topography and chorography, the description of particular places or of entire countries, should always be looked upon as integral portions of geographical research. It was they which furnished many of the blocks needed to rear their geographical edifice, and which constituted the best training school for the education of practical geographers, as distinguished from mere theorists. That their maps, however elaborate, should be supplemented by descriptions would not even be gainsaid by those who were most reluctant to grant them their independent existence among the sciences which dealt with the earth and man who inhabited it. That concession, however, could never content them. They could not allow themselves to be reduced to the position of collectors of facts. They claimed the right to discuss the facts they had collected, to analyse them, to generalise from them, and to trace the correlations between cause and effect. It was thus that geography became comparative; and whilst comparative physical geography, or morphology, sought to explain the origin of the existing surface features of the earth; comparative political geography, or anthropo-geography, as it was called by Dr. Ratzel, dealt with man in relation to the geographical conditions which influenced him. Man was, indeed, in a large measure "the creature of his environment,' for who could doubt for a moment that geographical conditions had largely influenced the destinies of nations, had directed the builders of their towns, determined the path of migrations and the march of armies, and had impressed their stamp even upon the character of those who had been subjected to them for a sufficiently extended period. It was an old remark that climatic conditions exercised a most powerful influence upon man, and that the development of countries, where Nature yielded the necessaries of life without requiring a serious effort on the part of the inhabitants, had been very different from those whose climatic conditions compel the putting forth of a certain amount of well-directed energy to make life bearable or even possible. Those instances of the dependence of human development upon natural resources and geographical features might be multiplied, and their study must at all times be profitable and instructive. In concluding, Mr. Ravenstein said all that could be expected of the modern geographer was that he should command a comprehensive general view of his field, and that he should devote his energies and capacities to the thorough cultivation of one or more departments that lay within it.

THE ADDRESS IN ECONOMICS AND STATISTICS.

The Address in Section F was delivered by Prof. Cunningham, D.Sc., F.S.S., who, in the course of his remarks, said:—The cosmopolitan and international character of industry and commerce has not yet been sufficiently taken into account by economists. They inherit the conception of mankind as grouped for economic purposes in nations, and they adhere to it very closely. Adam Smith did much to break the old spell, and to show that it was not worth while to try and build up an independent national economic life; but he was still under the thraldom of the old phrases. He still spoke of the wealth of nations, and treated the nation as the economic unit. Cobden and the free traders thought of the nation as an economic whole; they hoped that unimpeded intercourse would bring about more friendly feeling between nations; they anticipated a great brotherhood in which each nation should be a member; but Cobden was intensely nationalist, and intensely patriotic. The intercourse has come about; but it has not drawn nations more closely together as nations; it has drawn the elements which composed separate nations into new relationships so as to form cosmopolitan ties and interests, and to break down national barriers and weaken national sentiments. We need to think more of the world as a whole; for the practical economic interests of the present are no longer so exclusively national as they used to be. The reality of the change is most obvious when we remember the diminished importance of national prosperity with reference to the sources of taxation. In days when national prosperity was the recognised basis of national power, Parliament desired to increase the "funds" from which it could draw for the expenses of the realm. For this purpose the limits of the nation have ceased to be of exclusive importance. Capital flows into all lands, and the income returns to London and the Income-tax Commissioners collect their *quota*

More than 20,000 lights are, it is stated, now connected to the Deptford system.

Because a driver running a G.W. train into Mansion House station turned the brake handle the wrong way, and so ran into the buffer stop, Major Marindin recommends that the continuous brake should not be used for ordinary stops at that station. The driver, it seems, had his brake on, but he wished to stop short, so as to be near the water-column, but unfortunately turned the brake handle the wrong way. Did any driver never make a similar mistake when continuous brakes were unknown?

It is stated that the experiments carried out in Texas with the view of bringing rain down by exploding dynamite attached to little balloons have proved "satisfactory in all cases."

It is said that M. Janssen has persuaded the Governor of Russian Turkestan to erect an observatory at Tashkend. The atmosphere is clear in those localities, and spectroscopy is the chief object of the work.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor *of the* English Mechanic, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

STAR MAGNITUDES.

[32640.]—In reply to "A. C." (75123, p. 581), I would say that many of the older observers used their own scales of stellar magnitude, which differed considerably from the photometric scale now in general use. "A. C." will find a comparison of some of such scales in the Rev. T. W. Webb's "Celestial Objects for Common Telescopes," 4th edition, p. 207. Smyth, Struve, the two Herschels, and, indeed, all the older observers under-estimated the magnitudes of small stars—that is, they classed them as belonging to a higher magnitude than that in which they would now be classed according to the more exact photometric scale. The history of the adoption of the photometric scale is as follows: —About half a century ago Sir John Herschel noticed that the light of an average star of the 1st magnitude is about 100 times as great as that received from an average star of the 6th magnitude. This would give $\sqrt[5]{100}$, or about 2·512 for the light ratio. Argelander had adopted a light ratio of 2½ in passing from one magnitude to another immediately below it; and some 40 years ago it was proposed by Pogson to adopt the light ratio whose logarithm is ·4—that is, the $\sqrt[5]{100}$ for the universal scale; the simplicity of the idea was at once recognised, and the ratio 2·512 has come into general use, first under the name of Pogson's scale, though it is now more generally spoken of as the photometric scale.

According to the Rev. T. W. Webb, Mimas has been seen by more than one observer with a 6½in. object-glass. It must, therefore, be at least of the 13th magnitude of the photometric scale; but the satellite is so near to Saturn that it would probably not be seen unless it is actually considerably larger. For small stars are lost or eclipsed by the light from neighbouring large stars.

A. Cowper Ranyard.

DOUBLE STARS, &c.

[32641.]—It says much for M. Gaudibert's (32626) eye, as well as instruments, that he should see Σ 2107 double. I know several 12½ mirrors of good performance fail at it completely. Of course, the weather this season has been almost useless for close stars, and in London a misty sky has always prevailed more or less, which will account for my own failure.

I do not consider β 648 at all difficult with a 9in. aperture. There has been so much notion that estimates of position are not much value; but I estimate it 250° ±. There are two minute stars preceding in field, one N. of the other.

I do not think I have looked at Σ 2315 Herculis; but will take first opportunity.

The mentioning in "Scientific News" of the greater brilliancy of the Perseid meteors on Aug. 10 makes me think a phenomenon I saw on that date may be worth mention. At 11.45 p.m. I was mounting steps to look in reflector, when right facing me my attention was attracted to a bright line of light. It extended from near ε Ursæ Majoris towards the pole horizontally—a little longer than distance from ζ to ε. It was quite straight, sharp, and clear, like a polished wire illuminated by sunshine. It persisted 20 seconds or more. I got down to call some one else to see it, and turning at the door, about six steps away, to look, it was gone.

If this was a meteor track, I think it has a bearing upon the supposed photo. of a meteor track exhibited at the meeting of the B.A.A. some little time ago, and of whose reality as a meteor track some doubt was expressed. What I saw on the 10th inst. was bright enough and persisted long enough to have made an impression on the sensitive plate. I should judge it would have taken less time to do so than a 2nd-magnitude star, and if a camera had been pointed in that direction, it would certainly have had a brighter track upon it than the photo. exhibited had. I was amongst those who doubted the meteor being photographed; but I now think I was wrong in such doubt.

It would be interesting to know if anyone else saw the above bright streak. **Edwin Holmes.**

METEORS.

[32642.]—Last night being very favourable for the observation of meteors, I improved the time for an hour. I did not observe for the purpose of counting them, but for the purpose of observing the point of radiation and direction. I observed that the *greater number* became luminous about two degrees *east* of β Cassiopeiæ, and moved directly toward Cygnus. All of these were white, and left a white streak. Some of these moved as far as the Dolphin. Another radiant seemed to be the great nebula in Andromeda; these were less frequent, and ignited with a reddish colour, and moved directly towards the "pointers" in Ursa Major. The third point of radiation was between the nebula and the first-named point; these moved a little east of Mizar, and several passed this point, leaving a trail of fire, indicating sulphur. A few meteors moved in opposite directions; but such may be seen any clear night.

Have Mr. Monck or Mr. Denning observed the above peculiarities? I should have said the meteors would average two per minute; yet they came in groups of four or five per minute.

R. Gobriel,

Milford Centre, Union County, Ohio, U.S.A.
August 11, 1891.

A GREEN RAY.

[32643.]—On Wednesday evening (19th) I noticed, at three minutes to eight in the evening, a ray of light of a distinct green colour shooting up into the sky for some distance, and proceeding from the place where the sun had just set. Not having seen anything of the kind before, I carefully watched it, and it gradually became brighter, and finally faded at two minutes past eight. It was of a distinct green colour, and became broader as it shot higher in the sky. A lady with me confirmed my observation. Can any reader say what this was? Surely it could not be the green ray Venn has written about? Was it a sun pillar?

Dewsbury. **E. Reginald Blakeley.**

RADIANT HEAT FROM THE MOON.

[32644.]—On seeing letter 32383, from Mr. Peal, I read through once again Prof. Boys' paper "On the Heat of the Moon and Stars," and I find there are two points to which I paid hardly enough attention at a first reading, though I am not sure even now that they vitally affect the question of radiant heat. The results given in Prof. Boys' paper might be briefly summed up, I think, under three headings:—(*a*) *The amount of heat stopped by a glass plate.* This was found to be 75 per cent. of the total heat received from the moon, Lord Ross's observations giving 82·7 per cent. (*b*) *The shape of the intensity curve at time of full moon.* Prof. Boys found this to be symmetrical on each side of the maximum, and he says in reference to it: "The remarkable symmetry of the curve for the full moon at first rather puzzled me, as I expected that the side that had been baked by the sun for from 7 to 14 days would be hotter than the side that had only been lighted up for from 0 to 7 days. However, if we consider that soil of any kind is so bad a conductor that it would acquire its final surface temperature in perhaps an hour or less, that is, if not protected by an atmospheric blanket, the symmetry of temperature is nothing more than should be expected."

(*c*) *The question as to whether any heat is given by the dark part of the moon on which the sun has just ceased to shine.* Prof. Boys found no effect whatever "until the terminator itself met the disc of the radio-micrometer." But does this prove anything one way or the other, as regards the lunar surface becoming heated by the sun's rays? If the surface would acquire its final temperature in an hour or less, how long would it take to radiate its heat back into space again at sunset? Remembering that the sun takes nearly an hour to set, as seen from the moon, and that by the time its lower limb reached the horizon its heating effect on the soil, notwithstanding the absence of an atmosphere, would be practically *nil*, I think it can hardly be wondered at that by the time the sun's *upper* limb reaches the horizon—in other words, it has wholly set—the surface of the ground gives us no indications of possessing any heat of its own.

Thus points *b* and *c* seem not to affect the result to any very great extent, and there is left to us point *a*, which does "corroborate Lord Rosse's results." This of course refers only to the particular paper I mentioned, as I have not seen any notice—except in Mr. Peal's letter—of later results obtained by Prof. Boys.

The notice of Prof. Langley's work, to which I referred in my last letter, is to be found in the *Observatory* for September, 1890. While "the principal conclusion drawn is that the mean temperature of the sunlit lunar soil is most probably not greatly above zero centigrade," we find it stated that "in the lunar spectrum two distinct heat-maxima are found—one corresponding to radiation reflected from the soil, the other to that emitted by it (when warmed by sunshine) . . . . unfortunately, the absorption-bands produced by the earth's atmosphere obscure this maximum, and render the conclusions somewhat uncertain." Thus it seems that Prof. Langley has obtained positive indications of some heat being radiated by the moon. **E. P. S.**

Adelaide, South Australia, July 15.

CAUSE OF THE MOON'S ROTATION.

[32645.]—I also, if rather late, beg to thank Mr. Slade for the diagram on page 337, which so clearly illustrates the lunar orbit, and beg leave to suggest that a fitting sequel to this discussion, as to the moon's rotation, is a consideration of the cause which compels our satellite to persistently turn one face towards our earth.

I think that Mr. Slade, "Sigma," "W.," and other students will find something both interesting and unexpected in this sequel to the question of rotation.

In the first place, it seems to be generally admitted that our moon formerly rotated far more rapidly, and has been slowed down by tides, due to terrestrial attraction. In the second place, Proctor, in his "Moon," p. 132, distinctly says that Lagrange has demonstrated that the moon must have an ellipsoidal figure. "If the moon were a perfect sphere, the earth would have no grasp on her, so to speak, whereby to maintain the observed relation between the equator plane and the orbit plane," and hence "we must conclude that the moon is an ellipsoid, and not a sphere."

As far as I can see, these are antagonistic propositions, and that the ellipsoidal figure has been (erroneously) assumed in consequence of looking on the globe as strictly homogeneous. If our seas were solidified, there can be little doubt that our N. hemisphere would have a much denser and heavier crust than the southern, as I pointed out in letter 32140, p. 51, March 13, and it is possible that the centre of the lunar disc facing our earth may be of this nature.

If so, it would release us from the dilemma involved in assuming tidal friction on a globe having an ellipsoidal figure, the increase in mass on our side of the moon, due to extra density of the crust, would produce the same effect as a meniscus added to an homogeneous spheroid.

Sibsagar, Asam, July 21. **S. E. Peal.**

ARE THE LUNAR RINGS AND RANGES CAPPED WITH, OR COMPOSED OF, SNOW?

[32646.]—As some misprints and mistakes have crept into my letter, No. 32475, page 405, rendering those portions obscure, I beg to point them out as briefly as possible. In the middle of column 2 "Fig. 1" should read "Fig. 2." In the first two lines of column 3 it should read, "and the constant renewal of the snow on the cliff faces would *not* be necessary." The "not" was omitted. Also, might I ask those interested in this matter to darken by lead pencil the further segment of the ring in Fig. 2? It has come out in the print as white as the near half, and should be darker. I cannot help feeling that *when* the case is carefully gone into by experts, this greater relative brilliancy of the inner cliffs in lunar rings compared to the outer and higher slopes, will be found to be a powerful argument in favour of the view that the rings are formed bodily of snow.

It is a feature not easily explained if the rings (from Messier to Bailly) are formed of cinders and lava, capped by snow deposit; in that case the cliffs should be darker than the higher gentle slopes outside the rim. What we see is just the reverse, and the surface is *whitest where it is steepest*, i.e., where gravitation could be most effective in removing the surface layers as they become loosened or disintegrated. **S. E. Peal.**

Sibsagar, Assam, India, July 30.

SEEING BY ELECTRICITY.

[33647.]—The description of an apparatus for seeing by electricity, mentioned by "T. R.," letter 33578, I thought was a well-known one. I have noticed it many times in primers and newspapers.

I believe the idea of seeing by electricity originated soon after the discovery of the action of light on selenium by Sir W. Siemens; apparatus was devised for the use of this metal, and that named by "T. R." I should say was the earliest; it appears almost absurd to mention anything requiring a hundred or so circuits, when by the aid of commutators and synchronising their motions, one circuit would suffice.

Another description, and a certainly more feasible one, was described in "Ours" some eighteen months ago. With a little modification (for it is doubtful if this was ever tried), I do not think this would fail to transmit a geometrical figure or the outline of an object. As this would be the most, what is the use of its whirling mirrors, and spots of light can never do more for us.

I was glad to see a correspondent (letter 32529) think like myself. In the future this dream will be realised, modern research assures us, but here on vastly different to anything yet made public. I differ here, for I believe the "base principle" to be already within the present range of physics, but owing to the theoretical knowledge and apparatus required, it becomes more a matter for the physicist than the inventor. Whether this be so or not, who cares? None, save a few amateurs; and so it still remains like a good prize competition, open to all.

While writing, I should like to offer a little suggestion as to the form of zoetrope. Could one be made by using a sensitised glass cylinder, but instead of the outside surface being curved, having numerous flattened planes running longitudinally throughout it while being rotated, the photographs recorded almost microscopically and spirally upon it for exhibition, the cylinder illuminated from the interior projecting arrangement outside, movements similar to a phonograph. One of certainly a manageable size could be made to last one minute—long enough to observe many interesting motions. I once tried a similar arrangement for making a permanent record for the telectroscope.

Numbers of us must have experienced great disappointment when the late "happy combination of electricity and photography" became known, a term certainly misleading; this bogie, it appears, is not to have all that is claimed for it.

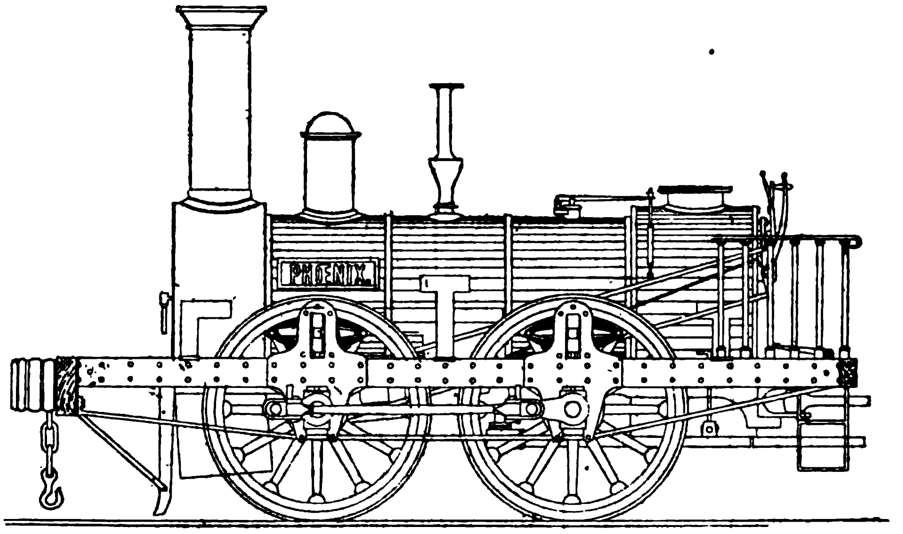
I must refrain from saying more now, for when I pose as a novice some may think I have said too much. **E. August.**

[32648.]—Having read with interest the letter of "T. R." about seeing by electricity, I venture to send an account of a machine I have designed for transmitting pictures by electricity. Kindly say if it is practical. I am not aware that there are already any made like it.

Between a bright light and a bar of selenium is placed a black screen with a minute aperture in the centre, through which a beam of light passes and falls on to the selenium. Between the screen and the selenium is a revolving disc of glass, or some fairly transparent substance on which is traced in black the picture to be transmitted. The disc so revolves that the same part never comes twice across the aperture. When the black part of the drawing passes in front of the hole, the beam of light is cut off, the reverse happening when the clear part is in view. At the other end of the wire a ray of light passes through a hole on to a mirror, which is so made to revolve that the light traces a coil on it; behind the hole is fixed a shutter which opens and closes as the electric current passes down the wire. Opposite the mirror is a photographic apparatus which records the tracing in the mirror. Can you tell me if, when a dark part is in front of the hole at the other end, so as to shut off the light, the electric current will be stopped and the shutter closed, and a corresponding dark space appear on the mirror, and vice versâ? If such happens, and the mirror and disc revolve at the same rapidity, will not a copy of the picture appear on the mirror and be recorded in the camera? If there is any difficulty in revolving the mirror and disc in such a manner, a backwards and forwards movement might be substituted for it. **R. C. C.**

HISTORICAL LOCOMOTIVE.

[32649.]—The diagram annexed illustrates an ancient locomotive engine named "Phœnix," built by R. Stephenson and Co. for the Leicester and Swannington Railway Company, and delivered upon that line on the 28th August, 1832 (59 years ago).



This engine ran upon four wheels of 4ft. 6in. diameter, the cylinders being 12in. by 18in. The boiler was 7ft. 7⅝in. long between the tube-plates, and contained 113 tubes of 1⅝in. diameter. The frame was 16ft. 2in. in length, and the weight of engine in working order, without tender, was 9tons 11cwt. The springs, it will be observed, were of the "grass-hopper pattern; but the experiments made by Mr. Cabry, the company's engine superintendent, showed that they possessed no advantages, and that pattern of spring was therefore discarded. In 1833 the "Phœnix," like the other engines on the Leicester and Swannington Railway, was fitted with a "steam trumpet," or whistle, and in December, 1836, it was sold and sent to the Birmingham and Gloucester Railway Company, to be used as a ballast-engine at the making of that line. Ultimately Mr. J. L. McConnell added a small pair of wheels behind the fire-box, thus converting the "Phœnix" to a six-wheeled engine.

Clement E. Stretton, C.E.

40, Saxe-Coburg-street, Leicester.

August 15, 1891.

BALL BEARINGS.

[32650.]—If "Ball" really does not see the point I have raised, he surely cannot claim to be of the despised "pig-headed" engineers, who have sufficient mechanical knowledge to deal with things as they are. "Ball" cannot be himself a practical engineer if he ignores the relation of surface to weight. I will take "Ball" on his own statement of facts. He draws a parallel between a Singer tricycle with a revolving shaft carried by two rows of balls. I will assume that the weight of a roadster tricycle is, say, 50lb. to 60lb.; the rider, say, 196lb, allowing him to weigh, say, 14 stone. The weight, therefore, on each ring of balls we may assume as, say, 100lb. But as this weight is carried by the balls at the lower side of the bearing (probably divided between two to three of them), we can form an opinion as to the load per ball, and, for the purpose of this question, we will say that each weight-carrying ball has to sustain, say, 35lb. to 40lb. each—a load well inside its capacity. The speed of rotation, also, is not very great, so that the ordinary size ball is sufficient. But, in addition, the instant traction is set up, the load is partly transferred by the angle of the traction, and is further distributed.

If the balls are true spheres, and the ball-race is also a true circle, the surfaces in contact are further distributed, thus easing the pressure per unit of surface of each loaded ball. But, for the sake of argument, we will still assume a load of, say, 40lb. to each ball. The laws of friction, again, tell us that hard metal, such as the balls and their races being of hardened steel, have less friction than of the softer wrought iron running on gun-metal, and that hence within certain limits such friction may be estimated at one-sixth of the whole pressure, and it is therefore possible to maintain both the balls and the races properly lubricated. Now, it is perfectly well known that unless the balls and races were properly lubricated the life of the bearing would be short indeed.

The total pressure against the side of the axle brass in an ordinary loco. of given size I have taken at just over 98,000lb., the pressure at which oil is squeezed out between two surfaces and friction and cutting set up is also known, and as "Ball" appears to be an authority on this question, which I do not pretend to be, will he show what amount of ball rolling surface practically worked out would be needed? If the ball races were not hardened, as should be the balls themselves, then he is still further to the bad. And as a practical engineer and builder of loco. and marine engines, in the first place I should not care to trust a hard steel race to the many and various blows and jars of the road, and, beyond this, see the various mechanical difficulties involved.

Practically, *it is not practical* to carry a weight of any amount on ball bearings, such as an engine or prime mover, and I could, if necessary, justify this statement sufficiently to convince any person open to reason, which I can only (judging by his statements) conclude "Ball" is not, in view of his expressed opinion. And it must be equally plain that his engineering knowledge has not yet led him to properly understand the difference between a lightly-loaded shaft revolving with practically perfect lubrication, and the crank-shaft of an engine where the tendency is to force out oil from between the contact surfaces. With the certainty that if the lubricant *is* forced out, friction and cutting must ensue. I do not in this statement bring into my calculation the effect of the blow necessarily inflicted on the ball-bearings, due to the pressure of the steam on the piston and the acquired momentum ere the slack was taken up. "Ball" may be an authority on bicycle bearings and light shafting carried on balls; but he must not attempt to convince engineers that what is surface enough for light loads is also sufficient for heavy ones. Had "Ball" had *practical* engineering experience of the working of, say, marine engines, and the difficulties and care needed to lubricate the bearing surfaces, he would not speak so rashly as to reducing, rather than increasing, wearing surfaces exposed to pressure and percussion. **Vulcan.**

THE PHYSICAL BASIS OF MUSIC.

[32651.]—On page 535 of your issue of the 7th inst., I notice that a Japanese student at Berlin named Shohe Tanaka is stated to have patented a new musical instrument, the key-board of which is provided with twenty keys to the octave; but it is not clearly stated whether this ingenious Japanese gentleman has actually discovered a means of dividing the scale into twenty equal intervals. At any rate, the invention referred to is not new, as you will see by the accompanying paper, written by me upwards of ten years ago, and then printed in a periodical now extinct. If you consider the subject of sufficient interest to your readers, you are quite at liberty to print my paper in your columns. **Thos. Myres Purday.**

63, Stanhope-road, Darlington, 10th Aug.

The noise caused by the falling of a deal plank would not generally be considered as at all musical, and yet, if a series of seven ordinary boards, cut to the following lengths respectively, viz.:—7ft. 6in., 6ft. 8in., 6ft., 5ft. 7½in., 5ft., 4ft. 6in., 4ft., 3ft. 9in., be allowed to fall successively, the ordinary major diatonic scale will be readily audible. A Hansom cab rattling over the London pavement seems to be an unlikely musical instrument, but the rumbling sound produced has been, by competent observers, during the silence of the night, identified with the C sharp yielded by the 32ft. stop on an organ.

[Since writing the above, I see that a Mr. Eugene M. Thayer, in this month's *Scribner*, undertakes to show that the sound produced by the Falls of Niagara is really a musical tone, and not merely a roar. He identifies the fundamental note with G *five octaves below* the first line of the bass cleff, and asserts that he succeeded in distinguishing nine overtones or harmonics! He calculates that, with a certain diameter, a pipe 160·42ft. long would yield the note of Niagara, and, as this is, as nearly as possible, the height of the Falls, he concludes that "the tone proves the height, and the height proves the tone." Pushing his investigations to the utmost limit, he boldly declares the rhythm of Niagara to be that of three groups of triplets per second, with a chief-accent or beat on the first note of each group of three. Apart from its scientific worth (which is small) the article is worth reading, both as an example of inflated style and as an excellent instance of innocent circular argument.]

The distinction between noise and musical sound is merely one of degree, and there is no real limit where the transition between the former and the latter can be absolutely determined. Speaking generally, however, noise may be considered as being produced by impact or shock, while musical sound or tone is due to rapid isochronous vibration. According to Dr. Stone the strictly musical forms of vibration may be tabulated as follows:—

VIBRATIONS.

- I. Of strings
  - 1. Transverse
  - 2. Longitudinal
  - 3. Torsional
  - excited by
    - a. Plucking
    - b. Striking
    - c. Bowing
    - d. Impact of air
  - Vary with
    - a. Nature of stroke
    - c. Place struck
    - b. Rigidity of string
- II. Of rods ..
  - 1. Transverse
  - 2. Longitudinal
  - 3. Torsional
  - with
    - a. Both ends fixed (approach to those of strings).
    - b. One end fixed (nail fiddle, musical box).
    - c. Centre fixed (tuning fork).
    - d. Both ends free, nodal points supported (hormonicon).
- III. Of Plates
  - 1. Radial
  - 2. Circular
  - As in Chaldini's experiments (gong cymbal).
- IV. Of bells ..
  - 1. Spherical
    - a. Excited by blows (clock chimes).
    - b. By tangential or radial friction (musical glasses).
  - 2. Of complex figure (give compound notes with irrelevant harmonics).
- V. Of membranes..
  - 1. Independent (tambourines).
  - 2. With associated air-chambers (kettledrum resonators).
- VI. Of reeds..
  - 1. Free (as in harmoniums).
  - 2. Beating
    - a. Single (clarinet, organ reed)
    - b. Double (bassoon, oboe).
  - 3. Membraneous
    - a. The lips (in brass instruments).
    - b. The larynx (human voice).
- VII. Of Cols. of air ....
  - 1. Organ pipes
    - a. Open pipes.
    - b. Stopped pipes.
    - c. Half stopped pipes.
    - d. Pipes with reeds.
    - e. Mixtures and mutation stops.
  - 2. Consonance boxes and vessels.
- VIII. Of flames
  - 1. Chemical harmonicon, pyrophone.
  - 2. Sensitive and singing flames.

The only form of vibration with which I propose to deal is the transverse vibration of strings. The laws of these vibrations are simple, relate to (*a*) the length, (*b*) the tension, (*c*) the diameter, and (*d*) the density of the string, and may be concisely formulated as follows:—

1. The number of vibrations of any string in a given time is inversely proportional to its length.

Let the number of vibrations in a given time be 1: then, if the length of the string be diminished so as to reduce it to one-half, one-third, one-fourth, one-fifth, &c., the number of vibrations in the same time will be 2, 3, 4, 5, &c.

2. The number of vibrations of any string in a given time is proportional to the square root of the stress of tension.

Let the number of vibrations in a given time with a given tension be 1; then, if the tension be augmented by 4, 9, 16, &c., the number of vibrations in the same time will be 2, 3, 4, &c.

3. The number of vibrations of strings in a given time is in inverse ratio to the diameter of such strings.

Of two strings—one of steel, the other of copper—both of equal length and subject to similar tension, but of which the diameter of one is double that of the other, the less will vibrate twice as fast as the greater in a given time.

4. The number of vibrations in a given time of strings of different material is in inverse ratio to the square root of the respective densities of such strings.

Of two strings, one of gut with a density of 1, the other of copper with a density of 9, both of equal length and diameter, and subject to similar tension, that of gut will, in a given time, vibrate thrice as fast as that of copper.

Of these four laws, the first is the most important with respect to the fundamental bearing which it has upon the subject under consideration, for, from this law is derived the musical scale, or regular succession of notes used in music. There are seven principal musical sounds which are distinguished by the first seven letters of the alphabet; and, taking unity as a basis, the length of the string, the ratio of vibration for each, and the respective intervals may be exhibited thus:—

Lengths......	1		$\frac{8}{9}$		$\frac{4}{5}$		$\frac{3}{4}$		$\frac{2}{3}$		$\frac{3}{5}$		$\frac{8}{15}$		$\frac{1}{2}$
Notes........	C		D		E		F		G		A		B		c
Vibrations....	1		$\frac{9}{8}$		$\frac{5}{4}$		$\frac{4}{3}$		$\frac{3}{2}$		$\frac{5}{3}$		$\frac{15}{8}$		2
Intervals		$\frac{9}{8}$		$\frac{10}{9}$		$\frac{16}{15}$		$\frac{9}{8}$		$\frac{10}{9}$		$\frac{9}{8}$		$\frac{16}{15}$	

This succession of notes is technically termed the major diatonic scale; there is also another form called the minor mode, but with that I do not propose to deal at present. It is essential to notice that, as the intervals between the degrees of the scale as above given are not uniform, if we start from D, for instance, the whole character of the succession will be altered, or, in other words, a different *melody* will be produced. The following diagram will help to render this clear. The letters representing the scale are placed relatively to each other so as roughly to represent the intervals:—

Diatonic scale proceeding from C.	C D EF G A Bc d ef
Scale with similar intervals proceeding from D.	1 2 34 5 6 7$1_1$ 2_1 3_1

In the new scale, indicated by the figures, it will be seen that the notes D, E, G, A, B, d, of the original series correspond with the degrees 1, 2, 4, 5, 6, 1^1, of the new scale; but that to the third and seventh degrees of the latter there are no corresponding sounds, so that in order to perfect the new scale, it becomes necessary to intercallate additional notes between F and G and c and d of the old scale, which shall bear similar relationship to the new scale that E F, Bc, do to the old. These new notes have in practice been added, and are called F sharp and C sharp respectively, and, as it is of course competent for us to adopt any note as a starting point or key-note, it will be at once apparent that each of the original notes will require to be slightly raised or depressed in order to form the new notes thus rendered necessary. Theoretically this is effected by multiplying the vibration ratio of the note to be elevated or sharpened by $\frac{25}{24}$, or by $\frac{24}{25}$ if it be desired to depress or flatten a note. Now, although on the piano or organ there is no distinction between sharps and flats (C sharp, for instance, being the same as D flat), it is evident that any two notes obtained by the process above indicated are not really identical, and it is highly probable that comparatively few who play the piano are aware that there is any real distinction between a sharp and a flat. In order, however, to show that such a difference does exist, I append a table of the true values of each note of the scale:—

JUST INTONATION.

Name.		Ratio of length.		Ratio of vibration.
C	....	1·0000	....	1·0000
C sharp	....	0·9600	....	1·0416
D flat	....	0·9259	....	1·0800
D	....	0·8888	....	1·1250
D sharp	....	0·8533	....	1·1718
E flat	....	0·8333	....	1·2000
E	....	0·8000	....	1·2500
F flat	....	0·7812	....	1·2799
E sharp	....	0·7680	....	1·3020
F	....	0·7500	....	1·3333
F sharp	....	0·7202	....	1·3888
G flat	....	0·6944	....	1·4400
G	....	0·6666	....	1·5000
G sharp	....	0·6400	....	1·5625
A flat	....	0·6250	....	1·6000
A	....	0 6000	....	1·6666
A sharp	....	0·5760	....	1·7360
B flat	....	0·5555	....	1·8000
B	....	0·5333	....	1·8750
C flat	....	0·5207	....	1·9200
B sharp	....	0·5120	....	1·9531
C_1	....	0·5000	....	2·0000

It will be noticed upon inspection of the above table that E sharp is higher than F flat, and that B sharp is higher than C flat; the notes are all however distinguishable, and that this is really the case I need only mention, as an example, that the effect of hearing a piano solo at a concert immediately after a string quartette, is such as to induce the listener to believe that the piano is not accurately in tune, which is really the case. The violinists played in just intonation whereas the piano is tuned upon the system of equal temperament, by which the inequalities are nearly equally distributed throughout the whole cycle of keys. That this is the case a comparison of the following table with that above given will at once make apparent.

EQUAL TEMPERAMENT.

Name.		Theoretical vibration ratio.	Actual vibration ratio.	Difference.
C	....	1·0000	1·0000	0·0000
C sharp	....	1·0608	1·0594	− 0·0014
D	....	1·1250	1·1224	− 0·0026
D sharp	....	1·1859	1·1892	+ 0·0033
E	....	1·2500	1·2598	+ 0·0098
F	....	1·3333	1·3347	+ 0·0014
F sharp	....	1·4144	1·4142	− 0·0002
G	....	1·5000	1·4982	− 0·0018
G sharp	....	1·5812	1·5874	+ 0·0062
A	....	1·6666	1·6817	+ 0 0151
A sharp	....	1·7680	1·7817	+ 0·0137
B	....	1·8750	1·8877	+ 0 0127
C_1	....	2·0000	2·0000	0·0000

It appears that actually, therefore, there is not a single note on the piano which is really in tune. The aim of equal temperament is the division of the octave, or vibration ratio 1 : 2, into twelve equidistant intervals. If this could be done, it would no doubt be a great boon; but, unfortunately, it is not possible to do so and yet adhere to the true scientific basis of music, as I shall now endeavour to show. If a string be caused to vibrate with small paper rings or riders threaded upon it, these riders will gradually settle down at certain different points of the string, thus denoting that at such points, which are termed nodes, there is no vibratory motion, and that hence, while the string is vibrating as a whole, it is also vibrating in segments. Now, according to the first law of vibrating strings above given, the number of vibrations is inversely proportional to the length of the string, so that the rate of vibration of these segments respectively must be greater than that of the whole string; but, as difference in sound or pitch depends upon the velocity of vibration in a given time, it follows, that besides the fundamental note emitted by the whole string, there must be other notes simultaneously given out, although with much less intensity. That this is actually the case can be easily verified by attentive observation. These secondary notes are called harmonics, overtones, or upper-partial-tones and are notes the vibration frequencies of which are exact multiples of that of the lowest or fundamental note of the string. The nodes can be artificially produced by lightly touching a vibrating string, and speaking generally, if touched at $\frac{1}{n}$ of its length from either end, the harmonic yielded will have a rate of vibration n times that of the fundamental note, the string dividing itself into an equal number of segments. Helmholtz was the first to investigate this phenomenon exhaustively, and to show that upon it really depends the scientific basis of music. Dr. Stone states the principle as follows: "When any note is sounded on a musical instrument, in addition to the primary tone, there are produced a number of other tones in a progressive series, each note of the series being of less intensity than the preceding. If m denote the number of vibrations of the primary tone in a given time, the vibration numbers of the whole series will be in the order m, 2m, 3m, 4m, 5m, 6m, 7m, &c. Thus, if the primary note be C, the whole series will be, for the first three octaves:—

Ratio	m	2m	3m	4m	5m	6m	7m
Note	C_1	C_2	G_2	C_3	E_3	G_3	X
Vib. number..	64	128	192	256	320	384	448

We have here three C's, two G's, one E, and a note marked X lying between A_3 and B_3. If the octave above C be sounded with it, the harmonic series produced by C_2 will be, in the first three octaves:—

Ratio	2m	4m	6m	8m	10m	12m	14m
Note	C_2	C_3	G_3	C_4	E_4	G_4	X_1
Vib. number..	128	256	384	512	640	768	896

Again giving three C's, two G's, one E, and one X, an octave above the former. If, then, the two notes C_1 and C_2 be sounded together, the first three octave harmonics of C_1 will be compounded with the first two octaves of C_2 as follows:—

C_1 1st intensity	G_3 + G_3 3rd and 6th intensity
C_2 + C_2 1st and 2nd intensity	E_3 5th intensity
G_2 3rd intensity	X_1 7th intensity
C_3 2nd and 4th intensity	

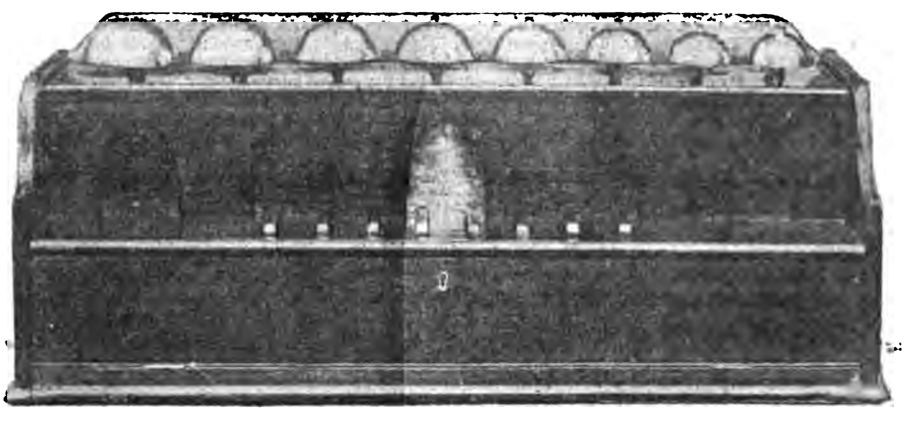
It is therefore evident that when the two notes C_1 and C_2 are sounded together, they produce overtones, upper partial tones, or harmonics, in which besides C's, the note G (the fifth) with its octaves, and the note E (the third) with its octaves, are more nearly related to C than any other notes are. It may be remarked that the combination of notes differing by an octave is to throw the notes X further back, making them less audible, and bringing out more clearly the relationship of C E and G." Now, the principles here stated are true for every vibrating string; consequently, if two adjacent strings tuned to different notes vibrate simultaneously, each will produce a complete series of harmonics derived from its fundamental note, and the harmonics of each string will either blend and enforce or neutralise each other, the result being that certain notes will be rendered more perceptible or prominent than others, and thus a series of resultant tones will be produced. Now, it must be clearly borne in mind that the relation between two musical notes does not depend upon the number of vibrations in a given time, say a second, of either note, or the numerical difference of the number of vibrations per second for the two notes, but on the *proportion* of the number of vibrations for one note to the number of vibrations for the other note. But from what has been already stated it will have been seen that, as represented fractionally, there is a want of arithmetical agreement between the various intervals between the degrees of the scale, for it is impossible, as Mr. Ellis points out, by multiplying any one of the numbers $\frac{3}{2}$, or $\frac{5}{4}$, or 2 each by itself, or one by the other, any number of times, to produce the same result as by multiplying any other one of these numbers by itself any number of times. An illustration will make this clear. Assuming that the octave be divided into twelve equal intervals or semitones, the "fifth" (C to G) should be seven of these; but it is actually 7·01955, so twelve such fifths will yield more than seven octaves by 0·23460 of a semitone. The octave and fifth are incommensurable, just in the same way as are the diameter and the circumference of the circle. This incommensurability is a law of nature, and is not merely the result of any given system. Very many attempts have been made to overcome this difficulty, but, naturally, without success. Equal temperament, which is the modern expedient, is therefore, as I before stated, impossible, and being irrational and unscientific, it must, I believe, ultimately be abolished, although so long as the present system of keyed musical instruments continues in use, it is difficult to see how it can be done away with, unless players upon them will forego the use of extreme keys, and be satisfied with a much more limited range of scales, tuned to the old unequal or mean-tone system. This, however, could not be considered as a solution of the difficulty, but merely as a clumsy evasion of it. A decimal scale constructed upon a constant difference of vibration ratio between the successive degrees would, with its semitones, yield the major triad (C E G), but the subdominant and the superdominant would be absent. Such a scale I have computed as in the following table, but apart from absence of experimental test I am unable to say whether its effect would be pleasurable, while, for certain theoretical considerations which it would take too long to develop here, I doubt whethere it would be practiably applicable to all music.

DECIMAL SCALE.

Degree.	Length ratio.	Vibration ratio.
1	1·000	1·000
½	0·952	1·050
2	0·909	1·100
½	0·868	1·150
3	0·833	1·200
½	0·800	1·250
4	0·769	1·300
½	0·740	1·350
5	0·714	1·400
½	0·689	1·450
6	0·666	1·500
½	0·645	1·550
7	0·625	1·600
½	0·606	1·650
8	0·588	1·700
½	0·572	1·750
9	0·555	1·800
½	0·540	1·850
10	0·526	1·900
½	0·512	1·950
1_1	0·500	2·000

The actual points of contact between this artificial scale and the natural scale can easily be seen by comparison with the tables above given, and the introduction of quarter tones, each equal to 0·025, would yield D and B accurately, and the following notes very nearly, viz.:—D flat, D sharp, sharp, F, G sharp, A flat, A, A sharp, and B harp. Whether this is a practical plan I cannot yet say; but I am inclined to believe that nothing short of an entire revision of the present system of music can remedy the defects which have gradually been introduced chiefly by pianoforte makers in the search after brilliancy and adaptability. How such a revision is to be effected is one of the problems of science which in the actual state of our knowledge appears to be insoluble.

I have already extended this paper to an inordinate length, although I have really only done scarcely more than touched the fringe of the subject; but I trust that what I have said may induce others to devote attention to a branch of study which, although rather abstruse, is yet of sufficient interest and importance to demand attention, and cannot fail to repay the student for the labour and time devoted to its investigation, while at the same time it will open out new fields of research and be productive of much mental training. I have purposely avoided the artistic aspect of the question, although the culture of music, which is certainly the noblest and most divine of the arts, is fraught with all that tends to elevate and refine our nature.



Standard works to be read upon the subject: Helmholtz, "Sensation of Tone"; Airy, "On Sound and Atmospheric Vibrations"; Sedley Taylor, "Sound and Music"; Lord Rayleigh, "Theory of Sound"; Tyndall, "On Sound"; Perronet Thompson, "On Just Intonation"; Donkin, "Acoustics"; Bosanquet, "On Musical Intervals and Temperament"; Dr. Pole, "The Philosophy of Music." **T. M. P.**

ELECTRICAL.

[32652.]—MR. GOODCHILD (p. 549) seems to think that capacity and conductivity are the same. Capacity varies as the size of the conductor, while conductivity depends upon the size, shape, and nature of the conductor. Capacity means the quantity of electricity a conductor will hold at rest, while conductivity refers to the absence of resistance to the electricity in motion. Lessening the resistance does not cause more electricity to accumulate, although increasing the capacity does, since it can contain more.

In my last letter to Mr. Goodchild (32579, p. 504) I meant to have said "current's strength," instead of resistance. However, it is of no consequence, since decreasing the resistance increases the current's strength; so it would have been correct to say either. I did not base my argument on the assumption of the necessity of one ohm to allow a current to pass, but on the assumption that force cannot exist without resistance. The former is the conclusion arrived at from the latter, although I know a current may pass with less resistance than one ohm.

Will Mr. Goodchild kindly say what objection there is in regarding an increase of chemical action as cause of an increase in the current's strength? I regard the increase of chemical action both the cause and effect of the increase of current's strength.

I am somewhat amused at the rather strong expressions "Sm." uses—viz., "utter nonsense," "a man beyond argument," &c. In his first letter he clearly said that if the zinc is enlarged, the volume of the liquid through which the current passes is also increased; and then, in his last letter, he says there is no such thing as a current, and goes on to talk something about the electrolysis of the liquid, which has not the least scrap of anything to do with the argument, thus evading a direct answer to my letter.

Does "Sm.," by saying there is no such thing as a current, mean there is no electricity in the circuit (of which the liquid is a part)? Perhaps he is an "etherite" who maintains that the electricity exists in the medium around the conductor in the form of ether. In conclusion, I must say that "Sm." uses far more fallacies than myself, and also that he has strangely contradicted himself, which I would be pleased for him to explain.

A. Benjamin.

THE OSBO-PREMIER BATTERY.

[32653.]—IF F. Hamer [letter 32609] will read our letter again, he will find we do not claim for the battery a small consumption of zinc (practically it uses a large percentage); but we do claim for it a long, constant life—the every point F. Hamer states is so necessary. F. Hamer errs in stating that the solution requires recharging every 6-8 hours. If F. Hamer will kindly read this again, he will find that the solution only requires reoxydising (the solution runs 20-100 hours). The recharging takes five minutes, the oxydising two minutes. If this is too long for F. Hamer, we think he had better have nothing to do with primary batteries whatever.

Clark and Montigue.

THE BELLPHONE.

[32654.]—SIMILAR in the construction of the bells, but to produce music under a different method, is the aim of the inventor of the "Palsiphone," of which the drawing and description appeared in the "E.M." (No. 1377) to an invention of mine which I christened the "Bellphone," and exhibited in the Royal Military Exhibition held in London last year. My aim, as well as the inventor of the "Palsiphone," was to produce music on bells, and although I worked mine under a different principle, it might be interesting to our readers to say capital music was produced in this way, and will show what might really be done. My idea, as will be seen by the drawing, was to play them by means of keys, similar to the piano, each bell being struck in its turn by a striker at the back, under the single-stroke principle. Care had to be taken to deaden the noise of the striker, which was overcome by felt pads; the drawer in the front being for music. The bells, eight in number, were cast, and tuned to an octave, by Moore and Hughes, London; but under this principle any number might be arranged.

H. Andrews, Corporal R.E.
Postal Telegraphs, Poole, Dorset.

RECREATIVE MICROSCOPY.

[32655.]—A PRETTY object for entertaining friends is the arborescent growth of silver crystals. To show this, dissolve a small crystal of silver nitrate (or a piece of lunar caustic) in a few drops of rain water. Place a drop of this solution in the centre of a slip of glass, and arrange it under a low power of the microscope, concentrating the light from above by means of a stand condensing lens. Now take a piece of copper bell-wire, 1½in. long, and bend it like a capital L, then bend the longer limb to form a hook, which will rest anchor-fashion when laid down. Place this at the side of the drop of solution, allowing the hook to dip into it *at the edge*. Chemical exchange results, copper going into solution, and silver crystallising out.

N.B.—Do not spill the solution, as it stains black.

Framlingham. **Henry Ebbage.**

CAULD KALE MADE HET AGAIN.

[32656.]—I ONCE knew an amateur scientist who used to exhibit at conversaziones and the like, and who, being a man of much ingenuity, sometimes unwittingly re-invented very old contrivances, and innocently showed them off as new. When the antiquity of these was pointed out by some too candid friend, we sometimes found them described in the next morning's newspaper as "locally discovered by Mr. X."

There are three instances in No. 1377 which remind me of Mr. X.'s local discoveries. On p. 548 we are told that the luminous fountains, of late years so common, owe their origin to a laboratory experiment by M. Becquerel in 1876. If my memory serves, the production of illuminated water jets of the kind that might suggest the photophone as described, is mentioned in a book of Mr. Pepper's as having been exhibited at the London Polytechnic nearly half a century ago. But the French have a large and comfortable ignorance of everything outside France.

On the same page we learn that a "new system of ventilation is to be tried on the Fourth Avenue Railway Tunnel" in New York. The system described as "new" seems to be what has been known here for years as the "Brattice system." Our smart American cousins have no doubt a great faculty also for local discoveries.

On p. 540 Mr. Charles A. Parker tells us that as lamps burning colza or sperm oil were only capable of illuminating pictures of a few feet in diameter, it was not until the invention of Mr. Marey, of Philadelphia, of the Sciopticon, "that the lantern quite grew out of its position as a scientific toy," implying that the Sciopticon was a direct and immediate improvement on the old colza lamp. The limelight, sometimes called the "Drummond light" (was not Drummond a Cornishman?), and the electric lamp of Dubosc are, in the mean time, quietly ignored, though they certainly were not mere scientific toys, and were in use long before the Sciopticon—perhaps even before the inventor of that excellent lamp was born or thought of himself. Indeed, it seems most likely that the effects produced by the limelight, showing what might be done, were the spur to the perfecting of the oil-lamp. At present I think most people would class the oil-lamp as much more of a scientific toy than the oxyhydrogen.

Belfast, August 17. **J. Brown.**

ROSE-VASE OR POT-POURRI.

[32657.]—It did not strike me, when the query about rose-vase first appeared, that the preparation called pot-pourri was probably the perfume intended. I made this preparation some sixty years ago from a recipe given me by an old lady, who resided for many years in France, where rose-leaves were plentiful. The following were the ingredients employed, and the mixture keeps good for many long years, provided it is kept in a jar with a well-fitting lid, which of course has to be removed and the mixture shaken up when it is desired to have the perfume pervading the room in which it is kept:—Provide a wide-mouthed china jar with a fairly well-fitting cover (one of those in which preserved ginger is imported will serve in the absence of anything more ornamental), and wipe the inside perfectly dry with a cloth. Collect as many fresh rose-leaves as are available from day to day, and see that they are free from dew or drops of water; if wet, spread them loosely on an old newspaper until the moisture has evaporated. Then procure some baysalt, put a handful of rose-leaves into the jar, and sprinkle them freely with the salt, and continue adding layers of rose leaves and of salt as they are procurable.

In addition to the rose-leaves, those of clove-carnations, jasmine-flowers, orange flowers, lavender, and other similar flowers are available, and add to the excellence of the perfume: also a few bay leaves.

Get a Seville orange, stick cloves into it, as full as possible, suspend it by a string in front of a fire, causing it to revolve, until it is dry; a good piece of orris-root may be put into the mixture, it will become soft after a few days, and can then be sliced up. A lump of gum benzoin should be broken up in a mortar into small grains, and the dried orange also broken up, and the whole mixed in with the rose and other petals. After a few months' keeping this should emit a most delicious perfume.

Gamma Sigma.

PHOTOGRAPHIC OPTICS.

[32658.]—There has just appeared under this title a work by Dr. Hugo Schroeder, which will be welcomed by practical opticians and amateurs alike. The latter will find in it an ample reply to the many requests for information addressed to these columns, and the former a practical treatise forming a reliable guide in their lucrative business of photo-lens making. In this royal octavo of some 200 pages a hard blow has been dealt to rule-of-thumb work. Those who will carefully peruse it need no longer work in darkness and uncertainty; but can do it in broad daylight and full conviction that every step forward will bring them one degree nearer to a successful result. And those students who have hitherto derived their optical knowledge from the meagre contents of textbooks only, will be surprised at the number of further considerations requiring attention before a practical plan for the construction of photo-lenses can be laid down, and they cannot fail to admire the skill and patience that has given us the good lenses we possess, without clearly understanding the numerous conditions they must satisfy. Though the work deals mainly with the construction of photo-lenses, it will prove itself as useful for the combination of any other kind of lenses, as the formation of images and the correction of chromatic and spherical aberrations, astigmatism, and diaphragms have been masterly treated. Actinism, of course, need not be taken in account in telescopic and microscopic lenses.

The work is preceded by a valuable list of the principal optical works that have appeared since Newton in English, French, German, and Italian, including fragmentary dissertations contributed to the learned societies, with annotations by the author. Whilst it numbers some 200 works on general optics, only six or seven refer specially to photography. First among these is Petzval's, published in 1843, 1857, and 1858. Dr. H. Zinken, Voightlaender's son-in-law; Dr. Lorenzo Billotti, Schiaparell's assistant at Milan; and Prof. Seidel, Steinheil's friend, at Munich, also contributed considerably to the perfection of photogr.-optics. Still, nothing *complete* and easily *understood* appeared until the work under notice was called forth by Prof. W. Vogel in Berlin to form a supplement to his new "Handbook of Photography."

It is unfortunate that most of this valuable information is in German. The present complete treatise, however, will no doubt soon also appear in an English dress. Meanwhile I shall be pleased to help those who may desire to know something more of the practical rules and formulæ developed by the author, if the Editor will afford me space. Dr. Hugo Shroeder possesses the rare advantage of being a linguist and practical optician, as well as a mathematician, and this advantage enabled him to simplify much that was hitherto obscure, and to bring together information that was scattered about in many inaccessible writings. He dissects all the lenses in actual use, and shows on what principles they have been constructed, and how they can be still further improved. **A. Caplatzi.**

REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[74657.]—**Hand-Cart.**—I am at a loss how to answer this query, as the querist says he wants to make a hand-cart, and then gives the sizes he is about to make it. Make it the size you say by all means, and you can use red deal, ash, oak, or anything that you have at hand; and as to size, that will depend on the weight it has to carry. As you wish the top flat, plane up your pieces straight, and frame them together, and you will have a flat top. If you want your top to be the same size as your cart body, then strike it out the same width and length. J. C.

[74757.]—**Couch.**—These things, which are called couches, are made of so many sizes and different patterns, that it is hard to give sizes, &c. Take two pieces 2½in. by 3in. by 4ft. 6in.—this is two sides—two pieces 2½ by 3in. and 19½in. long, and frame this together, keeping your crosspieces about 5in. or 6in. from the ends. This is where your stumps will be put on with their castors. This will be about 9in. or 9½in., castor and all measured. The stumps should be about 3½in. by 3½in. Put a piece each end when your frame is made, about 1½in. by 3 as the pattern at the back. This is as you wish to have it. J. C.

[74772.]—**Surnames of Jews.**—Many German Jewish families owe their surnames to the fact that law obliged them to take a distinctive appellation other than a common Hebrew one, for the Abrahams, Jacobs, &c., had become so numerous that identification of individuals was becoming almost impossible. The names taken were frequently very fanciful, for instance, Rosenberg (mount of roses or rose mount), Blumenthal (valley of flowers), Morgenroth (the red dawn). The names of cities or towns were sometimes made use of, as Emden, Frankfurter, Hockenheimer, or those of animals, as Baer (bear), Loewe (lion). Rothschild means red shield; Meyer is an old word for farmer, and in England has become Mears. Other instances occur of a German name being modified in England to imitate the English pronunciation.

C. E. T.

[74852.]—**Dynamo (U.Q.)**—To Mr. Bottone.—It is almost impossible for me to say what is wrong with your dynamo without examining it. Apparently something amiss with connections. Connect one wire from field-magnet to one brush. Take the other wire from the other field-magnet direct to terminal. Now connect up by a wire the free brush to the other free terminal. Drive the dynamo first in one direction and then in the other, trying whether you can get a spark on stroking one terminal with a bit of copper wire connected to the other. If it sparks when you are driving with the brushes, well and good: if it sparks when driving against the brushes, reverse the field-magnet wire connections. If you don't succeed, and you live in the London district, you may send it to me, and I will try to put it right.

Wallington. S. Bottone.

[74904.]—**Sulphurous Acid.**—This acid, when manufactured under skilled attention, is not more dangerous than any other chemical works' operation—not so dangerous as many; but then skilled attendance is required. S. T. L.

[74908.]—**Concertina.**—What sort of a concertina is it? German concertinas generally do give out "nasty, twangy" sounds; but they are good enough for the money. Deutsch.

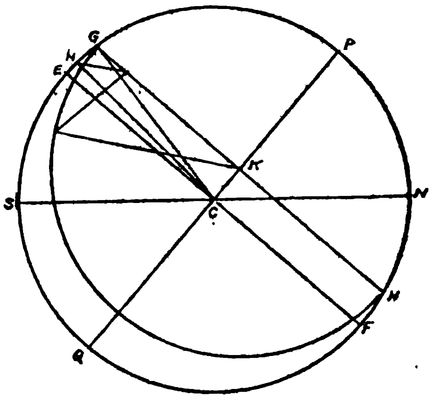
[74920.]—**Papering a Ceiling.**—Give your ceiling a good coat of size, and have your paper pasted; keep your hands as flat under it as you possibly can, and have some help, and let them hold it in the same manner; and when it is put to the ceiling so as to hold on, have a house brush, and press it up, keeping the hairs of the brush against the paper. Paper your ceiling the shortest way of the room. J. C.

[74932.]—**Artificial Foot.**—I thank C. V. G. Simons, M.B., C.M., for the diagram. I think the motion very good. The only objection I have got is to the weight—of course, my leg is weak, the amputation being only four months ago. I am carrying all my weight from the thigh. I have a 7in. belt laced in the front, with two steels attached to it, and riveted to the steels *b b*. I find, on walking, that the leather seems to give way, which causes a limp. Would Mr. Simons kindly tell me how I might get over that difficulty? Dunder.

[74950.]—**Solution of Mercuric Chloride.**—With reference to "Pel's" reply to this query, whilst acknowledging the true weight of what he states, we still hold to our previous reply. As an authority for same, we may give Dr. Tidy (who gives same in his book). We have no further books of reference here, or we would give further.

Clark and Montigue.

[74981.]—**Solar Altitude.**—"R. G. W." will, I think, find the following graphical mode of finding the sun's altitude sufficiently accurate for his purpose: Draw a circle N P S Q with any convenient radius; draw any diameter S C N; make the angle N C P equal to the latitude of the place (for Liverpool this angle equal 53° 24′); draw E C F through the centre perpendicular to C P. Take the sun's declination for the day from "Whitaker's" or other almanac, noting whether N. or S., and make the angle E C G equal to the declination (towards P if dec. is N., away from P. if S.) Through G draw G K H parallel to E C F. With centre K and radius K G describe semicircle G L H. Make angle G K L equal to sun's hour-angle, which is found by taking the interval from apparent noon to the time when sun's altitude is required, and reducing to angle at the rate of 1h.=15°, 1m.=15′, 1s.=15″. (Apparent noon differs from clock noon by the amount of the equation of time: it is before clock noon when the sun is before clock). Draw L M perpendicular to G K, and M N parallel to S C N; join N C; measure the angle N C S with a protractor: the resulting value is the sun's altitude. "R. G. W." will doubtless be able to make out the reason of the various steps himself. The first part of the construction (down to drawing E C F) may be conveniently multiplied by a copying machine, as it is applicable to all cases. A. C. D. Crommelin.



Montpelier House, Blackheath.

[75004.]—**Flywheel.**—I note the correct size of cylinder of your engine. Let the flywheel be 2ft. 6in. diam., and weigh 1¼cwt. You can with this size and weight safely run at 250 to 300 revolutions per minute, always supposing the wearing surfaces are sufficiently large. Vulcan.

[75009.]—**Electric Light.**—I am informed that there are patents in various countries, and a company in France (Paris), under the name of Perrier-Lloyd, supply $CuSO_4$ batteries for the supplying of isolated incandescent installations. The company buys the electrolytic copper deposited, claiming to make the light very cheap. Can this be practical? I think not. L. D. C.

[75029.]—**Microscopical.**—If Mr. Francis Birgh will advertise his address, the writer will probably be able to give him all necessary information. It is scarcely possible to convey it by writing.

Optus.

[75047.]—**Stand for Telescope.**—Far and away the best altazimuth stand that I have seen is that made by Mr. Calver for his reflectors. The defect in the ordinary claw and pillar-stand, and all on this principle, is that the universal joint is not rigid enough, from the pin, or axis, on which it moves being so short; and this is not obviated unless you go to, say, £3 for the joint alone, and even then the trunnion principle is better from the axis extending on each side of the telescope. It is mounted, indeed, like a cannon, revolving in the axis bed below. Such a stand as Mr. Calver uses for his smallest, say 5½in. reflector, would be the one to procure, and then make an axis in a ring to fit into the trunnions, and fix it to the telescope, and do the same with the elevating-rod. These have fast and slow motions in perfection, by which it is a treat to find an object through the finder, which no doubt "amateur astronomer" has. He would be surprised and delighted with the ease and pleasure and steadiness with which he can follow and observe his objects. The difficulty of the elevating-rod being in front, which is the best place for finding, and his observing behind, is obviated by fixing, say, a 3in. or 4in. wooden grooved wheel on the top of the elevator, and working the rising and falling slow motions with a line from behind. The azimuth motion is worked with a Hook's joint and handle from the eyepiece. Mr. Calver may have an adaptation of this to the refractor; but I am not sure that it would be better than making the one for the reflector as it is. A drawing of it can be seen in Mr. Calver's "Hints on Reflectors," price 1s. The telescope and stand would be placed on a stool or table the right height.

Fordingbridge. T. Westlake.

[75050.]—**G.E.R. Engines.**—417 class are precisely the same as 710 expresses, except for the wheels (drivers), which are 5ft. 8in., and that the frames are brought higher on the smoke-box. 470, or should it be 770? These are just the same except driving-wheels, one pair 7ft. dia., and trailing wheels 4ft. dia. If you have not got the dimensions of 710 class, I shall be glad to give them. I may as well add that these boilers (417 and 770) are made in two sheets, the dome being put in the first sheet. A. J. Brewer.

[75055.]—**Telephone Patents.** — "Tension Regulator" will find an exhaustive article by a well-known expert on this subject, together with working drawings of an efficient transmitter free of all remaining patents, in the *Electrical Engineer* (published at 139, Salisbury-court, E.C.) of July.

Angus McBell.

[75067.]—**Engines.**—The height of the highest drivers of the G.N.R. are 8ft. 1in. outside cylinders. On the Midland, No. 1870, 7ft. 10in. inside cylinders. On the L.N.W.R., Cornwall, 8ft. 6in. outside cylinders. A. J. Brewer.

[75079.]—**Silvering Glass.**—To a perfectly pure solution of silver nitrate, diluted with distilled water, add ammonia solution till the precipitate formed is redissolved. Now add a few drops of ethylic aldehyde (C_2H_4O). Immerse glass in mixture, and heat gently in water bath. When mirror is formed, wash off silver deposit on one side with nitric acid, and protect the other side by means of a tight-fitting little wooden cap, or, better, of aluminium. R. S. P.

[75079.]—**Silvering Glass.**—A process which we ourselves have used, and found to give every satisfaction, is the following due to Liebig (*Ann. Chem. Pharm.* Supp. V. 257): Make up two solutions A and B. The A solution consists of—1. 1pt. nitrate of silver, 10pts. water; 2. Dissolve 242 grammes sodium sulphate, and dilute to 1,200c.c. with water; 3. Caustic soda solution. To make up A take—140pts. No. 1, 100pts. No. 2, 750pts. No. 3. After mixing, allow to rest till solution is clear, when siphon off the clear solution. The B solution consists of—1. 50grm. white sugar candy are made into a thin syrup with water, and boiled for an hour with 3·1grm. of tartaric acid; this solution is then diluted with water to 500 c.c.; 2. 2·857grm. of tartrate of copper are moistened with water and KHO until the blue powder is completely dissolved; dilute to 500c.c. To make up B solution take 1 part No. 1, 1 part No. 2, 5 parts water. The glasses to be silvered are placed in a dish, and 150pts. A poured in, and diluted with 270pts. of water, and then to this add 10 parts of B solution. Do not use too much copper, or it will spoil deposit; also in winter use warm water. Any further particulars we shall be most happy to give on knowing details.

Clark and Montigue.

[75081.]—**Water Pressure.**—Make a "U" tube of glass, with arms, which I shall for convenience call A and B, 4in. long, or more if greater accuracy is desired. Now connect A to the tap by stout rubber tubing, then open the take a little and let the water run till it begins to rise in the arm B, then hermetically seal the open end of B by fusing. Now turn on the tap again full, and the water will compress the air in B. According as this is compressed, you can tell the pressure in atmospheres, hence also in pounds per square inch. Ohm.

[75089.]—**Photography.**—These are the defects to remedy which the art of retouching has been invented. They are caused by the selective sensitiveness of the photographic plate. Obtain from a photographic dealer what is known as a retouching pencil; bring the lead to a fine point by rubbing it upon a piece of fine glass-paper, and proceed to stipple in the light patches so as to hide them or blend them with the other parts of the face. A hard, good-quality lead pencil will do. If the pencil does not take readily or "bite" upon the negative, apply a little retouching medium.

Fry Manufacturing Co.

[75085.]—**Tempering Tools.**—

Temper Colour.	Description of Tools.
Very faint yellow	Lancets and instruments
Pale straw yellow	Turning tools for metal
Straw yellow ..	Razors
Dark straw yellow or orange	Penknives, and chisels for chipping hard cast iron
Light brown....	Taps and dies, reamers, shears, and scissors
Brown yellow ..	Hatchets, chipping chisels, and other percussive tools
Red............	Carpenters' tools in general
Light purple....	Saws, shear-blades, and punches
Dark purple	Fine watch-springs and table-knives
Bright blue	Swords and lock-springs
Full blue	Daggers, fine saws, and needles
Darker blue	Springs of augers
Dark blue	Soft, for common saws

Ohm.

[75091.]—**Increasing Power of Engine.**—Compound it, by all means. Low-pressure cylinder should be 8½in. in diameter; exhaust from high-pressure cylinder might, to save loss of heat, be taken direct to low-pressure steam-chest. Sketch if required. You ought to get double the power.

A. J. Brewer.

[75091.]—**Increasing Power of Engine.**—To "Vulcan."—I am much obliged to you for your reply. My boiler is 5ft. 6in. high, 2ft. 4in. diam., with two cross-tubes; steam cut-off is regulated by governors according to work. When governors are down steam is admitted ¾ stroke full, and as they rise cut-off is earlier. Cylinder is 5¼in. diam., 9½in. stroke; working pressure, 75lb. to square inch. Engine runs two speeds, 120 and 145. What size ought low-pressure cylinder to be, and should cranks be at right-angles? Any further advice will be esteemed by

A Young Beginner.

[75104.]—**N.E.R. Single Compounds.**—If this engine works accordingly well as the 6ft. 8in. coupled type, it ought to answer well. The coupled engines were reported to keep time, and to steam very easily on the Scotch express.

A. J. Brewer.

[75105.]—**Crystallisation.**—You ask what is crystallisation, and why are substances always met with in the same crystalline form? The one who can answer your query will have solved one of the great problems of the universe. You may be told that it is the action of molecular forces on matter causing it to assume a definite geometrical form of some kind with plane faces; but the real answer is that it is something "that no fellah can understand."

Plymouth. B.Sc.

[75107.]—**Electric Bell.**—You could use an earth return, but you could not practically use a person's body as an ordinary bell-push. You could also use bare wire, having proper insulators. Do not use (as we have found in our mining experiences) broken teacups, &c., but have proper insulators. Use No. 18 B.W.G. wire, and 4 to 6 No. 1 Leclanché cells. Clark and Montigue.

[75107.]—**Electric Bell.**—You must use two wires fixed on glass insulators, nailed to posts on the side of the road—that side which the "man-holes" are on, so that the person in one of these could ring without being in danger. You cannot complete the circuit through a man's body, and you must not use covered wires anywhere where you may want to signal at any time. I have one fixed about the same distance, and I use a local battery, and relay with a battery of six No. 3 (large size) Leclanchés for line, and two of the same size for bell (local circuit). It will be more convenient to use pushes for completing the circuit at the places where the signal will be used most. Use No. 14 hard-drawn copper wire. T. Hagues.

Chapeltown, near Sheffield.

[75115].—**Medical Coil.**—Why not have taken off the iron secondary wire, and wound all with s.c. copper? You would have obtained a much better result. Overhaul the coil again.

Clark and Montigue.

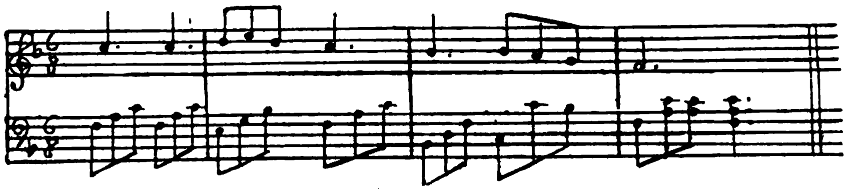
[75117.]—**Iron and Alumina.**—The solution from which silica has been removed is mixed with a little nitric acid and boiled for some time, and a slight excess of ammonia added. On boiling the iron and alumina are precipitated (care must be taken not to employ a too-excessive quantity of ammonia, or precipitate will not be complete). Wash the mixed oxides, thoroughly dry, and transfer to a platinum dish. The small quantity remaining on the filter-paper is dissolved in hot HCl, and also transferred to the dish. The precipitate in the dish is now dissolved in the least possible quantity by HCl, an excess of concentrated KHO solution added, heated to boiling, and a lump of pure KHO added in quantity sufficient to dissolve the alumina, and the boiling continued a few minutes. The contents are washed into a beaker, diluted with little water, and the filtered iron oxide collected, washed, dried, and weighed.

Clark and Montigue.

[75122.]—**Epilepsy.**—One of the best attested remedies for above distressing disorders is Dr. Brown-Sequard's famous prescription. This I have myself seen used with markedly beneficial results. It contains bromide of potassium, but in such judicious combination with tonic and other ingredients, that its action cannot be otherwise than beneficial. I shall be happy to send, for postage only, a copy of above prescription (in English), with fullest directions for use, &c., to anyone desiring the same. P. W. Stanley.

Analytical Chemist, 5 Billson-street, Poplar,
London.

[75120.]—**Harmony.**—There is no royal road to harmony. If "Do Re Me" wishes to attain his object he must do as many other students have had to do before him, spend many hours over his treatise on harmony, which is nothing more nor less than a chord indicator. And the result will be much more pleasing from all points of view than the method which the querist seeks to find. But there is one simple way (let musicians shut their eyes to this) by which he may effect his purpose. Take an ordinary melodeon, the common or garden kind (pardon that—it crept in unawares), the same instrument that we find so extensively advertised as warranted to make homes cheerful, and which our 'Arry finds so indispensable on his holiday rambles. Analyse it, or, rather, dissect it: you will find that the left-hand side of the affair has but two chords as opposed to the whole range of the gamut on the right-hand side, the common chord of the key-note on the "pressure," the common chord of the dominant on the "suction," this suffices to harmonise whatever melody the performer chooses to play with the right hand, and produces all sorts of dominant discords, resolved and unresolved. What matters?—the net result appears to be infinitely successful and pleasing to the lovers of this particular kind of noise. What do you say to that? It, at least, has the merit of being simple, more I won't claim for it. But perhaps a little serious explanation would be more to the purpose and to the interests of the divine art. As you are, perhaps, aware, there are three principal chords used in harmonising on which nearly the whole of the superstructure of music is built. There are, first, the common chord of the keynote, consisting of the keynote with its third and fifth above, this chord being, so to speak, a sort of sun to the system, around which the whole of the others revolve. Secondly, the common chord of the dominant, a chord which takes for its root the fifth of the keynote (above). This also has its third and fifth, and acts the part of right-hand supporter to the keynote. Thirdly, the common chord of the sub-dominant, being built on the note of a fifth below the key-note with its third and fifth, and forms the left-hand supporter of the key-note; the chord of the subdominant is generally heard to its fullest advantage in church music, where the slow movement of the tunes give prominence to its sonorous qualities. These, then, are the material with which you have to work, and with which you can add accompaniments to songs, or harmonise a given melody, but with this limitation, that the song or hymn is not to wander into adjacent keys, which would add complications that would appear very puzzling to a casual reader. But there is another chord which I think will be very necessary for our purpose—viz., that of the dominant seventh, consisting of our old friend the dominant common chord with another note added to the third and fifth; thus the chord would, in the key of C, be composed of G, B, D, and F, the latter note forming the discord that must be resolved on the third of a chord whose root is a fourth above the root of the discord, which in this case would be E. There are other ways to resolve that same chord; but of those we will not speak. Now, as an illustration, I will give a short phrase. You see in the above phrase I have introduced all the notes of the major diatonic scale. I have endeavoured to make it as simple as possible. If you notice closely the accompaniment that is wedded to the melody, you will find that I have used simply the three cords aforementioned, with the dominant seventh. The notes for the left hand, marked as triplets, although they are struck one after another, are still supposed to belong to the same chord, and are treated as if they were above each other and struck together. A single melody can be harmonised in many different ways, but the proper way would be to try and get an inkling of what the composer intended, that is, if you do not compose yourself. When you are "putting in" chords, try and steer clear of consecutive fifths,—that is, no two parts may proceed in perfect fifths with each other. I think this is the greatest sin that a musical (?) composer can commit—those horrid fifths. Next come fourths, which you had better not allow, although they are sometimes written with the full permission of the powers that be. Lastly come consecutive eighths, or octaves.



But I should like to know here, where are the exceedingly delicate sensibilities of our musical critics when the coupler stops of an American organ or harmonium, or even the king of instruments are used. Those daring couplers in a very few moments break all the laws that have ever been invented to govern consecutives or dog the pen of the unwary composer. You will often find that the root of a chord does not occupy the lowest place in the chord. The chord is then known as the 1st, 2nd, or 3rd inversion of the same chord, depending on what particular note happens to be lowest. Thus, if the third of the chord is lowest, it would be termed the first inversion of the common chord of C, or whatever it is; when the fifth of the chord is lowest, then it would be the second inversion; seventh lowest would be the third inversion, &c. But I will advise you not to use any inversions but the first, in using which you are tolerably safe. The other inversions have many vexatious restrictions, which perhaps you would not care to face. Then, I think, if you will use your head (mentally) and eyes, you may get on fairly well. I would not like to say much from a musical point of view, since yours is entirely the wrong way to get about it; but I hope I have been of some little assistance to you. But let me impress upon you the fact that it is not such a mechanical process, this dropping in of chords, as you seem to think, although the words of a celebrated painter may be used much to the same effect here:—All you have to do is to get the amount of notes you want, and put them in their proper places. As to transposing music from one key to another, that is almost a mechanical process which would take up too much space to explain here, but a process which would involve you in a thorough study of key-relationship before you could accomplish it to your satisfaction. I shall be happy to explain further if you still find a difficulty, or if you choose to advertise your address, I could add the accompaniment to anything you wish to send, not too long (as my time is limited), so that you would have a practical lesson.

D. G. Jones.

[75124.]—**Magnets.**—The most powerful magnets are compounded of thin plates screwed or bolted together; each separate plate should be separately magnetised, preferably by a coil of wire and battery, before fastening together. The centre plate should project the furthest, the poles being V-shaped.

Sm.

[75124.]—**Magnets.**—A good piece of hard steel is easily magnetised by inserting it in a hollow bobbin of thin wood or other material, wound with several layers of thick copper wire. A powerful current should then be sent through the wire, contact being made and broken several times during the operation. By this means an 8in. horseshoe magnet can be made to lift 8lb. or 10lb. at least, and is the best of the many ways of magnetising.

F. Askew.

[75124.]—**Magnets.**—Your failure to produce magnets capable of lifting more than their own weight depends, in all likelihood, on the nature and temper of the steel you employ. The best cast steel, free from phosphorus, is alone adapted for this purpose. It must also be hardened, as hard as fire and water can make it, if it is to retain the magnetism imparted to it. Although it is perfectly practicable to magnetise bars and horseshoes of steel by passing them into coils through which a powerful current of electricity is circulating (and this is the process followed by many), yet, personally, I prefer stroking the steel bars or horseshoes with the poles of a powerful electro-magnet; and, in fact, I have rigged up in my workshop a special dynamo in conjunction with an electro-magnet for this very purpose. In a few seconds I can, with suitable steel, magnetise bars and horseshoes to the full.

S. Bottone.

[75125.]—**Ruby Pin in English Lever.**—There is no such term used in watchmaking as foot-plate. I suppose querist means the roller. If so, get a ruby pin suitable, and then shellac in by holding it over the gas. "Hannah" would get more information through some good book on watchmaking.

Rose.

[75128.]—**Gas Furnace.**—If F. Tyler will get No. 1262, Vol. XLIX., of the English Mechanic, he will find a good description of how to make a gas furnace, &c., upon pages 277 and 278. H. E.

[75131.]—**Piano.**—I could not answer this query without knowing what kind of piano you are going to make. If you state whether it is to be a grand or cottage piano, built up of wood only, or iron-framed, cross or vertical strung, trichord or bichord, then I will send a drawing to scale if not answered by one of "ours" in the mean time.

J. H. Schucht.

[75134.]—**Dynamo for Charging.**—A shunt machine can be used for charging accumulators: but if fitted with H armature is not suitable. Should the armature of your dynamo be of the drum type (which is not very likely), you could charge two cells with positive plates having an area of 12sq.in., which would have six ampère hour capacity. F. Askew.

[75134.]—**Dynamo: will it Charge Accumulators?**—As I have already stated on several occasions, the Siemens H form of armature is not well adapted for accumulator charging, even when the dynamo is shunt-wound. The smaller the dynamo, the more is this non-adaptability perceptible. It depends on the fact that the brushes lie on *both* segments of the commutator twice in every revolution, and as soon as the accumulator gets a certain charge it short-circuits itself through the armature, and the charging proceeds no further. The very small current (1 or 2 ampères) given by the 5c.p. dynamo renders them, apart from the above considerations, unsuitable for accumulator charging, as the time required would be excessively long. S. Bottone.

[75138.]—**Negatives.**—Remove the varnish with methylated spirit, and apply the following: (A) Sulphocyanide of ammonia, ½dr.; water, 1oz. (B) Nitric acid, ½dr.; water, 1oz. Must have a freshly mixed solution for each negative. This is followed by being well washed; and after, by a saturated solution of chrome alum. The cleared negatives, when dry, ought to be varnished with good negative varnish.

Heyside, Royton. A. E. G.

[75138.]—**Negatives.**—Old negatives turn yellow through imperfect washing, whereby some sod. hyposulph. is left in the film. In course of time, sulphide of silver is formed, which is absolutely impermeable to actinic light, so that it is impossible to print from the negative. I do not know of anything that will restore the negative to its pristine condition, but as it is utterly useless for printing purposes, you might experiment by soaking in diluted hydrochloric acid. You must take care that the film is not destroyed by too strong a solution.

Sm.

[75143.]—**Noisy Valves.**—Long-stroke pumps are generally pretty noisy. The cause is that, for one reason, the valves are too small in diameter, and hence they require excessive lift; and, also, that makers do not usually fit air-vessels on both the suction and delivery. You will find that if you fit an air-vessel on the top of the valve-chamber (or on the top of the delivery valve, if the valves are in separate boxes), and also another air vessel on the delivery, as near as may be to the inlet valve, the noise will be much reduced, and should the valves have ample area, reduce the lift of both valves as much as may be without reducing the necessary waterway. Very possibly part of the noise is caused by the water-hammer action on the long horizontal suction. If I am correct in this, the air vessel on the suction will reduce it, as rendering the flow of water more uniform. Vulcan.

[75145.]—**Burnt Paper.**—If thoroughly burnt, the ashes consist chiefly of carbonate and sulphate of lime, a trace of alumina, and if blue has been used to colour the paper, traces of cobalt oxide or ultramarine. The latter is, however, decomposed if the paper has been thoroughly burnt. S. Bottone.

[75147.]—**Glass Silvering.**—Dissolve 4 grains of nitrate of silver in ¼oz. of water. Add, drop by drop, liquor ammoniæ, until the precipitate which is first formed, is just redissolved. Now place the articles to be silvered (if flat) at the bottom of a clean dish, and having made up the solution to 4oz., by the addition of 3¾ of water, add 10 drops of oil of cloves, dissolved in 1 drachm of spirits of wine, shake up, and pour into the dish. In a few minutes the articles will be silvered. If the interiors of glass globes, &c., have to be silvered, the liquid must be poured inside until they are brimful. The glass must be scrupulously clean. Cost, less than a penny per square foot. S. Bottone.

[75150.]—**Locomotive Donkey Pump.**—Certainly; with pleasure. A ¼in. ram would throw ample volume of water. But the difficulty is to get these small rams to work. If the water cistern or supply can be placed, say, a foot or 18in. above the pump level, you might find ¼in. ram work all right. Otherwise the ⅜in. would be preferable, if it only has to lift the water 2in. or 3in. As to the best position for feed inlet, if it can be done, pump into the barrel rather than the firebox water space, as you will find delivering the feed into the latter very much more check the steam than into the barrel.

Vulcan.

[75154.]—**Magnet Construction.**—The magnet you unwound was all right, and if you wind yours the same way it will be right. One coil does not neutralise the other unless you turn back with the wire and wind it on the other way. See Mr. Bottone's "Electric Bells," page 73, for the winding of electro-magnets. T. Hagues.

[75154.]—**Magnet Construction.**—No; you need not lead the wire again to the start, but coil backwards and forwards, the direction of the current will be the same in each layer, and not alternately left and right-handed as you suppose. You do not say if your magnet is bar or horseshoe, but in the latter case imagine a bar wound from end to end, and then bent in the middle; then, looking at it from the poles, one helix will be right-handed and the other left-handed. Sm.

[75154.]—**Magnetic Construction.**—When you have laid on one coil of wire you continue winding in the same direction over the first coil, until you reach the starting end again, and so on, until you have laid on the required number of coils. Your difficulty arises from a misconception of the terms "right-handed" and "left handed" helix. When we wind in the direction of clock-hand motion we call it right-handed, and when we wind in the opposite direction, viz., opposed to the motion of clock hands, we call it left-handed. This, of course, is irrespective of our coiling one coil over another, or going back over a previous layer: it depends on always winding in the same direction.

S. Bottone.

[75154.]—**Magnet Winding.**—The construction of the electric magnet which you dissected was quite correct, and if you had given a moment's thought you would have understood that although the second layer is brought back over the first, the direction of winding is not altered. If this were the case, you might wind 1,000 layers without any effect. F. Askew.

[75156.]—**Furnace Steam Blower.**—If you propose to use an undergrate blower, make an injector similar to that shown at page 578, reply 74742, with this exception: that the steam nozzle should be much smaller. Undergrate blowers of small size are seldom satisfactory. You may, therefore, make the areas large enough. Let the steam-pipe A be ⅜ bore, nozzle reduced to $\frac{3}{32}$. The size of the air-pipe B might be ⅞in.; but the use of the second nozzle, as shown in my sketch, vastly increases the delivery. You would not melt the firebars unless the steam pressure is very high. The shape of the furnace may be that of a cylindrical chimney. The fire bars being, say, 12in. from the bottom, you will need a chimney to carry off the fumes.

Vulcan.

[75159.]—**Electric Lighting.**—Presuming that you will use a 15-volt lamp of Edi-Swan make, you will need 8 cells of double-carbon single-zinc chromic-acid battery, single fluid. This will run for about three hours at a stretch, especially if you add a little chlorate of potash to the exciting fluid.

S. Bottone.

[75159.]—**Electric Lighting.**—If you want your light for any length of time at a stretch—say three or four hours at a time—then my advice is, don't attempt it. I have tried it, and can speak from experience, and would urge anyone proposing such a thing to turn the money and time to more account. But maybe you merely want to try the experiment and derive amusement. In this case I will give you what, in my opinion, is the best mode of procedure. The battery I shall recommend is the single-fluid chromic acid cell. Obtain 16 plates of good gas carbon 5in. by 2in. and ⅜in. thick, and 8 plates of amalgated zinc of the same dimensions. Copper the top of each carbon, and solder thereto a strip of brass or copper; the strip should be ┌─┐ shape. A carbon plate is soldered to each short arm, leaving the plates 1in. apart. Eight of these couples are now taken and fastened to a board, about 1ft. long and 6in. wide, by screws. In the centre of each strip connecting the carbon plates bore a ⅜in. hole. The same size hole should be made through the board also, just above the strip. These holes should be bushed with indiarubber or ebonite, for the purpose of insulation. Now drill and tap a hole at the top of each zinc to take the tang of a binding-screw. Place the zincs between the carbons, the tang of screw passing through the bushed hole in metal strip and board, and is kept in place by head of binding-screw. The elements should now be connected in series—that is, the zinc of one cell to the carbons of its neighbour. By so doing we shall have a zinc at one end and a carbon at the other left free for the leads to lamp. The connecting wires and leads should be 16-gauge wire, double cotton covered. Eight stoneware pots, 6in. by 4in., are now selected, and stood side by side, and the whole row of elements lowered therein. The charge for the battery consists of chromic acid and sulphuric acid, 2lb. each in one gallon of water. Bichromate of potash may be substituted for chromic acid, but is not so lasting. One charge of the former will give three hours' light, either continuously or at intervals. Your lamp must be a 15-volt one, or if of higher voltage more cells must be used. Each cell gives about 2 volts and 25 ampères on the short circuit.

F. Askew.

[75160.]—**Electro-motor for Boat.**—Your best form of motor will be a $\frac{1}{4}$H.P. Manchester type motor, series wound, taking a current of about four ampères at 60 volts pressure. This will cost you about £15. To work it, you will need 30 storage cells, costing about £1 10s. each; and, of course, some means of charging your accumulators when discharged.

S. Bottone.

[75162.]—**Boiler Priming.**—The usual cause of priming is insufficient steam space in the boiler.

Sm.

[75162.]—**Boiler Priming.**—The cause of your boiler priming is the sudden reduction of pressure when the starting valve is opened, there being no corresponding deduction of temperature in the water in the boiler, and causing it to boil furiously. I do not think a perforated plate inside the steam pipe would be of any use; you should draw the steam from a pipe inside of the boiler, both ends closed, the top perforated with a number of holes, also a few holes in the bottom to let out condensed water.

Sunderland. Wm. Grimshaw.

[75162.]—**Boiler Priming.**—The cause is not far to seek. It is caused by deficient steam space, and hence, when you allow the steam to flow away by means of the steam-pipe, the slight reduction of pressure permits the highly-heated water to rise bodily, and thus cause priming. Loco. boilers are very prone to this, as the heating surface is usually large in relation to the water volume, and the steam space also is usually small. Your best plan is to get on a dome or a steam drum, and this, by increasing the steam storage space, prevents the uprush of aqueous steam. If a steam dome cannot be fixed, an anti-priming pipe might help you somewhat; but the fact of the deficiency of steam space still remaining, if you can carry the water level a little lower, it would help you, as affording not only more steam storage but also a larger steam-disengaging surface. Anything I can do to assist you I will do with pleasure.

Vulcan.

[75164.]—**Dynamo Winding, Single or Double c. Wire.**—Provided the covering is good, so that the insulation is perfect (and this can be insured by running the wire through melted paraffin wax previous to winding), it does not matter which is used. As a matter of fact, if the insulation is good, the single-covered wire will lie closer, and therefore give rather better results.

S. Bottone.

[75164.]—**Dynamo.**—Double cotton covered wire is preferred to single on account of its higher insulation. For very small machines I prefer silk-covered wire, although the price is higher, as you can get more conductor into a given space than when d.c.c. is used.

F. Askew.

[75165.]—**Electric Light.**—To Mr. Bottone.—My 15s. 9d. dynamos, having solid armatures, are not adapted to continuous running. You will need the next size, with laminated armature, to do the work you require. Provided you can get sufficient pressure of water from your house main—viz., about 80lb. to the inch—you could drive it well and easily by means of a Thirlmere water motor, which you can get from Bailey, of Salford; price, I believe, £3 3s. See my reply (75134) about the proper kind of dynamo to charge accumulators. It is usual to run incandescent lamps in parallel, so that increasing the number of lamps demands a larger current, not an increase in E.M F. A 5c.p. lamp takes about 2 ampères of current if of about 8 volts pressure.

S. Bottone.

[75166.]—**Telephone.**—You have evidently constructed your telephones all right; but the main thing is the adjustment, which should be about the thickness of an ordinary postcard. But previous to doing this see that the plate is not buckled, for when it is tightened up the plate will lift up on account of the crease, perhaps $\frac{1}{8}$in. from magnet. As to the leads being No. 32, that would not make much difference for so short a distance, although you see it does not give your instruments a proper chance, as you must understand it is not because the wire on magnet is fine that the leads should be, because the wire on magnet is really the seat of the current, or part element which produces it, and should not be taken into consideration unless a battery is used. If the querist lives in London, perhaps I could adjust it for him, gratis.

Mick.

[75167.]—**Fuller's Battery.**—I can give this correspondent my experience of this battery. I find it much superior to Leclanché's, all round. The E.M.F. is nearly 2 volts. The charge is as follows: Chromic acid, 2oz.; sulphuric acid, 1oz.; water, 10oz. The zinc is in the porous cell, and is surrounded by water only. A tablespoonful of mercury should be put into the porous cell to keep the zinc well amalgamated. The cell will run about one year without attention if kept in a covered box.

Heyside, Royton. A. E. G.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

Since our last S. Bottone has replied to 74862.

74686.	Siren, p. 368.
74693.	Valve-gear for Hydraulic Engine, 368.
74695.	Compound Engine, 368.
74697.	Grinding Scissors, 368.
74709.	Brush Dynamo, 368.
74718.	Spectroscope, 368.
74719.	Boiler, 368.

74860.	Telephone Wire, p. 461.
74866.	Magnetic North, 461.
74868.	Letter Engraving, 462.
74869.	Solenoid, 462.
74870.	Polariscope, 462.
74872.	Telephone Switch Board, 462.
74873.	Horological, 462.
74875.	Ruhmkorff Coil, 462.
74876.	Open and Closed Circuits, 462.
74879.	Straw Paper, 462.
74880.	Steam Coppers, 462.
74881.	Annuity, 462.
74897.	Wet Plate Lantern Slides, 462.
74900.	Jigs, 462.
74911.	Fire Revivers, 463.

USEFUL AND SCIENTIFIC NOTES.

Cutting Steel.—It is well known that a smooth disc of steel driven at a high speed will cut in two a file held to the edge of the disc. The principle does not seem to have been practically used, save in one instance named by Mr. Richards, the well-known American engineer, who states that it was employed in the U.S. Armoury at Springfield, Mass., in preparing a tenon, or reduced section, on the ends of tempered steel ramrods, such as were used in loading the muskets of twenty-five years ago. The material was hard and could not be cut, so small wheels of iron about 6in. in diameter and 1in. thick were used. They were driven at 6,000 revolutions per minute, and melted or abraded the metal away instantly, at the same time drawing the temper, so that a screw thread could afterwards be cut on the end of the tempered rod.

Two Cylinders in One.—A new departure in compounding locomotives, which is almost as radical as the idea of compounding itself was, has been put into practical and successful operation by F. W. Johnstone, superintendent of motive power of the Mexican Central Railway. Coal costs about 11 dollars per ton on the Mexican Central, and Mr. Johnstone undertook to reduce fuel consumption by the introduction of a compound system of his own, in which the high-pressure cylinder is encircled by the low-pressure cylinder. The high-pressure cylinder is 14in. in diameter, and the low-pressure cylinder has a diameter of 30$\frac{3}{4}$in., which is equal to a cylinder 24$\frac{1}{4}$in. in diameter. The stroke is 24in., and the two rods of the low-pressure piston are coupled with the single high-pressure rod to one crosshead. In a competitive test of 12 trips with a single engine, the compound locomotive showed economy in fuel of about 25 per cent., which means a great deal on a road where the fuel account is the largest item of operating expenses, being 22 per cent. of the total.

An interesting installation of the electrical transmission of power has just been inaugurated at St. Moritzbad, in the Engadine. The motive power is obtained from the Julier brook, which is situated near Silvaplana, about three miles distant from the lighting centre. Instead of driving the turbines on the spot, the water is conveyed to them along an iron pipe 2ft. in diameter, and about 2,300ft. in length. Throughout this length the main is inclosed, the total fall at the generating centre being 610ft. Here are installed three turbines of 160H.P. each. These drive direct three Ganz alternators arranged in parallel, and having a total output of 240,000 watts. The regulation of the turbines is effected automatically, and the alternators are capable of feeding 4,500 incandescent lamps of 16c.p. at the same time. From this generating station the current is transmitted at 3,000 volts by overhead conductors carried on oil insulators fixed to wooden posts, to five transformer stations in St. Moritzbad. The 3,000-volt current is there reduced to 100 volts and distributed throughout the town for the lighting of the hotels, restaurants, and other places.

QUERIES.

[75169.]—**Electric Lighting.**—There is a proposal on foot in a town to replace gas by the electric light. A rapidly flowing river divides the town into two parts, and this could supply the motive power. It is said that even in droughty summer it has sufficient power to drive a dynamo. About half a mile from the town, and near the river, there are the old water works which used to pump the water from the river into a reservoir above the town, and thence to supply the public. These are not used now as we get our water from a lock by gravitation, three miles from the town. If these were put in order, would it not be suitable to supply the town with electric light? As the town council propose to spend £10,000 on improvements in the gas works for a town of 20,000 inhabitants, it is thought that before entering into this a chance should be given to see if the electric light would be cheaper and more effective.—Chemicus.

[75170.]—**Engraving.**—I should be much obliged for a few hints concerning the above, tools required, where obtainable, cost of same, and advice on sharpening. I think many will welcome information about this most interesting winter evening—Hobby.

[75171.]—**Keeping Milk and Meal.**—Could any reader of Ours inform me what the solution is, and its proportions, which milkmen and butchers use in Scotland at the present time—the former for preventing milk turning sour, and the latter for preventing decomposition of butcher's meat during the summer months?—Scot.

[75172.]—**Engine Query.**—I am in charge of an engine, with cut-off gear. When I cut off at 1$\frac{1}{2}$" per piston stroke, there is a grating noise set up at point of cut-off at the back stroke of valve, only my expansion valve has no tail-rod. Would a tail-rod stop this evil? I put plenty of good oil in steam-chest—that doesn't do much good. The noise stops when I shut the expansion up; but we prefer cutting off, as it saves fuel. Should be obliged if some practical engineer would give me his opinion on this subject. Valves work freely.—Expansion.

[75173.]—**Skin Eruption.**—I have been troubled for some time past with an eruption in the form of reddish-brown blotches on the chest, extending to the right shoulder. A doctor told me that it is caused by a gouty tendency in the blood. It is very obstinate, and although I think I have benefited by taking sulphur, I cannot get quite rid of it. I am also troubled with an eruption of a scaly nature on the face, and although it gets better at times, I have not been perfectly free from it for several years. I should be greatly obliged if some medical correspondent would advise. Perhaps "The Lydney Dispenser" could tell me what to do?—Richmond.

[75174.]—**Terebene Dryers.**—Could any reader inform me how to prepare terebene (patent dryers) or the name of book that would give me directions?—Scot.

[75175.]—**Magnetic Polarity.**—Suppose a voltaic pile belt is put round a person's loins, the zinc end being on the left and the copper end on the right side (the pile being across the back of the person, and about 1ft. long, the circuit being completed with wires across the abdomen). The electric current generated will go from the zinc to the copper, the same as the hands of a watch when held horizontally with its back to the ground. The magnetism induced will have its N. pole towards the feet, and its S. pole towards the head, I believe. But if the pile is the reverse way—if the zinc is on the right and the copper on the left—the magnetic polarity will be reversed, I suppose. Will someone kindly inform me whether the zinc end should be on the left or on the right side of the person, so that the magnetic polarity shall be the same as it is naturally in the person, the pile being otherwise placed across the back as above? Also, what is the best substance to dissolve in the water to moisten the felts that go between the elements of the pile, so as to keep them moist enough to generate a continuous current for the greatest length of time without remoistening or other attention? Is chloride of lime good?—Evil.

[75176.]—**Nickel-Plating.**—Can anyone inform me as to whether or not the evolution of hydrogen gas in nickel-plating bath should cause deposit to show a speckled surface—i.e., small, minute holes—and if not, the source of this defect, and how best remedied? Would the solution being in a dirty state have such a result in working?—Oxonian.

[75177.]—**Electric Lighting.**—To Mr. Bottone.—I have recently purchased a second-hand arc light Brush machine, with automatic regulator, double carbon lamps, &c., and should like to fit up same to light a small saw-mill and timber yard; but since I do not quite understand the connections, I should be very glad if you would help me over the difficulty, and give me a sketch of the connections showing how the regulator is connected to the machine, the proper place for the switch, and the object of the two terminals between the two main ones on the base of the machine. I have everything fixed and ready with the exception of the regulator and switch, and if you will favour me through the columns of the next issue of the "E. M.," if possible, with a sketch of the connections, and give me any further particulars, I shall be very much obliged.—Timber.

[75178.]—**Pianoforte Playing.**—What could be done by a person over 40 years of age to render the fingers more flexible for pianoforte playing? Is there any system of gymnastics for the fingers, or gymnastic apparatus which would give good results.—F. Sharp.

[75179.]—**Photographing Diagrams.**—I am desirous of photographing a series of diagrams and woodcuts for lantern slides. Can any of the readers tell me how to proceed, and the best plates and developer for the purpose? My camera is a $\frac{1}{4}$-plate instantograph.—Pyro.

[75180.]—**Expense of Mail Steamers.**—As political economy is acknowledged to be a science, although hitherto not very generally understood as to its details, I trust that a question relating to it may not be considered out of place in "Ours." It has been publicly asserted that the success of the great lines of English steamships is owing, in a great measure, to the large subsidies paid to them by Government, over and above what is paid for mail service. As this has been as publicly denied, and as you must have correspondents well informed on the subject, which is one of universal interest, I trust that some one of them will be kind enough to give us some positive information.—H. Florence.

[75181.]—**Medical Coils.**—I have a small coil, but it is not strong enough. If I bought or made another like it, and connected them up, the primaries together and the secondaries together, and used only one contact breaker, should I get double the power, and would it be necessary to have one core go through both instead of two separate cores?—Holmes.

[75182.]—**Ice-Making.**—Will any reader kindly give me a general idea of the principle upon which the ice-making machine now in the market depends? Also, if I continue to exhaust air and aqueous vapour from a vessel containing water, should I not (theoretically at least) eventually freeze the contents? Please do not refer to back vols. I have taken (and valued) the "E.M." for over 20 years; but cannot keep it on account of the accumulations requiring so much space.—Toto.

[75183.]—**Electric Tramway.**—There is being put down here (Leeds) an electric tramway on what I am told is the Thomson-Houston system. I should be glad to know details of working, for wires are being laid down between the rails without any insulation. I could understand the use of one for a return lead; but in places there are two wires between the same rails.—Toto.

[75184.]—**Electrical Testing.**—To Mr. Bottone or others.—Will any reader give me a little instruction how to work out the following tests without the aid of mathematics or logarithmic:—For example, I have a Thompson galvanometer having a resistance of 5,500w. at 60° F., 100,000w. resistance-box, and another resistance-box from 1w. to 1,000w., a 200-cell battery, and all the necessary keys. For taking the constant I use the 200 cells, shunt the galvanometer through 1w. resistance, and the deflection I get through 100,000w. is 55°. What does this equal, and how is it worked out? I know it would be easier using shunts 1-9, 1-99, 1-999; but as I have not got these I am trying the former method. Now when I am testing the insulation resistance of insulated wires I use the same battery, but different shunts, say, for example, 850w., and get a deflection of 200°, or sometimes no shunt, and get a deflection of 250° What would be the respective resistance of each? Please give examples how they are worked out. I have Kempe's book; but being an amateur, do not understand the various formulæ.—Geo. Clayton.

[75185.]—**Weather-Glass.**—Could any of your numerous readers kindly tell me the way to make a good and inexpensive storm glass or barometer for telling the weather with wet, dry, fair, &c.—One in a Fix.

[75186.]—**Compression Type Gas-Engine.**—Many thanks to "Vulcan" for his reply. What I want was the bore of cylinder, &c., for a gas-engine similar to the one described by "Jock" in "E.M." some time ago Could you give me sketch of simple flame ignition valve also, how it is used, and oblige?—Ohm.

[75187.]—**Astronomical.**—Mitchell, in his "Planetary and Stellar Worlds," mentions that a comet was seen to transit the sun in 1836. Can "F.R.A.S.," or some other astronomical friend, give details of this observation, also if any others of a like nature have been made? (2) What is the accepted theory with regard to the light of comets, whether they are self-luminous in any degree? (3) Is Proctor's theory of the origin of comets (given in "Other Suns than Ours") accepted? If not, what is the accepted theory? (4) Has any corroborative evidence been received with regard to the alleged observation of a comet by Mr. Eddis at Grahamstown?—E. R. B.

[75188.]—**Induction Coil.**—To Mr. F. C. Allsop.—I have constructed a Gower-Bell telephone by your instructions given in this paper about a year ago. I wish to have an induction coil in it, which I want to be suitable for a distance of from half to two miles. Kindly say what weight of No. 28 B.W.G. double silk-covered copper wire should be used in each coil, and also of No. 28. Is the No. 28 to be single or double silk-covered, and what must be the diameter of the soft iron core? You say having an exposed diaphragm is a disadvantage; would it be better to have it covered in somewhat the same way as in the Johnson telephone?—Herbert Hall.

[75189.]—**Dynamics.**—Will any of your readers acquainted with dynamics answer the following question? A criminal is to be hanged; his weight and the length of drop being given, in calculating the effective momentum at the end of the fall, ought I to multiply the velocity by the entire weight of the man, or only by the weight of his body minus his head?—J. H. L.

[75190.]—**Detecting Oil in Jute.**—I should feel obliged if anyone could inform me how to detect oil in jute and other yarns; also quantitative analysis of same, and such goods as guttapercha, indiarubber, red lead. Stockholm tar, pitch, &c. Any information or name of books will oblige.—Tom B.

[75191.]—**Brazing of Cycle Joints.**—Will some reader kindly inform me how to braze the joints of bicycles, and what is the best braze to use, as I have the tubes, and I wish to try to put them together.—W. Duke.

[75192.]—**Small Arc Lamp.**—Will any electrical correspondents oblige me with sketch or information how to make a small arc lamp to work with lowest possible voltage? Supposing small carbons to be used, and the lamp being made delicately, could not it be managed with low pressure of 20 volts?—Nante.

[75193.]—**Model Locomotive.**—To "J. H."—I wish to place the driving and trailing wheels of your "A Model Loco." inside the frame-plates instead of outside, as in your loco. Please state if it will give a great deal of extra trouble, and also give the width of framing, length of axles, &c., if the wheels were placed inside instead of outside the frame-plates.—A. B.

[75194.]—**Colouring Steel.**—Will some reader kindly inform me how to colour small steel articles blue, so that the colour will not easily come off? After polishing the steel, I have heated it in hot sand until it becomes blue, but the colour always readily comes off if anything rubs against it but very slightly.—A. B.

[75195.]—**Model Yacht.**—Will someone kindly give instructions how to build a model yacht similar to those that are to be seen on the Serpentine, Hyde Park, on Sundays? Also instructions as to management. A rough sketch would be acceptable.—G. Dawson.

[75196.]—**Boiler.**—What is the meaning of drawing a fire, and which is the proper way? Also how to tell condition of plates inside boiler, and if plates cake through using limy water? What is the best thing to use to clean them?—T. H. B.

[75197.]—**Battery for Making Wire Red-hot.**—I want to make a piece of platinum wire 3in. long, about 24 gauge, bright red, or white-hot, for 30 seconds, four or six times a day, by electricity. Would a Leclanché battery be most suitable for this, or what? How many cells, and what size should I require? Should the zincs be coupled to the zincs? I thought of using No. 10 copper wire for conductors. How would this best be connected to the platinum wire? How long would the battery last without recharging?—Crucible.

[75198.]—**Testing Battery.**—To Messrs. Cathcart and Peto.—Mr. Bottone has referred me to you for information respecting a battery with elements of zinc and lithanode only, in dilute H_2SO_4. Lithanode, I believe, is chiefly peroxide of lead, and I suppose in a voltaic cell would act as a depolariser by oxydising the liberated H forming H_2O. Is this correct? If so, then the lithanode must soon be exhausted? Can it be revived? Would dilute H_2SO_4 be the best liquid? What would be the E.M.F. of such a cell? Would the current be constant with low external resistance in circuit? Any practical hints you could give me would be esteemed a favour. A portable testing battery must necessarily be a single-fluid one, and such a couple as this, if it had a reasonably high E.M.F. and did not polarise, would be the very thing.—C. J. B.

[75199.]—**Magneto-Electric Machine.**—To Mr. Bottone.—I am constructing a small magneto-electric machine; I am not particularly anxious to collect the alternating currents to their proper poles. Can I dispense with the commutator arrangement for this purpose usually on the axle and revolving with the bobbins? The machine would then give alternating currents at the poles. It seems to me that this is the case with the machine constructed in its ordinary form for medical purposes. I would be quite satisfied with these alternating currents. My magnet is a steel horseshoe 8in. in height. Would No. 24 silk-covered wire do to wind the bobbins with? Kindly say how many layers of wire I should put on the bobbins. If I put another magnet same size as the one I have, so as to form a magnetic battery, would the same bobbins do for one as for both together?—J. S. K.

[75200.]—**Strength of Springs.**—I am a smith, and I wish to fix a simple contrivance to test the strength of rather heavy springs. If I fix a lever 10ft. long, hinged at one end to work up and down, and I place the spring to be tested under the lever 1ft. from hinged end, and then place 1cwt. on top of lever direct over spring, it will, of course, have the 1cwt. besides the lever. Now, what I wish to know is, supposing I shift the weight 6in. each time towards the end of lever, what will be the extra pressure until I get to end, which will, of course, be 9ft.?—A Well-wisher of "Ours."

[75201.]—**Cancer in the Stomach.**—What should be avoided in eating and drinking by one disposed to cancer in the stomach? Are tea and coffee injurious?—Yan.

[75202.]—**Blue Copying Process for Plans, &c.**—I have tried 1drm. ferro-prussiate potash, 1drm. ammonio-citrate iron, 2oz. water, brushed over paper by candle light and dry, then write or draw on tissue paper prepared by brushing over with Canada balsam and dry. Lay tissue paper on the chemically prepared paper, cover with glass and expose to light, then wash resulting print in water. The tissue paper seems to obstruct the light too much, therefore the groundwork of print is a very pale blue. Can I obtain a better paper, or are the proportions of chemicals wrong? How can I get blue lines on a white ground? I was told a few months ago that a process was about being brought out for doing so. Can I get any different colours, or alter the blue into any other colour? Is there a black process?—Wenkentdaor.

[75203.]—**Red German Polishing Paste for Metals.**—Can any reader give me a reliable receipt for this? I have tried several but failed. Why are the rags a very black colour after using the genuine article? Is there any mercury in it? I am willing to remunerate for information through Query Columns if necessary.—Yendys Nikmis.

[75204.]—**Dynamo.**—I have replaced an H armature with drum 6in. long by 2½in. diam., 6in. section (12 coils), wound the same way as you described (July 31st, 74818). I have put 1¼lb. of 18in. wire on. It want to get 50 volts from its fields with 5lb. of 14in. wire series. What speed must I run at? I want to light an arc lamp about 4 or 5 ampéres.—A.C.

[75205.]—**"Kola" and Cocoa Manufacture.**—Where could I find a reliable account of the manufacture of "kola" and cocoa? Perhaps a reader would give a brief account.—Yan.

[75206.]—**Decorated Tin Plate.**—Can any reader kindly explain how to get the pearline finish on small sheet-tin articles.—Amateur.

[75207.]—**Peroxide of Hydrogen.**—I have been trying to bleach horny tissues such as elytra, &c., with peroxide of hydrogen, but with only partial success. I put the objects in the peroxide and stand them in the light. Is any other process necessary?—Zain.

[75208.]—**Condensing.**—Will "Vulcan" kindly give me sketch, with sizes, for a condenser to suit engine 9in. bore, 18in. stroke, 100 revs. per minute, exhaust-pipe 2in. inside diam. My present way is simply exhausting steam on the top of water inside of tank holding 1,000 gallons. The tank is supplied by gravitation from another tank. I inserted steam-pipe in the water; but it made so much noise that I had to take it out again. I am consequently using hot water; but it takes a long time to heat it the way I am working. I have no pump. I think one like you show in last week's "E.M." would do fixed horizontally in the tank with induction pipe dipping in the water.—Hot Water.

[75209.]—**Dynamo.**—Will Mr. Bottone or others please tell me what is the best form of armature for Siemens drum—whether solid iron cylinder, plain punchings, or Pacinotti punchings with projecting cogs? How many layers of wires will be best, and how shall I wind armature and fields to get 60 volts and 20 ampères, what size wire, and how much on armature and fields, what diameter, and length of armature? Will 4H.P. engine drive it?—Magneto.

[75210.]—**Harp Making.**—Can any reader of this paper inform me if there is any work or book on the construction of harps, single and double action, or give some information.—Musical.

[75211.]—**No Rent.**—I shall be greatly obliged if some of our various readers will advise me, saying what I have power to do, who is responsible, and what I can claim in the following matter:—My father, who was the eldest son of his father, died before I was of age. After my father died my grandfather made a will, and left his property to be equally divided between his second son, his two daughters, and myself. Part of the property includes a dwelling-house with a field, gardens, and outdoor premises occupied by the second son, but he both declines to pay any rent, or to leave the house—he now owes five years' rent. One of his sisters and myself wish to have our share of rent for the house, &c., but his other sister does not trouble if he pays, stays in, or leaves the house. In this case what can be done? There are two trustees—one a solicitor who made the will. I may mention the son has spent all his share, and the solicitor trustee is the mortgagee for his part. I am anxious to know if I can claim my full share for the past five years, and if the son cannot pay it, whether I cannot claim it of the trustees who are supposed to see all rents paid. The son also rented lands of the other three concerned, and owed up to 1886 £172, which has not been paid. As he did not pay his rent for the land, he was no longer allowed to rent it. I shall be glad to know how to proceed, so as to get my share of house and land rents for the whole time paid in full. The income of the whole property was to be equally divided between the four, so the house does not belong to one more than the other.—Part Landlord.

[75212.]—**Cyanide of Gold.**—Will any friend inform me how to make cyanide of gold from alloyed gold? —F. Tyler.

[75213.]—**Drills for Small Watch Pivots.**—Would some reader describe the practical way to make pivot drills for small watch pivots? I find it very difficult to file down the Swiss drills small enough, and flatting, shaping, and sharpening. I should like to know how it is done by the trade. Also, how are the hairsprings which are bought with eleven or twelve coils made to suit verge movements, which only contain four or five coils?—Horological.

[75214.]—**Ball-Bearings.**—I have a bicycle, the back-wheel bearing of which has a hard clicking noise in it when riding. I have tried adjusting it both loose and firm, but without any good result. The cones, balls, and cups are quite bright and smooth. Any advice on this matter will oblige—Derf.

[75215.]—**Gilding Solution.**—To Messrs. Bonney and Co. or Mr. Bottone.—Will you please tell me the weight of 95 per cent. cyanide of potassium to use per pint of solution when making the same by battery process, and what weight of gold should I dissolve from the anode per pint of solution? I see in some price lists cyanide for gold and cyanide for silver. What is the difference in them?—F. Tyler.

[75216.]—**Gold Refining.**—I have an 18c. gold chain and another 9c. chain, which I should like to refine into fine gold so that I can use it for an anode in gilding. If any friend will tell me the best way to proceed, I shall be obliged.—F. Tyler.

[75217.]—**Petroleum or Kerosene Furnace.**—Not being able to use gas, I wish to use a small kerosene furnace for laboratory use and the assay of small quantities of metal. Will some kind brother reader assist me in giving directions for making or referring me to some previous description?—Optus.

[75218.]—**Galvanometer.**—To F. C. Allsop.—I would like to construct a galvanometer for general amateur work, and would like to know if I should make bobbins and needles same way as the galvanometer described by you in the "E. M." of March 7, 1890, only somewhat smaller. You might say if the following dimensions would suit:—2oz. No. 36 double silk-covered; needle which works inside the bobbins made of two pieces of watch-spring 1in. long; bobbins of brass; ⅝in. between flanges. You might say how many ohms it will measure, and give me a idea how to grade the dial. —An Amateur.

[75219.]—**Rope Gear.**—What is the best kind of rope to use for conveying about ¼H.P. a distance of 100ft.? the rope travelling, say, 1,200ft. per minute. I want to know size of rope and material—Manilla or Europe. And how can it be made impervious to effects of weather? F. S. F T.

[75220.]—**House Flies.**—Will some one of your correspondents answer the following:—1. Do flies grow in size after they are developed from their larva state 2. What is their average life? 3. The name of any books treating on this subject.—F. G. R., Liverpool.

Over the whole of the various collieries throughout India for the 12 months ending March 31, 1891, there were 17 fatal accidents, 56 serious accidents, and 182 minor casualties.

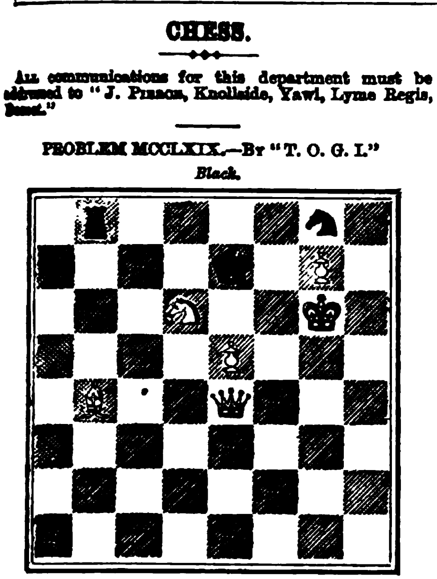
At a recent meeting of the Paris Academy of Sciences, a paper on experimental researches on the probable *rôle* of gases at high temperatures and pressures, and in rapid movement, in various geological phenomena, by M. Daubrée. The experiments show how gases at high pressure, and contained in a closed reservoir, may, by a sort of latent action, violently push out rocks into conical or bell-shaped formations without any noise or escape of gas occurring to indicate their gaseous nature.

CHESS.

All communications for this department must be addressed to "J. Pierce, Knollside, Yawl, Lyme Regis, Dorset."

PROBLEM MCCLXIX.—By "T. O. G. I."

Black.



White. [6 + 3

White to play and mate in two moves.

Solution to 1267.

White.	*Black.*
1. B-K R 3. 2. Kt-Kt 4 (ch). 3. Q or B mates.	1. P-K 3 (*a*). 2. K moves.
2. Q takes K Kt-P, &c.	(*a*) 1. K-B 3 (*b*).
2. Kt-B 7 (ch), &c.	(*b*) 1. K-Q 3 (*c*).
2. Q-Q B 6, &c. Also 1. B-K Kt 5.	(*c*) 1. Kt-P moves.

NOTICES TO CORRESPONDENTS.

Correct solutions to 1267 by Jacobus (very good; the mate, 1 . . . P-K 3, very pretty), R. W. Houghton (quintuple), E. Bygott, T. H. Billington (2, and triple), W. T. Hurley (second solution and quintuple), W. L. Martin (second solution and quadruple), G. Collins (second solution), Biene (ditto and quadruple), T. H. Littlewood (second solution), J. Johnston (2); to 1266 by T. H. Billington, T. H. Littlewood, J. Ashworth, C. S. Bright, and J. Johnston; to 1265 by W. L. Martin (second solution).

T. H. Billington.—Yes, because they score.

G. Collins.—The last problem with which you have favoured us is hardly up to publication mark, as *two* mates are threatened after first move. The P at Q 5 spoils all.

F. H. Guest.—Very fair, though we expect you will soon do better.

Scientists find evidence of primitive savagery in a custom in almost universal use among the criminal classes of tattooing emblems on different parts of the body.

A sole for a boot, to be made of a mixture of glue with a quantity of clean quartz sand, and applied to a thin leather foundation, is the invention of a German, and they are said to be flexible, indestructible and water-proof, and will enable the wearer to walk safely over slippery places.

Recent longitude experiments at McGill College, Montreal, under the auspices of the British and Canadian Government, led to the determination of the length of time it takes a telegraphic signal to cross the Atlantic. Out of 200 signals sent, it was found that the average time taken to cross the Atlantic and back again—about 7,000 miles—was a trifle over one second.

The oldest of the Bombay cotton mills, according to *Indian Engineering*, was established in 1851; and between that and 1870 only seven others were set going. Five years afterwards there were 22 mills at work, and between 1875 and 1880 16 more were added to the list. Ten more were started in 1881, 19 more between that year and 1886, five in 1887, five in 1888, five in 1889.

The *Railroad Gazette* says:—As we have before noted, the Baldwin Locomotive Works are building a lot of 21 by 26 ten-wheelers for the Erie road, which are probably the largest ten-wheelers yet built in this country. They have just received instructions to compound one of these engines. It will be finished about the end of September, and an exhaustive test will be made of it in comparison with a simple engine of identical design in every way except the compound action.

Holloway's Pills.—A course of this admirable medicine clears the blood from all impurities, and improves its quality. The whole system is thus benefited through the usual channels without reduction of strength, shock to the nerves, or any other inconvenience; in fact, health is renewed by natural means.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, August 26, and unacknowledged elsewhere:—

P. Y. Alexander.—Medical Battery Co.—Disheartened.—Clark and Montigue.—A. F. Shakespear.—Amateur.—Anglo Saxon.—Hydraulics.—Metric.—An Amateur.—S.—A. Caplatzi.—Draughtsman.—H. M. G.—Wire.—A Fellow of the Royal Astronomical Society.—H. Wake.—W. H. Monck.—Puzzled.—J. Foskett.—W. C. Carter.—C. A. M.—W. Pickering.—F. E. P.—G. A. Towers.

Ampere. (If your query was received, it was certainly inserted or answered in some form—most likely by referring you to back volumes, as the subject has been dealt with many times, and it is a waste of space to give illustrations merely that some inquirer may ascertain how much wire to wind on a piece of iron so as to saturate it. You give Birmingham as an address. You can see all the back volumes there, and you need not look back very far to find all the information you require.—Novice. (Please see recent back numbers. The chromic-acid battery will suit best; but if the electric lamp is wanted only for a few seconds, then use the Leclanché).—Gold. (Only with some abrasive powder such as emery or pumice. Any acid preparation that would dissolve the gold would also dissolve the metal on which it is placed).—Yarmouth. (Please see indices. More definite information must be given as to the nature of the lenses; but as a general rule it may be taken that lenses specially adapted for photographic work will not do good telescopic work.—Arithmetic. (What do you mean? The rules given in any good book on arithmetic will enable you to work with decimals. With such factors you must work by decimals — fractions would be too complicated and troublesome.)—J. K. (The secretary of the Pharmaceutical Society, 17, Bloomsbury-square, W.C., will give all particulars as to the examinations necessary to use the appellation of pharmaceutical chemist.)—Fitter. (Do not understand you. The "life" of a cell—or battery—depends on the work it does. You will find all the information required in Mr. Sprague's work on "Electricity," and in back volumes. See also recent back numbers.)—A Workman. (Nystrom's "Pocket-book" is published in London by Trübner and Co., who probably sell the other work you mention.)—Otter. (The simplest and safest way to clean oil-paintings is to lay a damp towel over them, and keep it damp for a day or two. Then sponge the dirt off with a little clean tepid water—no soap. To attempt to rub the dirt off with the fingers is to run the risk of spoiling the picture. If the varnish must be removed, the picture, if valuable, should be sent to a professional cleaner; but, as a rule, the "cleaning" above indicated, and a wipe over with almond oil, is sufficient. To remove the old varnish requires great care, as the solvents may "wash up" the actual pigments of the picture.)—W. Woodhouse. (All examinations for the Civil Service are held by direction of the Civil Service Commissioners, Cannon-row, Westminster, from whom all particulars of such examinations can be obtained; but for marine engineering you must apply to the local marine office.)—E. C. M. (Several schemes have been propounded for utilising the rise and fall of water in tidal rivers and estuaries; but ingenious as many are, like yours, the expense of establishment seems to be too great to cover the probable output. The matter was argued out several years ago in connection with the river you mention—the Severn. There are not a few patented devices in connection with the idea.)—Ajax. (The reply has been given many times. The holes are the work of one of the wood-boring beetles, and the remedy has been frequently stated—fill the holes with grease or oil, which will kill the larvæ. See indices and recent back numbers.)—A Confined Sufferer (No one can answer such a question to any good purpose without examining the patient. Spinal disease might cause a variety of symptoms, and it is only an expert who can determine the cause of them.)—May. (Depends on what they are wanted for; but there is nothing that answers the purpose of rubber in its special properties.)—C. T. Butler. (Will not one of the many dynamos illustrated and described in back volumes suit you? Full directions have been given many times. Whence did you obtain the dimensions of the iron parts?)—Iago. (Applications for detailed estimates are advertisements, not queries.)—J. Willis (In type.)

Weak and Languid Feelings may be speedily overcome by wearing Harness' Electropathic Belt. Doctors recommend it as positively the only bonâ-fide reliable means for the self-application of mild, continuous currents of Electricity. It has been the means of curing thousands of sufferers from nervous exhaustion, brain fag, liver and kidney diseases, rheumatic affections, ladies' ailments, &c. Copies of testimonials, pamphlet, and consultation free on application to the Medical Battery Company, Limited, 52, Oxford-street, London, W.

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Messrs. James W. Queen and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 3d. each copy, to cover extra postage.

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Dr. Pollard says of Sherman Rupture Treatment.—He thanks God and every other influence that determined him to try it. All who want to get rid of Rupture and Trusses should send to—J. A. SHERMAN, Hernia Specialist, 64, Chancery-lane, London, for his Book, 7d. post free.

OUR EXCHANGE COLUMN.

The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.

Stamp Collection wanted. Will give good exchange. Also will exchange Duplicates with collector.—Edward W. Drury, 125, Coltman-street, Hull.

Magic-Lantern, first-class lamp, sheet, and 150 slides, &c., for Launch Engine.—Leith, 6, Trafalgar-street, Greenock.

New massive outside **Lamp**, gas or oil, ornamental iron scrolled bracket cost 90s. Electrical or reasonable offers. Stamp for particulars.—James Taylor, Ilminster, Somerset.

Strong 4½ centre backgeared **Lathe**, 4ft. straight bed, slide-rest, hand-rest, two face-plates, drill chuck. Exchange 30in. bed gap, 3in. centre. Offers.—Mackay, Cromarty.

A complete set of "**English Mechanics,**" Vols. I. LII., newly half-bound cloth. What offers? Safety Bicycle preferred?—Melville, New Walls-road, Totterdown, Bristol.

Steam-Gauge, 4in., Bourdon's improved, correct and nearly new. What offers? Exchange.—Address G. Bailey, Post Office Cottages, Wrecclesham, Farnham, Surrey.

Wanted, Nicholl's Polarising Prism, ½in. field; Gassiott's Cascade Tube. small Incandescent Lamp, 5 volt. Offer Lantern Slides, other good exchange.—Price, Fernleigh, Wellington, Somerset.

"**English Mechanic,**" from November 26th, 1886, to July 31, 1891, complete, with indices, unbound, perfectly clean. What offers?—Dennis, Rose-street, Hopwood-lane, Halifax.

Portable Forge, round, 16in. bellows. Good. Exchange anything in harmonium line or photographic material.—S., 2, John-street, Hackney-road, London.

Horizontal Boiler, 18in. by 12in., ⅜ plate, stand 200lb.; Lawn Mower, 20in., by Green, equal new. Offers.—Letters to 7, Rookery-road, near Bilston.

Bicycle, 53, racing, nearly new. Exchange for Dynamo, Microscope, ¼ plate Instantograph. or anything useful.—J. Boydell, Brown-street, Leigh, Lancashire.

Concertina, English rosewood, 48 keys, steel reeds, polished baywood box, cost £5 10s. Exchange anything useful.—J. Boydell, Brown-street, Leigh, Lancs.

Six-inch 6ft. **Lathe** in exchange for Safety Bicycle.—S. D., 105, Marylebone-lane, W.

Splendid vertical **Engine,** 1⅞in. by 3⅜, ditto 1⅝in. by 3in.; also good Vertical Boiler. Photo. and particulars sent.—W. M., 75, East-road, West Ham, E.

Compound **Launch Engine Castings.**—James Boulton, Ashton-under Lyne.

1891 cushion tire diamond **Safety,** balls all over, ball pedals, like new, cost £18. Exchange good Lathe or offers.—Harris, Watchmaker, Markhouse-road, Walthamstow.

Exchange large **Hand Dynamo.** 14in. wheel, value £3, for good 4in. Slide-rest.—E. Woodward, 8, Brunswick-street, Barnsbury-road, N.

A strong **Treadle Lathe**, 6¼ centre, 3ft. 7½in. bed, Universal chuck, two tools. Exchange.—C. L. G., 66, High Cross-street, Leicester.

Cassell's "**Family Physician**," equals new, cost 24s.; Ripoingille's Stove, 1½in. burner, cost 18s. Offers.—A. Philip, Alford, N.B.

Splendid ½-plate photo. view **Lens**, rotating diaphragms, by Watson, as new, cost 21s. 6d. Cash or exchange to 17s. value.—Balmforth, Scout Hill, Dewsbury.

Telescope, Wray, 2½in. objective, Lancaster's mounting, four celestial, one terrestrial eyepieces, powers 30 to 150, mahogany tripod and brass table stands, steadying rod, two dark glasses, pine box. Exchange for first-class Photographic Outfit, or what other offers?—Hutton, Broadbottom, Manchester.

Three 5in. **Cylinders**, 6in. stroke, all bored and faced for piston valves, for Launch Engine or Boiler.—Laith, 6, Trafalgar-street, Greenock.

Safety, racer, by Brookes, good on road, nearly new, balls all over. Exchange for Screw-cutting Lathe.—H. Goulding, 31, Marine Approach, South Shields.

Correct Trade Formula for Fruit Preserving in Bottles. Exchange for Books, Tools, Clothing, anything useful.—Machain, 120, Globe-road, Mile-end, London, E.

Powerful **Medical Coil and Bunsen Battery**. Will exchange for Magneto Electric Machine.—W. F. Hammond, 12, Victoria-road, Gt. Yarmouth, Norfolk.

Edison Mimeograph, foolscap size. Prints thousands of copies from one writing. Best reduplicating device ever invented, cost 60s. What offers?—Lamberton, Hatter, Sheffield.

Gem **Air-Gun** (No. 3), complete, with pincers, darts, slugs. Splendid weapon for indoor or outdoor sport. Not a toy, cost 35s. What offers?—Lamberton, Hatter, Sheffield.

Cuckoo Clock, natural tone cuckoos, wings open and close automatically. In handsome carved case, new, just cost 40s. What offers?—Lamberton, Hatter, Sheffield.

Microscopic — Wanted, mounted and unmounted, Objects of every description; especially Cockchafers, Crickets, Cockroaches, Sawflies, Hornets, Locusts. Foreign exchanges invited — Henry Ebbage, Framlingham, Suffolk.

Two ebonite **Bell Telephones**, Concert Flute, eight keys, Electro-motor, worth 17s. 6d., Lecture Table, Dynamo, new, Medical Coil and Battery, Combination Electric Bell, new.—Below.

Dunlop pneumatic **Safety Bicycle**, new condition, diamond, ball steering and bearings. List £25. Want solid tire Safety, and offers.—1, Great Western-road, Gloucester.

Dress Rapier, 30 whole cake Water Colours, Bowie Knife, cost £3. Exchange anything the value of 35s.—Brook Villa, Raunds, Thrapstone.

Batteries. — A few very good Leclanché cells, scarcely used. — Willatt, 51, Salcott-road, Wandsworth Common, S.W.

"**Shakespeare and His Friends**," three vols., 1636, "Peter Pindar," four vols., scarce, Bell's "British Theatre," 15 vols., handbook on Soapmaking. What offers?—Garforth, Chemist, Sheffield.

Two sets **Diver's Apparatus**, complete, with brass helmets, suits, boots, &c. Wanted, good Safety Bicycle or American Organ.—Huddleston, 21, Upham Park-road, Chiswick.

What offers for quantity of useful **Brasswork of** Instruments, 3,000 Carbons, and lot of 6-block Leclanché cells?—Huddleston, 21, Upham Park-road, Chiswick.

220 Edison-Swan **Holders**, 100 80-volt W. and R. Lamps, Siemens Dynamo—100 volts, 40 amps., compound wound. What offers?—Huddleston, Chiswick, W.

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Premier type **Safety Bicycle**, cushion tires, hollow non-cutting rims, balls throughout, value £6 10s. Exchange for good Screw-cutting and Turning Lathe or offers.—10, Ratcliffe-road, Romford-road, Forest Gate.

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Screw Plate, doubled handed, notched, 3-16in., ¼in., 5-16in., and ⅜in., best Lancashire make, used half-an-hour, perfect condition. Exchange.—Garside, Cecil-terrace, Stamford.

Gas-Engine, ½-man, compression tube ignition, water jacket, tank fittings, complete, perfect. Exchange Lathe value £5 10s.—Pride, 22, Fernhead-road, Paddington, London.

Wanted, well-finished iron **Flywheel**, about 12in. diam., also gunmetal Eccentric, ½in. throw. Exchange Printing Press.—Hambling, jun., Snape, Suffolk.

Wanted, 2½in. **Slide-rest**, modern tool, in good condition. Exchange Books on Electricity.—Smith, 3, Bowling Green-row, Woolwich.

30 hour three-quarter chime **Grandfather's Clock**, brass dial, without case; Lineman's Detector or Electric Bell, for good set of Drawing Instruments.—8, Culverland-road, Exeter.

Monocular Microscope, two objectives, concave mirror, and cabinet; also 72 mounted Slides. Exchange for Lantern Slides, or offers.—White, 17, York-street, Nottingham.

Will exchange **Model Arc Lamp**, with regulating mechanism, for model Vertical Engine, 2¼ by 2¼in.—Apply, A. S., 4, Broseley-villas, Wood Green.

Wanted, few **Lathe Tools**, also Face Plate and adjustable Centring Chuck, for 2½in. lathe.—H. Parsons, Midland-road, Nuneaton.

Books.—Warne's "**Universal Shakespeare**," as new, "Ivanhoe," and "The Man of the Hour," published 21s., to value, say, 10s. 6d. Want photographic.—Chipper, Highgate-hill.

Plated Teapot, chased, value 6s. 6d.; silver mounted Sticks, acacia, ebony, malacca, and cherry. Photo for stamp. Value 6s. 6d. Exchange Photographic.—Chipper, 39, Highgate Hill.

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4ft. brass **Rail Bedstead**, spring mattress and feather bed, value 50s. at least, as good as new. Want Photographic.—Chipper, 39, Highgate-hill.

Electric Scarf Pin, accumulator, switch, and cords, best French make, 4 volt, 2½ hours, cost 38s. Offers.—Chas. L. Ford, Stalybridge.

Wanted, Screw-cutting Lathe in exchange for **Bonds** £500. Provident Building Society, London, paid over £19.—Wardle, 36, Butcroft, Wednesbury.

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Gas-Engine, by Andrews, 2-man Bisschopp, in perfect working order. Wanted, large Drilling Machine, Screw-Cutter, or Shaper.—17, Pitlake-bridge, Croydon East.

43 **Flywheel**, 1½in. bore, 19in. Flywheel, 1½in. bore; several turned Driving-Pulleys from 9in. to 16in. diameter. Offers wanted.—Taylor, 17, Wakefield-street, Warrington.

Wanted, Model Boiler for engine, 1½ by 3. Also pair small back-geared Lathe heads, about 3½ centre. Can offer good exchange.—Tipping, Painswick, Gloucestershire.

THE SIXPENNY SALE COLUMN.

Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.

New Illustrated Price List of Screws, Bolts and Nuts for Model Work, drawn to actual size, sent on receipt of stamp.—Morris Cohen, 132, Kirkgate, Leeds.

Millar's Electric Depot, 14, Deansgate, Manchester.—Best of everything electrical. Large stock. Low prices. Catalogues 3d.

Wheel-cutting and Dividing to 12 inches diameter, in brass only.—Clegg, Belinda-street, Hunslet, Leeds.

Dr. Allinson writes:—"Consult Fournet re Eyesight and Spectacles." Fee 5s.—18, Bentinck-street, Manchester-square.

102 **Family Recipes**, with useful information, post free.—Address Higson, Box 561, Mansfield-road, Nottingham.

Manchester Electrical Stores.—Bentley and Co., 17, Newton-street. Bells, Cells, Wires, Fittings. Best and cheapest.

Geo. F. Chutter, Engineer, Birmingham, eldest established works in the trade. Electro plating and Polishing Plants.

Dynamos, highest efficiency, vats, fittings, and every requisite for Plating and Polishing all metals. Estimates free

Lathe Chuck, 4s., self-centring, marvel of productions, takes ⅛ wire to a large drill.—Below.

Bench Drilling Machine, with table and six drills, 11s. 3d.; Best Parallel Vice, 2½in. detachable jaws, 9s. 6d.

Pocket Speed Counter up to 5,000; nickel plated, 7s. 3d.; Stock and Dies, cutting six sizes, from 6s.

Economic by-pass **Gas Tap** for workshops, 1s. 2d.; patent lock joint soldering iron, 3s.

Telephones, with powerful magnets and vulcanite cases, good speakers, 4s.; Vulcanite Cases only, from 2s.

Brass Terminals, large, 12s. 6d.; gross bell cases, 8s. doz. Large stock of gongs, hammers, and all fittings.

Catalogue, largest in the trade, sent with discounts on receipt of 4d. and trade card.

Illustrated "**Electric Bell Fitter's Instruction Book**," new edition, 1s. 1d., free.—Baughan and Co., Electricians, &c., Charlbury, Oxfordshire.

"**Heat is Simply an Overflow from the Earth.**" Post 2d.—Humphreys, Camoria-street, King's-road, Fulham.

Mackies, Limited, Sole Manufacturers of Mackie's Patent Spring Pulleys, 70,000 in use. Berks Iron Works, Reading.

Kidney Complaints, stone, gravel, inflammation, Botanic receipt, and full instructions 7 stamps.—Botanic, 156, Stockwell-road, S.W.

Steam Launch, 25ft., very excellent and powerful boat by John Samuel White.—Apply, J. Cam, New-street, Worcester.

J. Leaney and Son, Moulding Letter Manufacturers, 16, Langton-road, Brixton.

Military Moustache rapidly and secretly produced. Valuable recipe, post free, 7d.—Harris, Hightown, Crewe.

Model Boiler, vertical steel tubular, size 6½in. by 13½in., tested to 50lb. pressure, brass fittings, perfect order, nearly new, price 17s.; also a larger boiler.—Lawn, Nailsworth, Gloucestershire.

Write for **King, Mendham, and Co.'s** (Bristol) new Illustrated Catalogue, 6d. Acknowledged to be invaluable to amateurs. See front page.

"**The Wimshurst Machine**," by W. P. Mendham, gives theory of action and many experiments. Post free, 13d.—King, Mendham, and Co.

Telephones, Carbon Transmitters, and parts of same.—King, Mendham and Co., Bristol (see front page).

E.S. Dry Battery.—See Mr. Bottone's opinion on page IV. Best and cheapest battery yet produced.

Mica or Talc Cut for all Purposes.—Mica chimneys, &c.—C. Johnson, 140, Charing Cross-road, W.C.

Watkin's **Exposure Meter**, a thoroughly reliable instrument for photographers, price 15s.—Field, Suffolk-street, Birmingham.

Watkin's **Meter**. Send for particulars and testimonials from experienced photographers in all parts of the world.

Bicycle Cement.—One pound very best Bicycle Cement sent free for 1s.—Address Rose, Northallerton

Brass Name Plate, 9 by 4½in., engraved, 4s. 6d. Any size to order.—Gilkes' Engraving Works, Reading.

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Buy, sell, or exchange **Microscope Slides** with Henry Ebbage, Framlingham, Suffolk. Foreign parcels despatched. Postage cheap.

Engine and Boiler (vertical), 1½H.P., tank base nearly new, complete £26. A bargain.—P., 71, High-street, Sutton, Surrey.

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Lathes, Tools, Chucks, and appliances for plain and ornamental turning.—Frost, Berner's Mews, Castle street, W.

Military Brass Band Instruments for sale, part of band, less than half-price. Cornets, tenors, baritones, euphoniums, bombardons, large circular double bass; clarionettes, trombones, drums. All as good as new. No dents. Guaranteed perfect. Will send any or all on approval before purchasing. Rare opportunity for starting band. Particulars on application.—Address Band Secretary, 4, Arthur-street, Gray's Inn-road, London, W.C.

Dynamo, 10 candles, 20s.; 20 candles, 25s.; 30 candles, 28s. List, one stamp.—D. Walton, Hebden Bridge.

Dynamo 60 candle, 45s.; 80 candles, 70s.; 120 candles, 90s.; 200 candles, 160s. List, one stamp.

Dynamo, Manchester type, ring armature, 300 candles, £14; 400 candles, £18; 600 candles, £22. List, one stamp.

Patent Equilibrium Arc Lamp, 100 candles and upwards from 30s. List and engravings, one stamp.

Dynamo Wire from 1s. per pound; Lamps from 3s. each; Punchings, &c.—D. Walton, Engineer, Hebden Bridge.

"**Sheet Metal Worker's Instructor**" (Warn's). Few copies cheap, 6s. Covers slightly soiled.—37, Marquis-road, N.

Dynamo Castings (Siemens and Gramme), wholesale prices from 2s. 6d., 5c.p. These prices only guaranteed for this month. List 1d. stamp.—Beardsall, Sheerness.

S. Bottone, Wallington, Surrey, supplies the following Electrical Books and Apparatus. Invaluable to Electrical Amateurs and Engineers.

"**Electro-Motors: How Made and How Used.**" A handbook for amateurs and practical men. Post free, 3s.

"**The Dynamo: How Made and How Used.**" All amateurs should read this book. Price 2s. 6d. post free.

"**The Dynamo**" contains tables for calculating the proper winding to use for any output. 2s. 6d. post free.

"**Electric Bells and All About Them.**" Second edition, post free 3s. Indispensable to bell fitters.

Motor Castings and Fittings of all patterns. Siemens, Simplex, Manchester, and others. Armatures, solid and laminated.

A beautiful little **Dynamo** that lights easily two six-volt lamps, post free in box, 15s. 9d.

Dynamos of the Highest Efficiency, from 15s. to £20; for lighting, plating, cauterising, and experimental work.

Dynamo Castings.—Beautiful sets for 5c.p. Dynamos, finished ready for wire, 10s. each; warranted efficient.

Ammeters, Voltmeters, Galvanometers, 5s. each. Tangents, 10s. Standard Ohms, 2s. 6d. Bridges, 5s. List, 1½d.—S. Bottone, Wallington, Surrey.

Sign-Writing Made Easy; also diagrams for marking out eight full-size alphabets, 1s.—Coulthard, Darlington-street, Bath.

Decorators' Stencils.—100 for 2s. 6d.; 60 large sheets, complete stock-in-trade.—Coulthard, Darlington-street, Bath (late Bournemouth).

Fretwork, Carving, Repoussé Designs.—100 of either, 1s.; 300 Turning Designs, 1s.—Coulthard, Darlington-street, Bath.

Engraved Brass Name Plate, on polished mahogany board, 9 by 4½, 4s. 6d. Stencil plates.—Johnson, Engraver, Leeds.

Rubber Stamps, latest novelties, lowest prices, best quality. Brands, steel stamps, checks, labels.—Johnson, Engraver, Leeds.

Unpublished Manufacturing Recipes (without plant). Profits enormous. 7,500 testimonials. Lists free.—Stanley (Box 1), Billson-street, Poplar, London.

Dancer's **Microphotos.** List (500) and sample free 1s. 2d.—22, Greame-street, Moss-side, Manchester.

Water-Motors from 5s. each. Cheapest and best power for driving all light machinery.—Walton. Below.

Water-Motors, ⅛H.P., price 20s. List stamp.—Walton, 9, Queen Anne-street, Stoke-on-Trent.

Splendid complete case of **Mathematical Drawing** Instruments, cost £5 10s.; £2 10s.—Mayo, 13, Comyn-road, Clapham Junction.

Clark and Montigue, Electrical and Chemical Engineers, Cloudesley-place, Liverpool-road, N.

Sole agents for the **Osbo-Premier Battery**, runs 20-100 hours with one charge, cost of 8½d. unit; suitable for electric light installation. Please write for lists, 2 stamps.

The **Osbo-Leclanche Cell**, 3s. 6d. complete. By means of this modified Leclanche a constant current can be maintained for 3—4 hours at a stretch. The very thing for small electric lamps.

Owing to the great demand we have for a small **Cell**, we are now making small Osbo-Premier cells, 6in. by 3in. by 4in., to give 2 volt 3 amperes, to run 20 hours constant with one charge of depolariser, price 3s. each. All electrical amateurs and trade should send for one of these cells.

Electric Lamp Stand and Set of Osbo-Premier Cells, in polished case, runs 6c.p. lamp 30 hours with one charge. Very thing for drawing-room, price 25s., complete.

Small single **Cells**, especially made for miners' lamps, pocket batteries, &c., each single cell measures 4in., 1in., 1in. Set of six cells in case, 4in. by 6in. by 1½in., price 6s.; gives 12 volt, 1 ampere for four hours. Single trial cells, 1s. 6d.

Special **Parcels** containing full instructions and materials for making (1) induction coil and motor, (2) 3-cell battery, (3) model transformer, (4) ammeter, (5) voltmeter, 18 stamps each.

Windmills (suitable to run small lathe and dynamo).—We are now prepared to supply full working drawings and instructions for erecting these, or to erect same.

All kinds of **Electrical Goods Supplied.** — Clark and Montigue, London, N.

One-man Bisschopp **Gas-Engine**, good working order, new gas bags, £10. Carriage paid London.—Below.

100-watt **Dynamo** (Austin's "Infant"), first-class finish, nearly new, £3.—Tudor House, Burgess-hill, Sussex.

Gas-Engine, Domestic Otto. Also ½H.P. ditto, cheap.—Address Smith, care of Garlick, Wells-road, Bristol.

All kinds of **Camera Repairing and Alterations** (parts made). Dark slide moulding 4d. per foot.—Below.

Additional mahogany **Dark Slides**, book pattern, ½, 8s.; 1-1, 11s.—Allen, Camera Maker, Maidenhead.

Screw-cutting Lathe, 5in. centres, 4ft. bed, chucks, £14. Bargain. Offers.—22, Elgin-road, Croydon.

Unpublished Trade Secrets.—All should see my unrivalled list, sent post free. Testimonials innumerable.—Flather, Sowerby Bridge.

Electric Light Installation for sale, comprising Roper's series wound dynamo with spare armature complete, also 13 of the above maker's 2,000c.p. lamps, 14mm. carbons, all in thorough working order. Can be seen by appointment any time.—Frederick Illingworth, Caledonia Works, Bradford.

Slide-rest, new, suit 3½ or 4in. lathe, 25s.; 4½ circular saw, 3s. 6d.—Tipping, Painswick, Gloucestershire.

Portable Vertical Engine and Boiler, 1½H.P., in good working order, £12 10s. No reasonable offer refused.—D. Carter, Newfields, Billingshurst.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, SEPTEMBER 4, 1891.

HOW TO CONSTRUCT A QUARTER CHIMING CLOCK.—XIV.

(*Concluded.*)

THE 'scape-wheel arbor carries the seconds hand (if it is desired to show the seconds), and the front pivot is made stouter and longer for this purpose. This being so, the size of the dial determines the position for the 'scape-pivots. In "pitching" the going train, the centre and 'scape-wheels come on the centre line, and the third wheel must be placed either to the right or left to depth correctly with centre and 'scape-wheels.

6.—The Pendulum, &c.

The length of a seconds pendulum is from 39in. to 39¼in. A flat brass rod, ½in. by ⅛in., with a bob like that described for the bracket clock, makes a very good pendulum, if the recoil escapement is used. The bob is made heavier, say 4lb. in weight.

A better pendulum is made by using pine or deal, well seasoned, and of a perfectly straight grain. Wood is less affected by heat, in the direction of its length, than a metal rod. To insure good fastenings at either end in so soft a wood as deal, the rod must be substantial, say ¾in. by ½in., and oval in section. Each end is slotted for an inch or two, and a brass plate pinned in securely. The suspension spring is fastened to the top piece by pinning, as in Fig. 94. The brass plate in the lower end is continued to form a screw for raising and lowering the bob. Two thin brass plates, one on either side, are pinned to the rod, where the crutch engages, and the slot is cut through the two from front to back. The bob for this pendulum is the same as with a metal rod. The rod must be either polished or varnished, as a protection from damp. The temperature error of such a pendulum is very slight. If the going train and escapement of the clock are really well made, and the "dead-beat" form used, it may be considered worth while to make a true compensation pendulum. The mercurial form is both expensive and awkward to handle, besides which, it is not so correct as metallic rod compensation. The steel rod is affected more quickly by a change in the temperature than the glass jar and mercury. I shall therefore pass over this form in favour of those in which the relative expansion of different metal rods is used. Either brass and steel, zinc and steel, or copper and steel can be used. The easiest to make is undoubtedly a brass, or copper and steel, "gridiron" pendulum.

It is, perhaps, needless to tell readers of the ENGLISH MECHANIC that different metals expand and contract under the influence of heat and cold in varying degrees. Thus steel is *less* affected than either brass, copper, or zinc. This fact is taken advantage of in clock pendulums. The effect of a rise of 10° in the temperature on a pendulum having a plain metal rod, is to slightly lengthen it, and cause it to vibrate slower. The suspension spring is also lengthened and *relaxed* somewhat, which adds to the original error.

The relative expansions of steel, copper, brass, and zinc are as follows:—

Steel	1,000
Copper	1,789
Brass	1,877
Zinc	2,140

From this table it will be seen that by using a rod of steel (which expands in a downward direction) and rods of brass (to expand upwards), the bob can be made stationary.

Fig. 106 shows a brass and steel "gridiron" compensation pendulum. The dark rods represent steel, and the light rods brass. They are of such a length that all the steel rods added together are in the proportion of 1,000 to 1,877 to the collective length of the brass rods. Equal pairs are of course counted as one rod.

The rods are best made of oval-drawn wire about 3/16in. wide by ⅛in. This is the smallest size capable of safely carrying the weight of the bob. They are supported at intervals by brass tie-pieces throughout their length. These ties or supports must only be fixed to one pair of rods, allowing the rest to slide freely. If the centre rod is steel, and the pairs of brass and steel rods on either side are 24in., 25in., and 26in. respectively, the compensation will be as nearly perfect as possible.

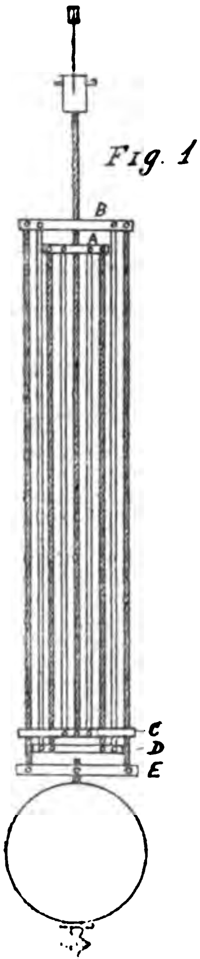


Fig. 106.

Fig. 106 is not a copy of any existing pendulum, but merely shows the principle upon which such pendulums are constructed. The dark rods are steel, the light ones brass. It will be seen that the expansion of the brass rods raises the bob, while the steel rods lower it, and there being approximately 50in. of brass and 94in. of steel (in proportion of 1,000 to 1,877 about), the effect of the total expansion upon the position of the bob is *nil*. The fancy of the maker enters largely into the design of a gridiron pendulum, mostly with a view to making an otherwise rather unsightly piece of mechanism neater and more presentable. If copper and steel rods are used, they will have to be rather longer, on account of the difference of expansion between copper and brass. Zinc, being a soft metal, cannot very well be used in combination with steel in the form of rods. It is, therefore, used as a *tube* outside the steel rod. From the top of the tube depend other steel rods, which support the bob. In this form of pendulum the total length of steel rod must be a little more than twice the length of the zinc tube, in the exact proportion of the relative expansion of the two metals given in the table above. I may say that this is the form of pendulum now considered the most reliable for regulators, and also it is the form used in the Westminster clock.

A very simple form of compensation pendulum is made by using a wood rod fitted with screw, nut, and washer at the lower end, and provided with a lead bob in the form of a heavy tube. The bob rests upon the washer, and of course expands in an upward direction. The degree of compensation in this case depends upon the height of the bob, which should be about 10 to 12in. in height. An inch lower than the centre of the bob, in this case, can be taken as the centre of oscillation. Any of these pendulums, if used in combination with the dead-beat escapement, may be made considerably heavier than with the recoil form—say about 6lb. A great deal of useful information about compensation pendulums will be found in Britten's "Handbook for Watch and Clockmakers."

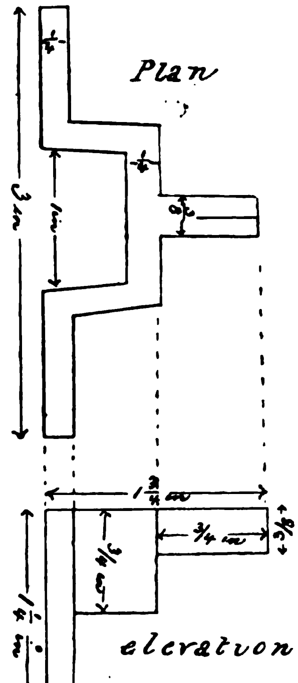


Fig 107

For these pendulums a stouter support will be needed than was used in the bracket clock; also the crutch can with advantage be made longer—say 6in.

Fig. 107 shows dimensions, &c., of a suitable bridge for a seconds pendulum.

The rest of the movement will be the same as in the bracket clock. It is firmly bolted (by means of the two bottom pillars) to a stout seat board, preferably of oak. In this board slots are cut to accommodate the lines, and also a space at the rear to free the pendulum. The seat-board rests upon blocks, or in grooves, in either side of the case, so as to allow of removal from the front.

It has already been pointed out in these papers that all clock cases *must* stand firm. And this is even more imperative in the case of a seconds pendulum clock, if good time is to be got out of it. If it stands upon the floor it must also be firmly nailed or screwed to the wall near the top. If it hangs on the wall, care must be taken that it does not rock in the slightest upon its supports, and it must also be fixed at the bottom.

Any remarks as to shape and size of the case would be useless; it must be left entirely to the fancy of the maker. As in the bracket clock, whatever the design may be it must be dust-tight, and at the same time provided with outlets for the sound of bells and gong.

This completes the description of the Chiming Clock. Although I have received numerous letters from readers who have successfully completed the bracket clock, I am afraid a great many have been frightened by the amount of work in it, but would not mind trying their hands at a simple timepiece having neither striking nor chiming work. Such readers will, with care, be able to find the information they require from the description of this rather complicated clock, taking only those parts relating to "going" trains, escapements, pendulums, &c. It was my intention to make these papers as complete as possible, that they might be of service to other readers besides those actually making the clock described, and I trust I have succeeded in so doing.

GEOLOGY FOR STUDENTS.

By Edward Aveling, D.Sc. Lond., Fellow of University College, London.

Chapter XIII.—Rocks and Minerals.

(*Continued.*)

THE crust of the earth is made up of rocks; the rocks are made up of one or more minerals; the minerals of one or more chemical substances; and these last of one or more chemical elements. In the preceding chapter certain simple chemical details were given necessary to the understanding of the mineral composition of rocks.

In this chapter the most important rock-forming minerals will be noted, and then a classification of rocks will be given.

Minerals.

The four most important minerals have already been mentioned by way of illustrating the chief kinds of chemical compounds that enter into the composition of minerals. They are felspar, quartz, mica, talc. The large proportions in which they enter into the formation of the earth's crust will be seen from a glance at the subjoined table, giving the mineral percentage composition of that crust.

Table IV.

100 parts of the earth's crust contain
48 of felspar.
35 of quartz.
8 of mica.
5 of talc.
4 of all other rocks.

Felspar is derived from the German *fels*, a rock. "Spar" is a common English termination, meaning, and often even used as a distinct word for, rock. Felspar is a silicate of aluminium $[Al_2 3 (SiO_3)]$, with which are associated silicates of potassium (K_2SiO_3) and sodium (Na_2SiO_3) always, and in some cases silicates of calcium $(CaSio_3)$ and magnesium $(MgSiO_3)$.

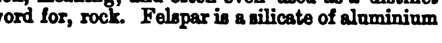


Fig. 35.

Here, once again, let me insist upon the absolute necessity of the student having actually before him, as he reads this, and as he reads what follows, a specimen of the particular mineral under consideration. With a piece of felspar before his eyes, and, still better, in his hands, he will really understand the meaning of what he reads. Even if, although this ought not to be the case, he cannot, for the moment, get hold of a piece of felspar, a piece of granite is sure to be obtainable. The glassy, softer crystals in this, so soft that they can be scratched by a knife, are crystals of felspar.

A crystal is a body that always, under similar circumstances, assumes a definite geometrical shape. All crystals can be referred to one of some six systems of geometrical form. And these systems turn upon the number and the inclination to each other of imaginary straight lines, or axes, around which the molecules of the crystal appear to be arranged. A cubic crystal—e.g., has its molecules grouped around three axes all of equal length. Two of these are in the same plane, that of this paper, e.g., are vertical and horizontal, and therefore are at right angles to each other. The third, of the same length as each of the others, is in a plane at right angles to theirs, and runs through the point of their intersection, as if a pin were stuck vertically through this paper.

The student should arrange three pieces of wood in the way in which these three axes are arranged. If their points are then joined, say by threads, the edges of a regular cube are formed, and if the space between these is imagined filled up with solid matter, you have the image of a cubic crystal.

The different systems under which all crystals can be arranged depend upon the number, the length, and the inclination of their axes. And these, again, determine the planes along which the crystals will easily split—i.e., their planes of cleavage.

There are two groups of felspars, depending upon the nature of their crystals. In the one group, one of the three axes is obliquely inclined to the other two, and the planes of cleavage of the crystals are always at right angles to each other. This group is the orthoclastic group. ορθος (orthos), straight; κλαστος (klastos), broken in pieces.

In the other group, all the three axes are obliquely inclined to each other, and the planes of cleavage are also oblique to one another. This group is the plagioclastic group. πλαγιος (plagios), slanting.

Quartz is pure silicon dioxide, or silica (SiO_2). Rock crystal is the transparent form of it, and opal, amethyst, and topaz are coloured forms. The student should compare a piece of pure quartz alone with the small hard crystals of quartz resisting the knife in a piece of granite.

Mica (*mico*, I glisten) is made up of silicates of aluminium $[Al_2 3(SiO_3)]$ and potassium (K_2SiO_3), with those of magnesium $(MgSiO_3)$ and iron $[FeSiO_3$ or $Fe_2 3(SiO_3)]$. The glistening, scaly crystals in granite are mica crystals. This mineral is the softest of the three present in granite, and is easily cut, or sectile. *Secto*, I cut. Mica is readily split up into the thin transparent plates that everyone has seen over the gaslights of chandeliers.

Talc is a silicate of magnesium $(MgSiO_3)$, whitish green in colour, and resembling mica. Like mica, it is soft and sectile, and transparent in thin plates. But, unlike mica, it is non-elastic, and generally occurs in masses not in crystals. It is amorphous. α (a), without; μορφη (morphe), form. And, as we have seen, their chemical composition differs. Talc can be bought in the shops, as it is in much request in the arts.

After these four chief minerals, the other most important forms are flint, chert, hornblende, augite, actinolite, asbestos, soapstone, serpentine. A word or two upon each of these. With the exception of the first two, familiar to everybody, the members of this group, more even than the four chiefs, need ocular and tactile observation, as they are less frequently encountered.

Flint is impure silicon dioxide or silex (*silex*, flint), occurring in irregular amorphous nodules, generally surrounded by chalk. At the place where I am writing—St. Margaret's Bay—and all along this south-eastern and southern coast, these flints, with their chalk envelope, abound.

Chert is a mixture of flint (SiO_2) with limestone $(CaCO_3)$. It is always amorphous, occurring in nodules or concretions, or irregular masses.

Hornblende is thus named from the fact that its fracture, i.e., the aspect of the faces exposed after cleavage, is horny and glistering. *Blenden* (German), to glisten. It is made up of silicates of aluminium $[Al_2 3(SiO_3)]$, *iron* $(FeSiO_3)$ the largest constituent; magnesium $(MgSiO_3)$ calcium $(CaSiO_3)$. It is dark green, or almost black in colour, gives forth a peculiar odour when breathed upon, and occurs in some granites as an addition to the usual quartz, felspar, and mica. The granite of Guernsey, and of Mount Sorrel in Leicestershire, and that of the celebrated quarries of Syene, in Egypt, all contain hornblende.

Augite is thus named from the Greek word αὐγη (augé), lustre. Like hornblende, its very near ally, augite is made up of silicates of aluminium, iron, magnesium, and *calcium* (the largest constituent). It is always heavier than hornblende, and of similar, but generally lighter colour. It is very frequent in igneous rocks.

Actinolite. 'ακτις (aktis), a ray; λιθος (lithos), a stone. Another near ally of hornblende. It consists of exactly the same silicates, only that actinolite has very little aluminium, much less iron, and much more magnesium than hornblende. Its dark green crystals are radiating or thornlike. It occurs in large quantities in some slates, which are known as actinolite slates.

Asbestos. α (a), without; σβεστος (sbestos), consumable. A fibrous variety of hornblende used by the ancients to make incombustible cloth. It occurs as mountain wood, mountain cork, &c.

Soapstones are sectile, greasy-feeling minerals, that owe their feel and name to the presence of steatite (*stear*, fat). Steatite is like talc, a silicate of magnesium.

Serpentine is another magnesium silicate, of green or blackish green or purple colour (hence the name serpentine). The darker hues are due to the presence of hæmatite (see preceding chapter). Serpentine occurs in very early rock—"primitive rocks" as they are called.

Classification of Rocks.

Rocks may be classed in many very different kinds of ways; the chief methods are, however, four. According to their chemical composition, chemically; according to their mineralogical composition, mineralogically; according to their physical structure, physically; according to their mode of origin, geologically. Really, as usual, all these different methods gradate one into the other, and in the plan now to be followed, the student will see that, although primarily the system of classification is based upon the geological origin of the rocks, yet chemical and mineralogical and physical differences and distinctions will be used.

The system of classification now to be considered will be more easily followed if the student keeps before him Table V., a table of rock classification.

TABLE V.

ROCKS.			
Igneous.	Plutonic	Granitic	Granite Syenite Porphyry
		Trappean	Basalt Greenstone Clinkstone
	Volcanic		Trachyte Lava Scoriæ Pumice Obsidian
Metamorphic.	Of two or more minerals	Non-schistose	Gneiss
		Schists	Mica-schist Hornblende-schist Talc-schist
	Of one mineral and one chemical compound		Quartzose rocks Clay slate Crystalline limestone
Aqueous.	Crystalline	Hydrogen oxide	Ice
		Sodium chloride	Sodium chloride
		Other salts	Alum Nitrates Gypsum
		Limestone	Ordinary Travertine Oolite Marble Dolomite
		Metallic ores	Metallic ores
	Clastic	Siliceous or arenaceous	Sand Gravel Shingle Boulders Sandstone Conglomerate Breccia
		Argillaceous	Loam Mud Clay Silt Till Shale Slate Marl
		Organic	Microscopic earth Coal Chalk Coral Shell beds Guano Bone breccias

The first broad distinction of rocks is into Aqueous and Igneous, with the inevitable transition form between these two, the Metamorphic.

The igneous rocks are those that owe their origin to the action of fire, to that process of powerful upheaval and outburst from within

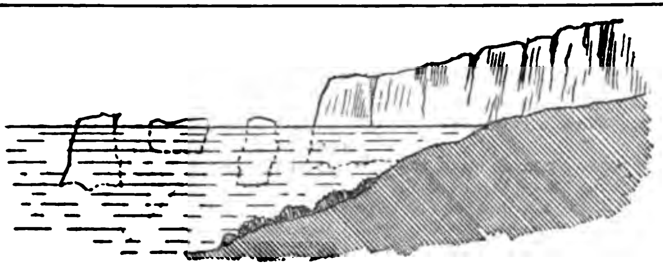


FIG. 36.

already explained. The igneous rocks form the smaller part, but still a very large part, of the crust of the earth. They are not sedimentary, but are due to upheaval. They are not stratified. They are not fossiliferous.

These igneous rocks at once fall into two divisions: the Plutonic (Pluto, god of hell), crystalline, older, deeper in origin (granite, e.g.); and the Volcanic (Vulcan, god of fire), non-crystalline, comparatively recent, comparatively superficial (lava, e.g.)

The differences between the older, more deeply formed, plutonic rocks, and the younger, less deeply formed, volcanic rocks are due to the different conditions under which the originally molten matter of both kinds has consolidated. In the case of the plutonic rocks, the rate of cooling has been slow, and the consolidation has been gradual, and has taken place under great pressure. Hence the crystalline, coarse-grained structure of the plutonic rocks. In the case of the volcanic rocks, the rate of cooling has been fast, and the consolidation has been rapid, and has not taken place under great pressure, but in the air. Hence a vesicular structure (as in pumice), or a disintegrated (as in scoriæ), or a vitreous or glassy (as in obsidian). *Vesicula*, a little bladder; *vitreus*, glassy; οψσιανος (opsianos), connected with looking-glasses.

The transition rocks between the volcanic

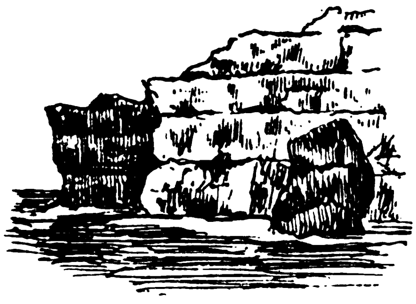


FIG. 37.

above and the plutonic below, are the more or less vertical dykes and veins (p. 27) of igneous rock. These connecting igneous masses running through older rocks are called intrusive, Fig. 35.

The aqueous rocks (clay, e.g.) are those that owe their origin to the action of water—to that process of denudation, transfer and deposit upon which so much stress has already been laid. The aqueous rocks form the largest part of the crust of the earth. They are sedimentary, i.e., formed by the deposit, as sediment, of matter either in suspension or in solution. They are, as a rule, stratified, or made up of successively deposited strata. They are almost in all cases fossiliferous, or contain fossils. *Fero*, I carry. After deposit, they have been consolidated by pressure. As might be expected from that which was said in Chapter XI., every one of those definitions of an aqueous rock is broken through by some one or other of the rocks that are undoubtedly of aqueous origin; but in the main the definitions hold.

The inevitable transition between the aqueous and igneous rocks is furnished by the metamorphic rocks. *μετα* (meta), across; *μορφη* (morphé), form. These, gneiss, e.g., are crystalline and non-fossiliferous, like the plutonic; but they are stratified, like the aqueous. They may be regarded as aqueous rocks, originally deposited as sediment and afterwards transformed or metamorphosed by the action of heat.

The chapters that follow this one will be specially devoted to an account of the igneous and metamorphic rocks. So that, here and now, we need only note the chief forms of them.

The plutonic rocks are either granitic or trappean. The granitic, represented by granite, syenite, and porphyry, are older than the trappean. The latter derive their name from the Swedish word *trappa*, a stair, because of the fact that many of the rocks belonging to this group occur in large tabular masses of unequal extent, so that they appear as a succession of steps or terraces. The trappean rocks include basalt, greenstone, clinkstone.

The volcanic rocks are trachyte, a transition

FIG. 38.

form really between the trappean and the volcanic, lava, scoriæ, pumice, obsidian.

The metamorphic rocks can be divided into two main groups. The rocks of one set contain two or more minerals and are schistose, i.e., fissile as well as crystalline. σχιστος (schistos) split. This group includes gneiss and the three schists, mica, hornblende, and talc.

The rocks of the other set contain only one mineral and one chemical compound. This group includes quartzose rocks (SiO_2), clay-slate ($Al_2 3SiO_3$), crystalline limestone ($CaCO_3$).

As was said above, the next two chapters will be devoted to a more detailed account of these plutonic, volcanic, and metamorphic rocks, whose names only are given in the text and in the table.

The aqueous rocks fall into two groups—the crystalline and the fragmental or clastic. The crystalline aqueous rocks include ice; sodium chloride in its various forms; other salts, such as alum, a sulphate of aluminium and potassium ($KAl2SO_4$); nitrates of potassium (nitre, KNO_3) and of sodium ($NaNO_3$); gypsum or calcium sulphate ($CaSO_4$); limestones ($CaCO_3$), in the form of ordinary compact limestone, travertine, oolite, marble and dolomite; metallic ores.

The aqueous rocks that are not deposited in the form of crystals are called clastic or fragmentary. κλαστος (klastos), see above, is the Greek word for broken. The clastic rocks are

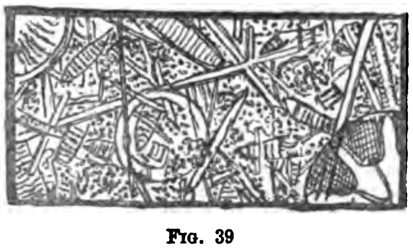


FIG. 39

grouped under the siliceous or arenaceous (*arena*, sand), including sand, gravel, shingle, boulders, sandstone, grit, conglomerate, breccias; argillaceous (*argilla*, clay), including loam, mud, clay, silt, till, shale, slate, marl; organic—i.e., those formed by deposits of vegetable or of animal origin—including "microscopic earth," all the forms of coal, chalk, coral, shell-beds, guano, bone breccias.

Some of these aqueous rocks need a few words of description, and with that this chapter will conclude.

Under the limestones we find five forms. The ordinary compact limestone calls for no special comment. *Travertine* is named from a corruption of the word Tiburtinus, as this form of limestone is met with at Tibur, near Rome. It is a white, porous, concretionary rock, deposited from solution in the water of the river Anio, as result of the passing off of the free carbon dioxide (see p. 375). Travertine is formed here and at other places in Italy with great rapidity, and in a few years hardens into an excellent, light yet durable building stone. It has been used in the cupola of St. Peter's, at Rome.

Oolite is derived from ωον (oon), an egg; λιθος (lithos), a stone. A limestone made up of small rounded particles like the eggs or roe of fish. The calcium carbonate has been crystallised out upon and deposited around grains of sand as nuclei. In the centre of each rounded mass a small grain of sand will generally be found. We shall see, when we come to the study of the chief geological formations, that certain of these are called oolitic, from the prevalence in them of this form of limestone.

Marble is the name given to any limestone capable of taking a fine polish. Most of it is of aqueous origin, but some (see above, crystalline limestone) is metamorphic.

Dolomite (see Chapter XII.) is a magnesian limestone.

Passing now to the clastic aqueous rocks, the siliceous or arenaceous include the following:

Sand.—Water-worn particles of silicon dioxide, the result of the wearing down of other rocks. For the most part it consists of quartz grains.

Gravel.—Water worn fragments and pebbles, mostly of silicon dioxide, varying in size from that of a pea to that of a hen's egg.

Shingle.—Water-worn rock fragments, larger and less rounded than those of gravel.

Boulders (see Chapter XI.) — Water-worn massive blocks of stone, often many tons in weight, that have generally been deposited where they are found (perched blocks, Chapter XI.) by the melting of icebergs or glaciers. In Fig. 36 a Greenland glacier is shown with icebergs

FIG. 40.

detaching themselves from it. In an earlier figure was shown a picture of an iceberg carrying rocks. The student will bear in mind that glaciers themselves, as well as their detached bergs, also carry and drop boulders.

Sandstone is consolidated sand (see Fig. 37). The particles have been forced together by great pressure and cohere, or they are held together by cementing matters, such as lime (CaO), clay ($Al_2 3SiO_3$), iron oxide.

Grit is a sandstone with the particles unusually hard and angular. These grits are of use in grindstones and millstones.

Conglomerate.—Just as sandstone is consolidated sand, so is conglomerate consolidated gravel.

Breccias—breccia (Italian), a crumb. Rocks made up of angular, irregular, not water-worn fragments.

The argillaceous aqueous rocks include the following:—

Loam.—A transition rock between the argillaceous and the arenaceous rocks. It is a friable mixture of clay and sand.

Mud.—The fine matter worn down by water from minerals, vegetables, and animals, carried away by water and deposited at the bottoms of pools, lakes, the mouths of rivers, and the beds of seas.

Clay.—Like mud in all particulars, but that it is only aluminium silicate ($Al_2 3SiO_3$), contains no vegetable or animal matter, is solid, tough, plastic.

Silt.—Miscellaneous matter deposited in lakes, bays, estuaries, and still water generally. It may consist of sand, mud, clay, and other rocks.

Till.—The Scotch name originally given and since generally used for the better-named boulder clay. An unstratified, non-fossiliferous clay met with in the northern parts of Europe, associated with the "erratics" or boulders already described, and generally including many irregular fragments of rock. It is clay with sand, the result of the wearing down of older rocks by the glacier streams (Fig. 38).

Shale.—Consolidated mud presenting a laminated structure, which clay never presents.

Slate.—A hard, laminated, semi-crystalline, *fissile* rock.

Marl is a transition rock between the argillaceous and the calcareous or limestone rocks. It is a friable mixture of clay and limestone.

The organic rocks include the following:—

Microscopic or Infusorial earth.—The organic rocks are of vegetable origin, or of animal origin, or of both. The distinction between the vegetable and the animal kingdom is, as was noted above, an artificial one. The lower members of the two so-called kingdoms gradate into, and are ultimately not distinguishable one from the other. In fact, there are many zoologists and botanists who make use of a group of organic beings between, or rather below, both the kingdoms, Vegetabilia and Animalia, and probably representing the ancestral forms common to both plants and animals. This group is called Protista, from προτος (protos), first.

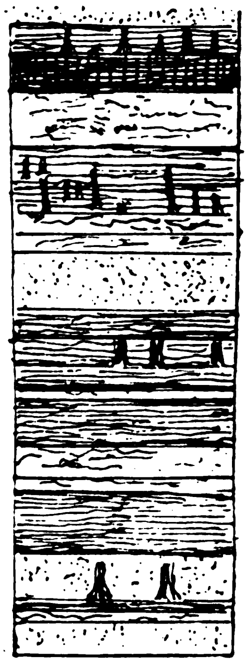


Fig. 41.

It is interesting, therefore, to find that the first organic rock is one formed by the remains of very lowly organisms, that would be placed by some very far down in the vegetable and animal kingdom respectively, by others in this yet lower group of Protista.

Microscopic earth, badly called infusorial earth, appears in the various forms of tripoli polishing stone (Tripoli and Bohemia), the mountain meal of Iceland and Lapland, the white earth of the American Indians, the thick layers occurring in the estuary of the Elbe, and the plains of the Amazon (edible clay). In all these cases, the rock consists of countless millions of siliceous shells, Fig. 39. These are the cases or coverings of certain very simple organised beings, known as Diatomaceæ, and classified by some among the very lowest of plants; by others, as I have said, among the Protista. They take their name, Diatomaceæ, from their method of reproduction. Each of the exceedingly simple little beings within these shells can reproduce itself by dividing into two, each part growing up into a complete diatom. δια (dia), through; τεμνω (temno), I cut. Wonderfully simple as these organisms are, they form very perfect and very beautiful silicious shells; and these by the million make up the "microscopic earth" in its various forms. A cubic inch of tripoli is said to contain 40,000 millions of diatom shells.

Coal.—All the forms of coal are derived from vegetable matter that has been subject to greater or less pressure through a greater or less range of time. Fig. 40 represents a peat-moss, the commencing stage of coal Fig. 41, a series of coal-seams one above the other, the upper and younger showing more remains of tree-stumps than the older and lower. A full account of coal will be given later, when we consider the coal-measures.

Chalk.—This is generally made up of the calcareous shells, or fragments of them, of certain low forms of animal life. The bed of our large oceans to-day is in many places covered with "ooze"—i.e., mud in which minute shells occur (see Fig. 42). These shells are not like those of the "microscopic earth" of silicon dioxide (SiO_2), but of calcium carbonate ($CaCO_3$); and they are not formed by diatoms, but by low animal organisations, known as Foraminifera, because the walls of their shells are perforated by holes. *Foramen*, a hole; *fero*, I carry. And our chalk cliffs and other vast chalk deposits are the beds of past oceans in whose waters the Foraminifera lived and died, their shells after death falling to the sea bottom. These organic rocks, and, indeed, all those mentioned here, will be considered at length later, when they are met with in our study of the geological formations.

Coral in reefs, islands, atolls, is due to the deposition of calcareous matter in the actual bodily tissues of certain animals, *not* insects, living in colonies. The coral animals are much more highly organised than the Foraminifera.

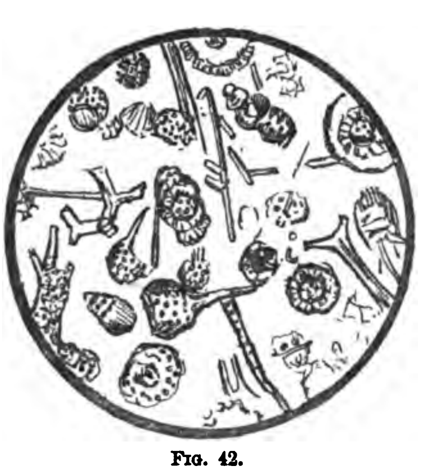


Fig. 42.

Shell beds are layers of rock formed from the shells of oysters, cockles, mussels, and other soft-bodied, hard-shelled animals. They are found in seas and estuaries everywhere.

Guano of the Pacific and other tropical islands is made up of the droppings of sea-birds, their eggs, and the bones of them and of fish and seals. It is largely a phosphate of calcium, $Ca_3 2PO_4$, and is of great use as a manure.

Bone breccias are collections of the bones and fragments of bones of the Vertebrata or backboned animals, and chiefly of the highest class of that sub-kingdom—viz., the Mammalia or quadrupeds that suckle their young.

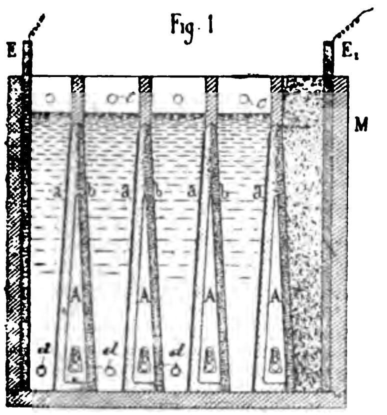
FAURE'S REGENERATING BATTERY.

SEVERAL students and inventors have been investigating the possibility of making a voltaic element which should contain within itself the means of regenerating the active substances, and M. Camille A. Faure, of Paris, has obtained a patent in this country for an invention which relates to improvements in the production of electricity and in means or apparatus therefor, and has reference to a battery element or couple, and to the use in conjunction therewith of certain apparatus for regenerating the substances used in the battery, and for supplying them to the battery to maintain the same in operation. According to one part of this invention, two carbon plates or electrodes, one of which is porous and is covered with a layer of suitable material (for example, canvas), and the other dense and non-porous, and covered with granulated or spongy iron, are immersed in a solution of sea salt or common salt, and a current of air, mixed with carbonic acid, is passed through the pores of the porous carbon plate, or electrode, so as to depolarise the same. This combination gives an electro-motive force on open circuit of about 1 to 1·2 volt, and the fall of potential in closed circuit, depends only on the density of the current per unit of surface of the plates. A potential of about 0·9 volt may be assumed in a closed circuit for a current of 3 to 5 ampères per square decemitre. The electro-motive force of 1·2 volt above referred to has never been obtained hitherto by using the substances, iron and common salt, and the patentee says that this proves the value of his new battery. The electro-motive force may be taken to be composed as follows:—Elements of iron and carbon, immersed in a solution of common salt (NaCl), produce chloride of iron, caustic soda, and hydrogen, and give an electro-motive force of about 0·30 volt. By consuming the hydrogen by means of air, an additional 0·40 volt will be obtained. Finally, if instead of compact iron, semi-compact reduced iron be employed, then about 0·15 volt will be obtained in addition. This makes a total electro-motive force of:—

$$0{\cdot}30 + 0{\cdot}40 + 0{\cdot}30 + 0{\cdot}15 = 1{\cdot}15 \text{ volt.}$$

In the course of the electrolytic action, the carbonate of soda and chloride of iron produced will react and form carbonate of iron and the chloride of sodium or common salt will thus be regenerated. Thus the battery will only consume iron which is converted into carbonate of iron, and can be easily separated from the solution and regenerated. The carbonic acid used is also regenerated by the same process of reduction. As a result there will have been finally consumed only about 0·300 kilogramme of carbon in the form of carbonic oxide requisite for reducing the carbonate of iron at a dark red-heat; this amount of carbon being necessary for each kilogramme of iron brought into operation, and consequently for each electrical horse-power produced, or approximately so. The industrial application of the invention is effected more advantageously when carried out on a large scale, for instance, when producing, say, a thousand electrical horse-power. An installation for this purpose comprises the following elements:—1. A battery consisting of, say, a thousand elements in which the surfaces of the carbon plates or electrodes are about one mètre high and two mètres long; these elements are arranged back to back in a trough, as in the trough type of Wollaston's battery. Each pair of electrodes is composed of carbon in the form of slabs, one side of which is porous, and the other side dense with a space, or spaces, formed in the interior for the admission and uniform distribution of the depolarising gases over all the surface 2. A pump capable of furnishing, say, about four thousand cubic mètres of gases for the thousand elements per hour. 3. Piping for supplying the gaseous mixture, and solution of common salt, and for carrying off the water charged with carbonate of iron in suspension. 4. A continuous action separator that serves for the separation in a continuous manner without stoppage, and without manual labour, of the salt water from the solid products. 5. A continuous-action machine for forming the mud separated, according to the preceding paragraph, into briquettes. 6. A cupola fed with carbonic oxide at a temperature of about 1,000° C., from a gas-producer, and provided with a heat regenerator. Into the top of this cupola the briquettes of carbonate of iron are charged through a hopper furnished with a cover, the reduced metal being discharged at the bottom. The surplus carbonic oxide, after the reducing operation, is finally burned and converted into carbonic acid, which is drawn off by the gas pump, and, after washing, is forced into the battery. The other apparatus necessary for completing the installation, such as pumps for water circulation, electric cables, and electric apparatus, will be readily understood by electricians.

Fig. 1 is a vertical section of part of a battery, or electric generator, according to this invention. The battery is usually composed of one or more strong troughs of wood, M, say about 25 mètres long, 2 mètres wide, and 1·20 mètres high, each containing 100 double electrodes. of 2 mètres length, in it may be, four pieces connected together, and forming a hundred separate compartments. Fig. 1 shows four of these electrodes, A. These electrodes, A, are composed of a carbonaceous agglomerate, and are made by ramming together a moist paste, obtained by crushing and kneading about one part, by weight, of cereals—for example, barley—one part of bituminous coal, and two parts of very porous argillaceous earth. These substances, after being moulded and dried, are baked in a muffle at a temperature of about 1,400° C. By these means they are rendered suitably porous—that is to say, they have a porosity which is almost molecular, and are not simply perforated, as are carbon plates or electrodes made of agglomerated coke. One side, say *b*, of each piece, is then covered with tar, and the piece is baked again, which renders this side dense and non-porous. In constructing the battery, the porous side *a* of each piece is covered with a layer of suitable material, it may be very course canvas; this side constitutes the positive side, and is depolarised by the gases that enter the space between the two parts *a b* by the holes B, the inert poition (nitrogen) of the gases escaping through the pores of *a* and agitating the solution. The oxygen and the carbonic acid are absorbed by the electrolytic action. The granulated iron, which may be in the form of briquettes, is charged into the spaces between the electrodes A, and the salt water is supplied by the pipes C C. The salt water, when charged with carbonate of iron in suspension, is discharged by the orifices *d d*. The iron briquettes are very good conductors of electricity, so that the resistance of the couples is very small. The current is taken from the two ends of the trough M by the metal plates E E¹. Between E¹ and the next carbon electrode, coke or copper filings is or are rammed in so as to obtain a contact capable of conducting a current of say about a thousand ampères, which may be obtained with the battery.



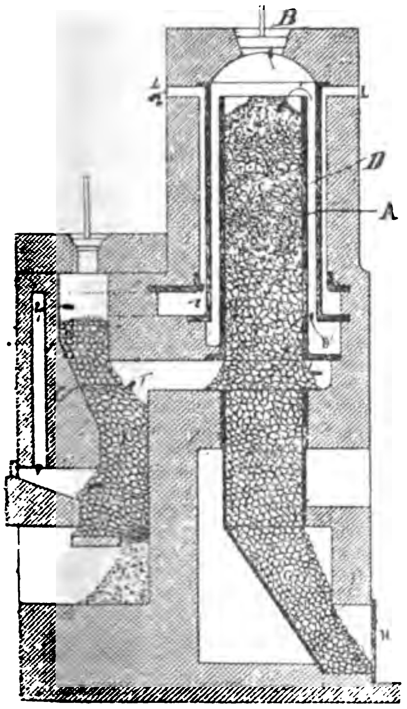


FIG. 2.

Fig. 2 is a vertical section of a furnace for regenerating or reducing the carbonate of iron produced in the battery hereinbefore described. A is a chamber in which the carbonate of iron to be reduced is placed. B is a charging opening for the introduction of the carbonate of iron. C is a gas generator for producing the carbonic oxide, mixed more or less with hydrogen and hydrocarbon, necessary for reducing the carbonate of iron. The gases, after passing through the fuel K in the gas generator, take the course indicated by the arrows 1 and pass into the chamber A. When they have arrived at the top of A, they receive through the opening or cover B a small quantity of air that effects the complete combustion of the carbonic oxide therein. The gases then flow through the space D into the flue or passage D¹, and thence pass to a chimney, whence a portion of them are drawn by the pump hereinbefore referred to, and cooled and washed on their way to the battery, for use therein. The air necessary to support combustion of the fuel in the gas producer enters at the inlets L, and takes the course indicated by the arrows 2; this air, which become heated by contact with the walls of the space D, enters the gas producer by the opening F. The spongy iron thus obtained by the reduction of the carbonate of iron treated, descends into the bottom portion G of the apparatus which constitutes a cooling chamber, and is closed by a door H.

THE ELECTRO-PHOTOPHORE.

DURING the last thirty years perhaps more persistent efforts have been made in France than in any other country in the direction of the development of the utility of primary and secondary batteries. One problem connected with these batteries has always had a special attraction for French inventors. We refer to their application to domestic purposes, and we have recently given some account in these pages of a new step in the direction of economic electric lighting by means of chemical cells.

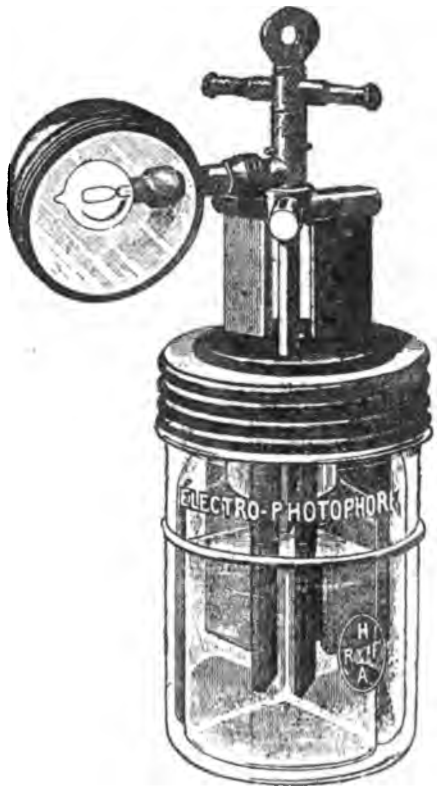


FIG. 1.

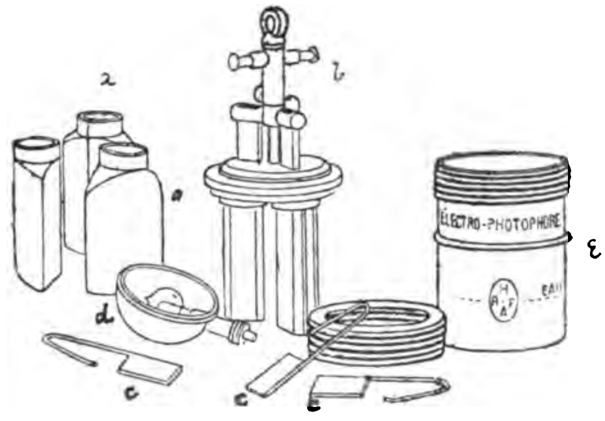


FIG. 2.

There is no doubt that the possession of a source of electric illumination, quite apart from that of the dynamo, is a great desideratum for some purposes. Batteries will probably always be used when the light is required to be portable, unless some happy inventor should discover some arrangement in which the use of chemicals is avoided, but which still is independent of mechanical installations. The problem of providing a portable electric light has been approached by a great many electricians, and their solutions, or, rather, their proposals, are legion. A thoroughly suitable lamp of this kind yet remains to be found.

We learn, however, that a distinct advance has been made in this direction by a French electrician, Mons. Radiguet, who has recently devised a portable lamp, which he calls by the fanciful title of the electro-photophon.

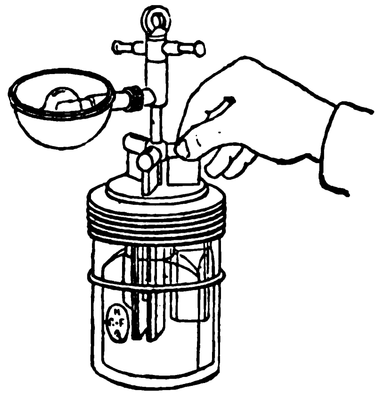


FIG. 3.

M. Radiguet is well known in Paris and elsewhere for a number of highly ingenious inventions which he has placed before the public, several of them being of great utility, and this would be sufficient to predispose us in favour of his latest production. Although he has done a great deal to popularise the domestic use of electricity, his latest venture cannot perhaps be said to be of strictly domestic utility; but it certainly constitutes a useful article for the photographer's laboratory, and possibly, when certain obvious modifications are introduced, it may prove well adapted for use in mines as well as in the house.

We call the attention of our readers to the sketch in Fig. 1, which shows at a glance the general appearance of the new lamp, or electro-photophore. It consists of a jar, which contains three bichromate elements joined up in tension. The intensity of the light given by this arrangement is equal to that of one standard candle. The cover of the jar, which is water-tight, is perforated in an ingenious manner, so as to allow of the sliding up and down of the three zinc strips; the cover also holds the three carbons. The zincs can be raised or lowered at will, so that when the light is not required there is no action in the battery. The intensity of the current produced, and therefore of the light, can be regulated by the depth to which the zinc strips are depressed, The zincs and the carbons plunge into these triangularly-shaped cells, placed side by side. These are pierced with holes at their lower ends, and through these holes the exciting liquid passes, the latter, as also the cells, being placed in the jar.

In Fig. 2 the various parts of the apparatus are shown. *a a a* are the triangular cells, *b* is the cover with the apparatus for raising and depressing the zincs, the latter being also shown; *c c c* are the carbons, *d* is the lamp containing the filament, *e* is the jar. Fig. 3 shows how the lamp is worked.

The lamp is fitted with a metallic movable reflector, so arranged that the light can be concentrated in any given direction. If desired, the glass may be of any colour.

Altogether, this little lamp with the long name appears to be an elegant source of light, and very convenient for certain purposes where portableness is a desideratum. J. T. N.

FITTING.—IV.

It now seems necessary to make some comments upon the materials with which the fitter has to work. They are invariably the common metals and their alloys. These, however, occur in such diverse grades that the fitter has to learn their several qualities and the modes of treatment suitable to each, until he knows them almost as if by intuition. These materials are cast iron, wrought iron, the steels, gun-metal, and brass.

Cast iron is used when mass and rigidity are required, or when intricate forms are wanted, even though the work is relatively light. Wrought iron is used for light rods and parts where elasticity is an advantage, and where greater elastic strength is obtainable than in cast iron of similar section. Steel is employed for similar purposes, but its greater rigidity and strength permit equal strength to be obtained with slighter proportions (a most important consideration in many instances) and also for tools. Gun-metal and brass are used for bearings of many kinds, and for light castings, for which cast iron would not have sufficient strength, and which would yet be too intricate to be forged or stamped. In time fitters learn to distinguish between different qualities of metal by the appearance of the fracture; but a good deal of experience is required to be able to do so. I wish I could illustrate, by shaded figures, the broad differences in quality of metals; but except by very perfect photographs, it cannot be done. I will, however, try what I can do by minute description.

The typical grades of cast iron are the white, mottled, and grey. Between these there are intermediate grades. Although the determination of these intermediate grades is not always easy, there is no mistaking the appearances of the broad types themselves. Though the quality of iron can be very roughly judged by the way in which it chips, files, and turns, the only way in which an accurate judgment can be formed is by noting the aspect of a fractured surface. The testing by machine is, of course, not a method available at the work-bench, neither is the method of judging by fracture always available. Still, where pieces are chipped off, or where parts have been broken by accident, or where runner ends have not been ground off, there is often sufficient surface left to enable the fitter to form a fairly correct judgment. The fracture of white iron is always of an almost silvery whiteness, and the crystals are arranged in long, needle-like bundles. Chilled iron has the same appearance. Grey iron, on the contrary, is of a bluish-grey colour. The poorer the iron, the more dull the appearance of the crystals; the stronger the iron, the brighter and more metallic-like the hue. The crystals of this grade are not needle-like, but rudely rectangular or prismatic in appearance. In poor iron they are coarser than in that of better quality. But their size depends mainly on the mass of the metal in which they occur. In small sections they are invariably of small size; in large masses invariably large, because they form more slowly in the latter case than in the former. In large masses of metal the crystals are of irregular size—small near the surfaces, larger as they approach the centre. In grey iron the particles of graphite can be distinguished by shading the specimen with the hand from the direct action of the light. The graphite will appear in patches darker than the other portions. It is mechanically intermixed with the mass. This is the class of iron used for all general jobbing work, for standards, plates of all kinds, castings where mass is the chief requisite, brackets, plummer-blocks, and such like. It is only moderately strong, but is very easily worked, and is used more than any other kind.

The mottled iron is a "strong" iron, combining the best qualities of the grey and of the white types. The characteristic "mottle" is caused by the intermixture of the silvery crystals of the latter with the graphitic carbon and grey crystals of the former. Thus it will be seen that different specimens of iron will contain the mottle in a greater or less degree, according as one or the other grade predominates. The designation "mottled" iron is therefore a very elastic one. But, speaking generally, it is tough and strong, is durable and wears well, and is tooled without special difficulty. It is used in all the best work—in engine cylinders and liners, hydraulic work, guide-bars, cross-heads, and air-vessels, in toothed gearing, and for anything where great shock and stress or much friction are encountered.

For ordinary engineers' work, iron must be sufficiently soft to be tooled. White iron is so hard that it can only be worked by grinding, or very slowly by scraping-tools. It has its special uses, but for our purpose it may be disregarded. In ninety-nine cases out of a hundred, soft iron, meaning by that, iron workable by the tools I have illustrated, is required. But "soft," again, is a vague term: some metal is so soft that it works dirty and dusty, owing to the presence of a large proportion of uncombined carbon. Though it is nice to have iron that can be cut and filed so freely, it is objectionable, through want of durability of wearing faces. Iron that is so soft is unfit for wearing faces, such as machine or engine slides, the bores of cylinders and journals. It is rapidly abraded by friction, and consequently wears out too soon. For such general purposes the iron must be tough and close-grained, and mottled, and this does not tool so freely as the other. Yet it can be cut with a sufficient readiness, and is strong, which the other is not. It is fortunate that mottled iron can be mixed in several grades. Thus a cylinder liner is made of tougher, smoother, or more "greasy" metal than the casing, and generally the greater the stress and wear upon a part, the nearer the metal is made to approximate to the extreme mottle—that is, towards the white quality. The fitter finds out these differences by experience, learns how to treat each kind of metal to the best advantage, both as regards facility of cutting and care in handling.

For cast iron is treacherous stuff. Many and many a time a foreman has to replace castings, partly or wholly machined, in consequence of the fracture of inherently weak parts; parts, however, that were strong enough for their functions if treated carefully. A slight tap of the hammer will break off a lug, forcing a tap will split a small boss, pinching a bolt too tight will fracture a flange, and so on. Cast iron in mass is strong, but all little projections and thin parts are terribly weak. All the more reason why due allowance should be made for these things, and care be taken to prevent mishap. For it must be remembered that in many cases it is only during fitting that fracture is likely to occur. When a mechanism is finished, and the parts are all jointed and fastened together, face to face, there is little or no risk of fracture happening until the time comes for taking the mechanism apart for alterations and repairs.

With wrought iron and mild steel these risks of fracture are very much reduced. These materials do not snap off without giving warning by bending. And, further, although there is a vast deal of difference in different qualities of wrought iron at the forge and testing machine, there is practically no difference at the vice. It is always easier to file wrought than cast iron, the file hanging well to it, instead of slipping, as it will on tough cast iron. It is more easily chipped also, the chisel not striking off so readily as from cast metal. The quality of a wrought iron is therefore judged better at the anvil than at the vice. But a good piece of forged iron should show a bright metallic lustre. Dull iron is always poor in quality. When a broken piece of wrought iron shows a highly crystalline surface, that merely proves that it was fractured by a sharp blow. The most fibrous material, when nicked and broken suddenly, will show a highly crystalline surface, not much unlike cast iron; but if bent and fractured by gentle hammering, or if torn asunder slowly, the iron, even though poor, will show a silky, fibrous condition. Hence the way to judge of wrought iron is by its metallic lustre, and by its behaviour under the hammer.

Good iron should not only show metallic lustre, but should be free from cracks. In inferior stuff, cracks, often of a large size, occur in the direction of rolling. When large, they are obvious on cutting the bar; when small, they may be seen black by contrast with the red or white heats of the forge. A fitter should, before spending much time on forged work, always endeavour to note if scale, and cracks, and imperfect welds are present in any vital parts. These are often hidden and invisible until a portion of the outer skin has been removed by clipping or machining. The larger the forgings, the more apt these defects are to occur, especially about the central portions. Another important point is that the grain of the iron should be disposed in the direction where greatest strength is wanted. The plane of the layers of iron should always be disposed at right angles with the line of greatest stress. Short grain should not occur in an inherently weak part, but the metal should be bent round continuously. A fitter can generally note the direction of grain on a surface brightened by filing.

Mild steel is not very different from wrought iron, except that it is harder, more rigid, stronger, and tougher. But mild steel includes many different grades. Castings of steel also occur in all grades, and some of them are very untractable and difficult to cut; others, again, are nearly as soft as forged steel. Cast steel used for tools and parts that have to be hardened or tempered is a material of protean character, requiring a deal of experience and skill to manage properly. It is difficult to judge of the quality of steel. Good steel should show a silvery fracture and fine grain; coarse grain is a mark of inferiority. It is, however, at the forge in working and tempering that the quality of steel is best determined. I shall perhaps have something to say at a later stage on the hardening and tempering of special classes of work.

Gun-metal and brass occur in all possible grades. But the chief point common to all is that they are homogeneous. Whatever the proportions of their components, the metals should be so well mixed that the cutting tools shall not be able to detect harder and softer spots. If gun-metal is hard, it should be uniformly hard; if soft, it should be soft throughout. That is about all that can be said from the fitter's point of view. J. H.

PRACTICAL HINTS IN BOILER DESIGN.—I.

By W. C. Carter.

It is proposed in the following articles to give a plain description of the considerations which are involved in the design of a modern steam-boiler, commencing with the data by which its proportions are usually fixed, and going, step by step, through the design, until the working drawing is made and ready for the shops.

For the purposes of illustration, a boiler of the highest class will be selected as an example—viz., a high-pressure boiler for marine triple-expansion engines, and inasmuch as such a boiler works under the most stringent conditions of pressure, wear and tear, and economy, it will be easy to apply the principles of construction and calculation to boilers of simpler design which are not taxed to the same extent.

In recent years, owing to the development and improvement of the manufacture of steel, it has become almost the sole material used for the highest class of boiler work—and this in spite of occasional failures, due to causes more or less remote and inexplicable. The careful and suspicious attitude assumed by engineers and responsible bodies during the infancy of the steel manufacture, has doubtless had its due effect in bracing up the trade to its present state of efficiency, and in at length establishing steel as the most useful metal for the purposes of the boiler-maker. We shall therefore adopt steel as the material for our specimen boiler, at the same time pointing out the changes that would be necessitated were some other material used.

The preliminary basis of our design is the power required to be developed by the boiler, and this is naturally expressed in indicated horse-power, which will be that of all the engines deriving steam power from it, plus a certain addition, depending upon the circumstances of the particular case, in order to cover losses by friction of steam and condensation in pipes, which is represented by the difference in pressure between the steam-gauge on the boiler and that in the engine-room.

Having decided upon the power required from our boiler, we have next to consider the room available in which to place it. Speaking roughly, the power that can be developed by an ordinary multitubular boiler is proportional to its cubic capacity—that is, to $D^2 L$, where D = diameter and L = length—and having found by trial a size of boiler containing the power we want, we must adapt it to its proposed situation by varying D and L to suit. This will be considered in closer detail further on, when we lay down the preliminary diagram for our boiler.

The first thing to settle is the grate surface, and this is found from the I.H.P., as we know by experience how much power can be obtained from each square foot of grate surface, assuming average conditions of combustion.

The following are average values gained from experience, and based upon a consumption of 2lb. of coal per indicated horse-power per hour for condensing engines, and 3½lb. for non-condensing:

	I.H.P. per sq. ft. of grate.
1. Combustion unassisted except by high chimneys, as in factories and marine boilers under natural draught	Cond..... 10 Non-cond. 6
2. Combustion assisted by auxiliary blowing arrangements producing forced draught	Cond..... 15 Non-cond. 9
3. In locomotives, in which case combustion is assisted by the air rushing into the ashpit and by the chimney blast	 25

It will be easily understood that absolute values cannot be given here, owing to the variable efficiency of engine-boilers and coal; but usually when a boiler has to be designed plenty of exact data are at hand, obtained in similar circumstances to those in which it is going to work.

Having found the required area of grate, we must settle the number and diameter of the furnaces, together with the length of firebars, in order to obtain it. No rules can be given for this operation, as the various parts of the boiler are so dependent upon each other that the final most suitable design can only be found by trial and error; though, of course, by practice and the accumulation of data, this process becomes considerably shortened. We shall, in working out our specimen design, show more clearly how this is to be done; and before going further into the practical process of settling the dimensions of the boiler, we will examine the general theoretical principles that govern the strength of the various parts.

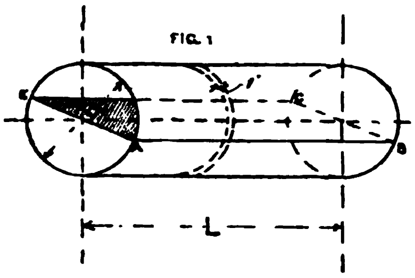
Shell.

We will commence our investigations by examining the laws governing the strength of the shell, which may be considered simply as a tube of large diameter with closed ends, containing a fluid pressure; and remembering throughout the special characteristic of such pressure—viz., that it acts equally in all directions. This form exists in some part or another in nearly all steam-boilers of the present day, as it is now known to be the strongest practicable form, the hollow sphere (which is the strongest theoretical form) being precluded on account of difficulties of manufacture. There is little doubt that the ends of cylindrical boilers assist the shell in some small degree to support the pressure upon it, especially in short boilers, and attempts have recently been made to estimate and allow for this support; but at present nothing reliable is known. We shall, therefore, disregard the ends as assisting the shell, and treat the shell itself as a simple tube.

Fig. 1 represents such a tube; and let us suppose it to contain steam under a certain working pressure, which we will call W.P.lb. per square inch.

Let us suppose the length of the tube to be L inches, and the diameter D inches. Now, conceive a partition plate or diaphragm to be inserted, and made steam-tight, in the position as shown at A B C E in the figure dividing the tube into two separate semi-cylindrical boxes. So far it is clear that the conditions inside are unaltered as regards the pressure upon either half of the tube, and owing to the diaphragm plate dividing the pressure, either side may be imagined to be removed without interfering in any way with the pressure acting upon the other side. Let us now suppose the lower half of the tube to be taken away having a semi-cylindrical box, the bottom side of which is formed by the flat plate A B C E, while no alteration whatever has taken place in the state of the pressure in the upper half of the tube. It is clear that the plate A B C E would be blown out were it not held by the two edges of the tube, which are attached at A B and C E.

FIG. 1



The pressure on the plate is clearly equal to its area in square inches multiplied by the pressure per square inch. This is Diameter × Length × Working Pressure, and the material resisting this pressure is Length × Thickness of plates*, which must be taken twice, as there are two sides; so that, summing up our results, we have established the formulæ—

(*a*) Tensile stress upon shell plating = D × L × W P
(*b*) Area of metal resisting this stress = L × 2 T.

We may further reduce these formulæ by striking out the common factor L from each of them, which is equivalent to basing all our calculations upon a strip of the shell forming a ring of a length of 1in. only (as shown by the dotted lines in Fig. 1), and this is what is done in practice, as we shall see when we come to apply our formulæ. Meanwhile, we note that—(*a*) the tensile stress upon the shell plating varies as D × W.P. (i.); (*b*) area of metal resisting the stress varies as 2 T (ii.) We must now remember that the above investigation is based upon the supposition that the tube is solid drawn or welded, so as to be of equal strength throughout. This, of course, is not the case except in small tubes, some furnaces, and in such boilers as are built up of rings rolled solid. The ordinary case with which we have to deal is that in which the tube has a joint in it which is essentially weaker than the solid plate, and therefore the strength of the solid plate may be disregarded except as a standard with which to compare the strength of the weaker portion at the joint, and the obvious method is to represent the strength of the solid plate as 100, and the strength at the joint by the corresponding proportional number, which is then the percentage of strength of the joint as compared with the solid plate. The design of the longitudinal steel joint is one of the most important points in the boiler, as by obtaining the highest possible efficiency the thickness of the shell plating may be kept as low as possible, weight and material being saved. We shall examine this joint in detail in its proper place.

ELECTRICITY IN MINING.

THE popular lecture at the meeting of the British Association—operatives' lecture, as it is called—was delivered by Prof. Silvanus P. Thompson, who explained in a lucid manner the working principles of electromotive force. Thus, to omit his introduction, he described electro-motors, saying: If you will take a dynamo machine, and will supply it with electric current through wires coming from another dynamo, it will begin to turn, and may be used as a motor to drive shafting or to do any other mechanical work. The current flows in through the brushes and enters the commutator, and thence traverses the copper coils of the armature. These copper conductors, so soon as the current flows through them, are powerfully acted on by the field-magnet which surrounds them, and are subjected to a powerful lateral drag by the invisible magnetic lines. This electro-magnetic drag drives the armature and sets it spinning with great force and speed. It therefore becomes a sort of rotatory electric engine of great power. Electric motors on a small scale—mere toys by comparison—have been known for 50 years. They could not become more than toys, or peform any work except of the lighest description, so long as feeble supplies of electric currents from voltaic batteries were the only supplies available. It was not until about the year 1860 that it was distinctly recognised that every dynamo could thus serve as a motor. It was not until 1873 that two dynamos were actually joined together by wires and used, one as generator, the other as a motor, to transmit power by wire electrically from one place to another. But the thing which was one of the wonders of the world in 1873 has become the merest commonplace of 1891; and there are to-day in the electrical industry literally hundreds of examples of power being thus successfully transmitted over long distances.

A fixed light of brilliancy hung in the mine near the working face may be very well for some purposes, but would never entirely supersede the use of portable lamps. Innumerable inventors have essayed to produce portable electric lamps, which, while having all the good properties of the ordinary safety lamp, should be absolutely free from every risk of causing an explosion. So long as a lamp with a flame is employed, however well protected by gauze, so long must there be some doubt as to its safety. Most of the suggestions for electric safety lamps have taken the form of small glow-lamps of one or two candle power, fastened to a battery of sufficient power to operate the lamp, and of sufficient capacity to maintain the light for at least nine hours, Mr. Swan's first miners' electric safety lamp differed somewhat from this. He inclosed a small glow-lamp in a strong outer bulb, protected by a cage of stout steel wires, and attached it to a flexible conducting cord several yards long, containing the leading wires. The lamp was thus tethered to mains, terminating a few yards away from the working face. In this primitive form the Swan safety lamp was actually used to a limited extent in 1881, at the Risca Colliery, in South Wales, at the Pleasley Colliery in Derbyshire, and at the Earnock Colliery in Lanarkshire. But it soon became evident that the tethered cord would not be satisfactory, and might get entangled. Nothing short of a self-contained lamp would suit the case. The Ellis-Lever competition of 1883 failed to bring forward any practical electric lamp, the only one submitted to the judges having a weight of near ¼cwt. In 1885, and again in 1886, Mr. Swan exhibited self-contained lamps at meetings of the British Association. In these lamps the electric current was furnished by a small secondary battery or accumulator in the base of the lamp. The light was satisfactory, but the weight was still too great. An ordinary miner's lamp of modern pattern, such as the Mueseler or Clanny, with protecting shield, only weighs from 3lb. to 4lb., and gives out a light less than that of a single standard candle. The Thorneburry lamp is brighter, but not less heavy; but Mr. Swan's lamp of 1885 weighed 17lb. With later improvements it was reduced to 7lb., and in this form it has been put into commerce by the Edison and Swan Electric Lighting Company, of London, and has been extensively tried. Another portable lamp, having a secondary battery to supply the current, is that of Mr. Pitkin, of Clerkenwell. This indefatigable worker has produced many varieties, but all agree in having a special compact form of secondary battery designed to stand rough work. An auxiliary resistance wire is added to moderate the brightness of the light, which on first charging is excessive. The principal objections that have been urged against them are their weight and cost. The weight, it is true, is somewhat greater than that of an oil lamp; but the light is far superior, and the safety absolute. Other inventors, amongst whom are Mr. T. Coad and Mr. A Schanschieff, have proposed portable electric lamps, having in the base of the lamp a primary voltaic battery wherein zinc plates are consumed by corrosive chemical liquids to furnish the energy for the light. Here in Cardiff Mr. Sydney Walker, and in France M. Trouvé, have produced some kindred forms. The trouble of maintaining the lamps, replenishing the spent acid liquids, and replacing the consumed zinc plates involves a serious charge over and above the cost of zinc and acids, which alone would not be prohibitive. Many of the lamps contain an automatic device to put the lamp out sparklessly in case of accident. I wish I could add that any of these forms of lamp had proven to be satisfactory in practical work. There can be no doubt that some such self-contained lamp will eventually be found to fulfil all the requisite conditions yet unattained. The increase of weight as compared with oil safety-lamps from 3½lb. to 7lb. is not so great as to make the electric safety-lamps useless. Much of the objection still felt to them is mere prejudice, which will wear off. In really fiery mines they ought assuredly to be made compulsory; the slight increase in weight is really of no importance beside the primary consideration of preservation of life and limb.

Electric Hauling.

Coming next to electric transmission of power for pumping or hauling, we find the earliest example of this application of electricity afforded by the erection in 1882 of a small plant for pumping in one of the levels of the Trafalgar Colliery by Mr. W. Blanch Brain. Two of Siemen's dynamos were used, one as a generator, the other as a motor, and the latter drove an ordinary horizontal pump with a belt from its pulley. This was a small beginning, as only 1½H.P. was thus transmitted. In 1885 this plant was increased to 2½H.P. by Messrs. Elwell, Parker, and Co., and again in 1887, when a 20H.P. motor was put down for pumping. The distance which the conducting cables carried the electric current from the generating dynamos to the motors was in this case 2,000 yards. Another example of a successful pumping plant, which has been several times enlarged, is that in use in the St. John's Colliery, at Normanton, in Yorkshire.

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* In any future use of this formula the initial letters only will be used, and the same system will be adopted as far as possible with all formulæ with which we have to deal.

I have mentioned incidentally two points to which colliery managers are likely to raise objections in the use of electric motors in pits. The first of these is the possibility of explosion being caused by a spark occurring at the commutator of the motor where the electric current is conveyed into and out of the rotating armature by means of the brushes. The second is the use, in the pit, of driving belts, which not only take up space, but cannot be kept in good working order in dirty and damp situations. Now the commutator difficulty is, I believe, largely an imaginary one. No doubt in many dynamos and motors a bright bluish spark may occasionally be observed at the tips of the brushes, especially if the latter are not in proper adjustment. In well-designed machines of modern construction the spark is practically non-existent under ordinary conditions of working. The question raised is whether it affords any realy danger. The spark is so close to a large mass of copper that it is practically cool; so cool indeed that it is extremely difficult to cause it to ignite anything. I have several times, and in vain, tried to light a gas-jet at the spark on the commutator of a dynamo, even when the brushes were purposely put out of adjustment. Many others have experimented on this point, amongst them Mr. Snell, Mr. Mordey, and Mr. Sydney Walker, all of whom agree in thinking the danger on this head to be very small—probably less than the danger from the sparks caused by the blows of a pickaxe used by the miner at the working face. However, it has been deemed advisable to provide against possible risk from this source. Accordingly, in the pumping machinery designed by Messrs. W. T. Goolden and Co., Harrow-road, London, three-throw pumps are used in preference to single- or double-throw, so as to equalise the load on the motor throughout the revolution. Pumps and motor are mounted on the same bed-plate; the pump crank-shaft being speeded down from the motor shaft by wheel gearing. The whole armature, including the commutator and brushes, is inclosed within an air-tight casing, provided externally with projecting gills to dissipate the heat arising from the current in the armature conductors. The designers of this inclosed motor maintain that they have met the difficulty in a thoroughly efficient way, and guarantee that the motor might be worked continuously for two or three hours in the midst even of an explosive atmosphere without fear.

Combined Hauling, Pumping, and Lighting Plant.

In the case of the St. John's Colliery at Normanton, the electric plant performed the double duty of pumping and hauling. There is no reason why the same electric supply should not furnish current for lighting purposes at the same time. An example, in which pumping and lighting are thus combined, is afforded by the plant at Messrs. Crawshay Bros., Newbridge, Rhondda Colliery. Here in your mountainous country of Wales you have in many districts ample supplies of natural power running to waste down the hillsides, which, if utilised and transmitted electrically, might widely increase your local industries, and at the same time preserve you from that pestilential blight of smoke-cloud with which the tall chimneys of the mills and factories in so many districts of England have ruined their natural beauty. Quite recently Messrs. Crompton and Co. have put down a large hauling plant at the Abercanaid Colliery at Merthyr Tydfil. This consists of a compound condensing engine of 40H.P. by Marshall, which drives a Crompton dynamo giving out about 150 ampères of current at a pressure of 500 volts. From the dynamo sheathed conducting cables are led down the pit shaft some 1,200 yards to a 50H.P. motor about 800 yards from the pit bottom, running at 800 revolutions per minute. This motor, which is also built by Messrs. Crompton and Co., transmits its power to a countershaft by ropes, and from this shaft the hauling drums are driven by wheel gearing. The cost of the plant was considerably less than that of a compressed air plant of equal power. Mr. Howell, of Llanelly, who erected it, says that the control of the motor is as simple as that of a compressed air-engine, the operations of starting, stopping, and reversing being accomplished by merely moving the regulating lever. It has been erected now only about a month, and has, since its erection, hauled on the average 500 tons per day.

Electric Coal-Cutting Machinery.

For a good many years past colliery managers have used coal-cutting machinery to aid them in the getting of the coal. Naturally, when it is found that electricity is so convenient an agent for pumping and hauling, and is so readily transmitted to any spot, the thought of applying it to drive coal-cutting machines has occurred to engineers. The construction of really practical machines dates from 1887, when Messrs. Goolden and Co. designed a coal-cutter, which consists of a tapered bar, rapidly revolving on its own axis, and armed with projecting teeth. Such bars have been used in hand-driven machinery for coal-cutting. After various intermediate modifications a form of machine was arrived at. The electric-motors are geared by steel double helical wheels to separate shafts, on which the cutter-bars are mounted. Great attention had to be paid to making every part as strong, and, at the same time, as compact as possible. The machine, mounted on its wheels, stands on rails laid along the working face. It is turned on its own turntable by worm-gear, so that the cutter-bar points along the heading. Then the electric current is switched on, and the bar, rapidly rotating, is slowly turned through a right angle, cutting its way into the face of the seam. The worm-gear being then locked, the machine is drawn along the face—being wound in by hand by a winch—cutting its way as it goes. In this way a deep cut is made all along the face at a few inches from the ground. The coal generally falls from above by its own weight, being temporarily wedged up in the immediate rear of the cutter-bar to prevent jamming. A speed of 400 to 500 revolutions per minute suffices for the cutter in hard coals. In soft coal it may be driven faster. The usual length of cutter-bar is 3ft. 6in. to 3ft. 9in. Owing to the wear of the cutting edges the points of the cutters have to be removed for grinding at intervals. The average length that can be cut without changing the cutter tools is about 40 yards in hard coal. One man or boy attends the winding-winch; one man attends to the cutter and to clearing the road in front of it; a third follows it spragging and putting up props. The motor is about 10-12H.P. Another form of electric coal-cutting machine, designed by Mr. Snell, is now being tried by the General Electric Power and Traction Company, having a wheel-cutter instead of a revolving bar. Of the results of this machine it would be premature to speak. Indeed, the whole of this part of the subject is so novel that it is impossible to give, as one can in the case of pumping and hauling, exact figures as to the economy effected by the introduction of the new appliances. For rock drilling and boring electric motors have also been used. We may divide all drilling machines into two classes—rotatory and percussive. Both sorts have been tried with electric power. For many years on a very small scale electric-motors have been used for driving dentists' drills and mallets, for boring and filling teeth. On the large scale for mining not much has yet been done. To attach an Ingersoll rock-drill to an electric-motor requires no great stroke of inventive genius; and has not proved a very practical device. What is wanted is a form of drill adapted to the peculiar capabilities of electric power. In conclusion, Prof. Thompson said:—"Everywhere, as one looks around the electric-engineering industry, one sees evidence that electricity is at last taking its place as an agent for doing the heavy work for which at one time only steam power and hydraulic power were deemed suitable. My task has been to illustrate recent practical developments of a science that has for years been the object of my daily and hourly thoughts." Before resuming his seat the lecturer paid a warm tribute to the capability of Mr. Snell, Mr. Atkinson, and Mr. Sydney Walker, without whose aid he would not have succeeded in expounding the progress of invention to its present point. All those were men who know their work and do it: men, he ventured to say, whose untiring efforts, whose intelligent appreciation of the practical problems with which they have to grapple, and whose inventive ingenuity entitle them to honourable mention, quite apart from the services which they had so courteously and willingly rendered to him. It is by such intelligent labour, such untiring application, and such inventive skill that scientific discoveries are made of use to mankind. It is by such effort, such invention, such enterprise, that the honourable fame of the British engineer has been established throughout the civilised world.

ON ELECTRIC STRESS.

THE subject of electric stress was chosen by Prof. Rücker for the second discourse delivered before the British Association. This year is, he said, the centenary of Faraday's birth. The authorities of the Royal Institution have been celebrating the event, and the room in which he so often lectured has been ringing with his praise. The occasion is of sufficient importance to attract the attention of all who take an interest in science, and I have thought it desirable that one of the lectures delivered this year before the British Association should be on a subject related to Faraday's work. I do not, indeed, propose to traverse again the ground over which Lord Rayleigh and Prof. Dewar have lately passed, but I shall follow out one of the ideas which Faraday gave to the world, and shall show you that what seemed at first a mere convenient mode of expression has proved to be a rigid description of a physical fact of profound importance. The idea of mapping out the space around an electrified or magnetised body by means of "lines of force" is now commonplace. Fifteen thousand candidates present themselves annually for the May examination in electricity and magnetism conducted by the Department of Science and Art, and the vast majority of these are well acquainted with the term. A small conductor, the length of which is considerable with respect to its other dimensions, and which is free to turn about its centre, will, if brought near to an electrified body, point in a certain definite direction. It is a kind of electrical compass indicating the direction in which the electrical forces are acting. If we move it on a step, so that the end nearest to the body occupies the position previously held by that which was then the more remote from it, the pointer takes up a new position. Repeating the operation, we gradually trace out a line or curve, the direction of which at every point indicates the direction of the electrical force at that point. Every schoolboy has seen the experiment in which the magnetic lines of force are traced out by means of iron filings. It is a much more difficult matter to depict electrical lines of force by means of electrified particles. It can, however, be done in several ways, and perhaps best in accordance with a suggestion of W. Stoltz. The electrified bodies are metal discs, or wires, placed at the bottom of a glass vessel filled with ether. If powdered sulphide of antimony be scattered over the surface it sinks to the bottom, and when the metallic conductors are electrified it collects along the lines of force, which are thus rendered visible. In one respect the experiment shows more than the more common one with the iron filings. The sulphide tends to accumulate about the positively charged body, so that the state of electrification of the conductors is indicated as well as the form of the lines that unite them. If a small area be selected on a positively electrified body, and lines of force be drawn from every point on the curve which surrounds it, they will inclose a tubular space. Such tubes of force extend from positively to negatively electrified bodies, and Faraday noticed that they tended to contract in the direction of their length and to expand sideways. Maxwell carried the matter a step further by showing that these peculiar tendencies could be explained if we suppose that in the medium which divides the electrified bodies there is a tension along the lines of force and a pressure at right angles to them, and that such a distribution of force is consistent with the equilibrium of a perfect fluid. It remained to prove by direct experiment that these forces really exist, and this crucial test we owe to Dr. Kerr, of Glasgow, whose experiments have been repeated and extended by Quincke. If in consequence of a tension or tendency to contract along the lines of force and a pressure or tendency to expand at right angles to them, and if by the action of these forces the particles of which the medium is composed are differently arranged or packed in different directions, this fact can be detected by the agency of light. Adopting the language of the undulatory theory of light, the motions in a beam which emerges from a Nicol's prism all take place in parallel directions. Light thus constituted cannot pass through a second similar prism placed at right angles to the first, and no difference is produced by the interposition between the prisms of a body the properties of which are the same in all directions. Liquids, or a plate of well-annealed glass, fail to alter the state of polarisation of the light. If, however, the glass be squeezed in one direction, so that in that direction the particles are forced together, while at right angles to it their original distance is maintained unaltered, the light undergoes a change which enables it to pass through the second prism. We cannot by ordinary mechanical means squeeze a liquid in one direction only; but if it be the supersaturated solution of the salt in the act of crystallisation, the particles as they group themselves into crystals become differently packed in different directions, they modify the light, and the formation of the crystals can be seen on a background of apparently opaque liquid. Hence, to test the state of a medium which is the seat of electrical forces, we pass a beam of plane polarised light between two metal plates immersed in a good non-conducting liquid. Bisulphide of carbon is found to be the best for the experiment. So long as the plates are unelectrified the plane polarised light passes unaltered through the fluid between them and fails to penetrate the second prism. If, however, they are oppositely electrified so that the lines of force run from the one to the other, the light breaks through the barrier and spreads upon the screen. This phenomenon, which was demonstrably caused in the case of the squeezed glass and the growing crystals by a rearrangement of the molecules so that they were packed in different degrees of closeness in different directions, must be due to a similar cause when the forces are electrical. By electrical stresses we have performed the apparently impossible task of squeezing a liquid in one direction while we are stretching it in another. The light test proves that the conceptions of Faraday and Maxwell are not merely convenient working hypotheses, not merely a framework, necessary, indeed, for the erection of a mathematical theory, but to be hereafter removed from it, but that they are the accurate expressions of actual fact. The subject thus explained by the lecturer was illustrated and expanded by a large number of experiments. If the mechanical or electrical stresses are sufficiently powerful the light is coloured, and bands of colour appear or disappear from the screen according as the electrical machine is rotated or brought to rest. If two pieces of glass are squeezed, the one in a vertical and the other in a horizontal direction, the particles are most closely packed along a vertical line in the one and along a horizontal line in the other. Hence they tend to neutralise each other's effects. Squeezed singly, each produced a band of light on the screen. When they were compressed simultaneously both bands appeared, but where they crossed, instead of double brightness there was darkness. This effect was also produced by electrical stresses. Two pairs of metal plates were immersed in two vessels containing carbon bisulphide. The one pair was horizontal, the other vertical, and when they were electrified simultaneously two bands of light were produced with a black patch at the crossing point. Next, the light produced when the electrical stresses were in play was analysed by a prism, and a spectrum was produced on the screen. The colours previously exhibited when the electrical stress was great was due to the fact that under these conditions some of the constituents of white light had passed through a cycle of changes, and were brought back again into the conditions in which they were incapable of traversing the second Nicol's prism. This was shown by the presence of a black band which shifted its position in the spectrum as the forces altered. Travelling from the blue end, it disappeared, when the forces were powerful enough, at the red. Beyond the red end of the visible spectrum there are, however, invisible radiations, to which our eyes do not respond, and the journey of the band of no radiations (which in the visible spectrum appeared as darkness) could be traced beyond the limits of vision. The method of carrying out this extremely delicate and difficult experiment is to place one of the radiomicrometers of Prof. Boys a little beyond the red boundary of the visible spectrum. A spot of light reflected on the screen indicates whether the instrument is heated or chilled. When the spectrum first appears heat can be detected, but shortly after the black band reaches the red end and disappears the instrument is suddenly cooled. As the electrical machine is revolved more rapidly the electrical stresses increase, the invisible band of no radiation passes beyond the instrument, and the presence of heat is once more registered. Finally, Prof. Rücker pointed out that in studies such as these we are passing from the investigation of the properties of ordinary matter to those of the ether, which may perhaps be the material of which matter is composed, and which is certainly something of a more subtle and fundamental kind. Its existence is now proved beyond the possibility of doubt. We may some day be able to control and use it, as we now control and use steam. If this is so, the centenary of Faraday's birth will not be the last festival held in his honour, and the generations which reap the harvest which earlier students of the science of electricity have sown will not forget the name of Dr. Kerr, as that of the physicist who completed in the laboratory of a training college a chain of evidence of which Faraday and Maxwell had forged the first links.

DE LALANDE'S NEW OXIDE OF COPPER BATTERY.

In the old models the oxide of copper was generally employed in the form of grains placed simply at the bottom of a metallic vessel forming the receptacle of the element, or else in a small cup occupying the bottom of a glass vessel. The zinc was arranged at the upper part of the vessel, in the form of a horizontal plate or of a rolled band. In the new models (Figs. 1, 2, and 3), the plates of agglomerated oxide ot copper, C, are held vertically opposite the zinc plates, z z, against metallic supports, D D, fixed to the covers, B B, of the elements. The whole is immersed in a solution (about 35 per cent.) of potash contained in a glass jar, A. Among other advantages, this arrangement presents that of giving elements that are compacter and easier to dismount.

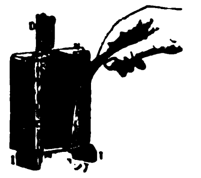

Fig. 4.—Mounting of Agglomerates.

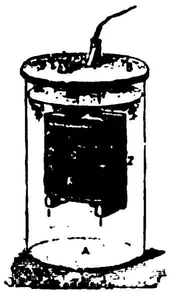

Fig. 1

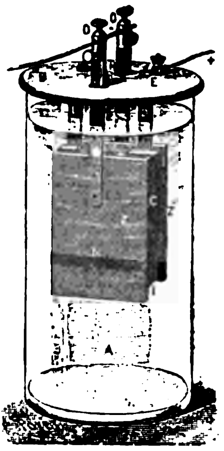

Fig 2.

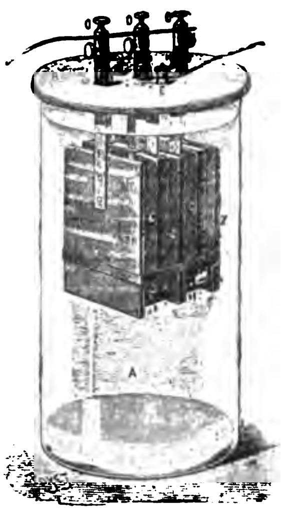

Fig 3.

The agglomerates of oxide of copper may be prepared by moulding in a hydraulic press a damp mixture of copper scales with 4 or 5 per cent. of clay, and baking the product at a temperature of from 600° to 700°. The scales may likewise be mixed with 6 or 8 per cent. of tar, and be moulded and submitted to red heat in a reverberatory furnace. There is first produced a reduction of the oxide, whence results the agglomeration of the mass; then, under the influence of the air, the metal oxidises without alteration of form. The plates thus obtained, although containing no foreign matter, are very strong. Their porosity in both cases is sufficient to allow the whole of the oxide to exert its depolarising action without the introduction of a notable resistance into the battery.

One of the most interesting peculiarities of the zinc-oxide of copper couple is the increase in depolarising power consequent upon the work of the element. This rare phenomenon of a battery whose disposable energy continues to increase from the beginning of the discharge before reaching the state of regular operation can be easily explained. The oxide of copper, being a poor conductor of electricity, is capable of depolarising only at the points of contact with the electrode; but, as the copper produced by its reduction conducts very well, the surface interested in the depolarisation increases very rapidly, and the absorption of the hydrogen becomes more easy and rapid. There is thus produced a sort of *formation* of the electrode. If, then, the agglomerates manufactured as has been described were used just as they are in the batteries, the depolarisation would be imperfect at the beginning, the parts in the contact with the metallic support being alone capable of acting through their feeble surfaces.. The element would have to be closed upon itself for some minutes in order to be put in condition.

It is much preferable to put the depolarising electrode immediately in the best condition for operating by metallising it, so as to render it conductive. The active surface is thus greatly increased, and this suppresses the period of formation. To this effect the agglomerate is covered with a thin layer of zinc by immersion in a mixture of water and of zinc in suspension, and is then dipped in slightly acidulated water. The zinc in dissolving forms a series of local couples with the oxide of copper, whose surface is rapidly reduced to a metallic state. The agglomerates thus treated, having a conductive surface, would give good results in batteries; but if, after washing them, we wish to dry them, the porous copper reduced on the surface rapidly reoxidises, and the conductivity is lost. In order to obviate this inconvenience, the agglomerates, on coming from the acid bath, are put into an electrometallurgic bath, and are covered with a thin and continuous layer of copper. On employing a current of short duration and great intensity (2 to 3 ampères per square decimètre of surface of the agglomerate), the deposit will have a porosity such as not to increase the interior resistance of the batteries. It then sufficies to wash and dry the metallic plates. The deposited copper does not reoxidise, and the surface remains conductive. These agglomerates, converted into metallic copper by the work of the battery, may be employed again for several times, after being washed, grilled, and metallised. The system of mounting the agglomerates and zincs is the same in the three models. The support, D D, of the agglomerate (Fig. 2) is fixed to the earthenware cover, B, by means of screws and nuts, one of the screws carrying the positive terminal, E. It is formed of a copper-coated plate of iron, of rectangular form, hollowed out, and with parts of it bent so as to form a lodgment for the plate. In order to mount the agglomerate, it is placed in the position that it is to occupy (Fig. 4), and is held by two curved springs, L L, of hammered copper, whose lower extremities enter apertures, M M, at the base of the support. The upper extremities of the springs are afterwards introduced into slits, N N. This very rapid method of mounting keeps the agglomerates in perfect metallic contact with the support.

As for the zincs, they are supported by strips of metal, F F, passing through rectangular apertures in the cover. To the upper part of these supports are fixed steel springs, H H, which are capable of traversing the cover on being compressed, and which, on afterwards resuming their natural position, support the weight of the zinc and rest upon the surface of the cover. In the small model, a conducting wire is fixed to the zinc; in the other models, there are placed in each of the zincs metallic binding-screws, O O O, connected by the negative conductor.

The zincs, moreover, are supported at a proper distance from the negative electrode by ebonite insulators, I I, fixed upon the supports of the oxide of zinc. The agglomerated plates and the zincs are surrounded by a rubber band, K.

The zincs must be kept entirely immersed on account of the rapidity with which they wear away at the level of the liquid. Their supports are usually made of copper or amalgamated brass. Tinned iron, which is cheaper and more resistant, may also be employed.

The electrodes do not extend to the lower part of the vessels. The zinc-potash compound that forms during the operation of the battery separates quite freely, in consequence of its great density, in the form of a layer that occupies the bottom of the vessel. The electrodes, being near the surface, therefore remain the longest time possible in the solution of potash that is to attack them. In the presence of a saturated alkaline solution, or a nearly saturated one of oxide of zinc, the surface of the zinc would become covered during the operation of the battery with a layer of oxide, in consequence of the need of a solvent, and would no longer be able to operate effectively.

The general properties of the oxide of copper battery are well known. Up to the present it is the only primary element with permanent mounting that is capable of a large discharge, and that consumes its elements only in proportion to the work furnished. In the new models, the use of agglomerates with metallised surface permits, from the beginning, of causing a very wide depolarising surface to act, and this increases the constancy of the elements. The bringing of the surfaces near to each other diminishes the internal resistance. The discharges are, consequently, greater, and the constancy more complete for elements of comparable dimensions, in the new as well as in the old models.
—*Le Genie Civil.*

MUSICAL INSTRUMENTS: THEIR CONSTRUCTION AND CAPABILITIES.—III.*

The so-called wood wind-instruments are the flute, oboe, bassoon, and clarinet. It is as well to say at once that their particular qualities of tone do not absolutely depend upon the materials of which they are made. The form is the most important factor in determining the distinction of tone-quality, so long as the sides of the tube are equally elastic, as has been submitted to proof by instruments made of various materials, including paper. I consider this has been sufficiently demonstrated by the independent experiments of Mr. Blaikley, of London, and Mr. Victor Mahillon, of Brussels. But we must still allow Mr. Richard Shepherd Rockstro's plea, clearly set forth in a recently-published treatise on the flute, that the nature and the substance of the tube by reciprocity of vibration, exercise some influence, although not so great as might have been expected, on the quality of the tone. But I consider this influence is already acknowledged in my reference to equality of elasticity in the sides of the tube.

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* By A. J. Hipkins, F.S.A. Extracted from a series of Cantor Lectures before the Society of Arts.

The flute is an instrument of *embouchure*—that is to say one in which a stream of air is driven from the player's lips against an edge of the blow-hole to produce the sound. The oboe and bassoon have double reeds, and the clarinet a single reed, made of a species of cane, as intermediate agents of sound-production. There are other flutes than that of *embouchure*—those with flageolet or whistle heads, which, having become obsolete, shall be reserved for later notice. There are no real tenor or bass flutes now, those in use being restricted to the upper part of the scale. The present flute dates from 1832, when Theobald Boehm, a Bavarian flute-player, produced the instrument which is known by his name. He entirely remodelled the flute, being impelled to do so by suggestions from the performance of the English flautist, Charles Nicholson, who had increased the diameter of the lateral holes, and by some improvements that had been attempted in the flute by a Captain Gordon, of Charles the Tenth's Swiss Guard. Boehm has been sufficiently vindicated from having unfairly appropriated Gordon's ideas. The Boehm flute, since 1846, is a cylindrical tube for about three-fourths of its length from the lower end, after which it is continued in a curved conical prolongation to the cork stopper. The finger-holes are disposed in a geometrical division, and the mechanism and position of the keys are entirely different from what had been before. The full compass of the Boehm flute is chromatic, from middle C to C, two octaves above the treble clef C, a range of three octaves, which is common to all concert flutes, and is not peculiar to the Boehm model. Of course, this compass is partly produced by altering the pressure of blowing. Columns of air inclosed in pipes vibrate like strings in sections; but, unlike strings, the vibrations progress in the direction of length, not across the direction of length. In the flute, all notes below D in the treble clef are produced by the normal pressure of wind —by an increasing pressure of overblowing the harmonics D, in the treble clef, and A and B above it—are successively attained. The finger-holes and keys, by shortening the tube, fill up the required intervals of the scale. There are higher harmonics still, but flautists generally prefer to do without them when they can get the note required by a lower harmonic. In Boehm's flute, his ingenious mechanism allows the production of the eleven chromatic semitones intermediate between the fundamental note of the flute and its first harmonic by holes so disposed that, in opening them successively, they shorten the column of air in exact proportion. It is, therefore, ideally, an equal temperament instrument, and not a D major one, as the conical flute was considered to be. Perhaps the most important thing Boehm did for the flute was to enunciate the principle that, to insure purity of tone and correct intonation, the holes must be put in their correct theoretical positions; and at least the hole below the one giving the sound must be open, to insure perfect venting. Boehm's flute, however, has not remained as he left it. Improvements applied by Clinton, Pratten, and Carte, have introduced certain modifications in the fingering while retaining the best features of Boehm's system. But it seems to me that the reedy quality obtained from the adoption of the cylindrical bore which now prevails does away with the sweet and characteristic tone-quality of the old conical German flute, and gives us in its place one that is not sufficiently distinct from that of the clarinet.

The oboe takes the next place in the wood wind-band. The principle of sound excitement, that of the double reed, originating in the flattening of the end of an oat or wheat straw, is of great antiquity; but it could only be applied by insertion in tubes of very narrow diameter, so that the column of air should not be wider than the tongue straw or reed acting upon it. The little reed bound round and contracted below the vibrating ends in this primitive form permitted the adjustment of the lower open end in the tube, it might be another longer reed or pipe which inclosed the air column; and thus a conical pipe that gradually narrows to the diameter of the tongue reed must have been early discovered, and was the original type of the pastoral and beautiful oboe of the modern orchestra.

Like the flute, the oboe has only the soprano register, extending from B flat or natural below middle C, to F above the treble clef, two octaves and a fifth, which a little exceeds the flute downwards. The foundation of the scale is D major, the same as the flute was before Boehm altered it. Triebert, a skilful Parisian maker, tried to adapt Boehm's reform of the flute to the oboe; but, so far as the geometrical division of the scale was concerned, he failed, because it altered the characteristic tone-quality of the instrument, so desirable for the balance of orchestral colouration. But the fingering has been modified with considerable success, although, it is true, by a much greater complication of means than the more simple contrivances that preceded it, which are still preferred by the players. The oboe reed has been much altered since the earlier years of this century. It was formerly more like the reed of the shawm, an instrument from which the oboe reed has been derived, and that of the present bassoon. It is now made narrower, with much advantage in the refinement of the tone. As in the flute, the notes up to C sharp in the treble clef are produced by the normal blowing, and simply shortening the tube by opening the sound-holes. Beyond that note increased pressure, or overblowing, assisted by an harmonic "speaker" key, produces the first harmonic, that of the octave, and so on. The lowest notes are rough and the highest shrill; from A to D above the treble clef, the tone-quality of the oboe is of a tender charm in melody. Although not loud, its tone is penetrating and prominent. Its staccato has an agreeable effect. The place of the oboe in the wood wind-band, between the flute and the clarinet, with the bassoon for a base, is beyond the possibility of improvement by any change.

Like the flute, there was a complete family of oboes in the 16th and early in the 17th century; the little schalmey, the discant schalmey, from which the present oboe is derived; the alto, tenor, pommer, and bass pommers, and the double quint or contrabass pommer. In these old finger-hole instruments the scale begins with the first hole, a note in the bagpipe with which the drones agree, and not the entire tube. From the bass and double quint pommers came ultimately the bassoon and contra-bassoon, and from the alto pommer, an obsolete instrument for which Bach wrote, called the oboe di eaccia, or hunting-oboe, an appellation unexplained, unless it had originally a horn-like tone, and was, as it has been suggested to me by Mr. Blaikley, used by those who could not make a real hunting-horn sound. It was bent to a knee shape to facilitate performance. It was not exactly the cor Anglais, or English horn, a modern instrument of the same pitch, which is bent like it, and of similar compass, a fifth below the usual oboe. The tenoroon, with which the oboe di caccia has been compared, was a high bassoon, really an octave and a fifth below. It has been sometimes overlooked that there are two octaves in pitch between the oboe and bassoon, which has led to some confusion in recognising these instruments. There was an intermediate instrument a third lower than the oboe, used by Bach, called the oboe d'amore, which was probably used with the cornemuse or bagpipe, and another, a third higher than the oboe, called musette (not the small bagpipe of that name). The cor Anglais is in present use. It is a melancholy, even mournful, instrument, its sole use in the orchestra being very suitable for situations on the stage, the effect of which it helps by depressing the mind to sadness. Those who have heard Wagner's "Tristan und Isolde" will remember, when the faithful Kurwenal sweeps the horizon and sees no help coming on the sea for the dying Tristan, how pathetically the reed pipe of a careless peasant near, played in the orchestra on a cor Anglais, colours the painful situation.

The bassoon is the legitimate bass to the oboe and to the wood wind in general. It was evolved, in the 16th century, from the pommers and bombards—the tenors and basses of the shawm or oboe family. With the older instruments, the reeds were not taken hold of immediately by the lips, but were held in a kind of cup, called a *pirouette*, which only allowed a very small part of the reed to project. In the oboe and bassoon the player has the full control of the reed with the lips, which is of great importance both in expression and intonation. The bassoon economises length by being turned back upon itself; and, from its appearance, obtains in Italy and Germany the satirical appellation of "fagotto" or "fagott." It is made of wood, and has not, owing to many difficulties as yet unsurmounted, undergone those changes of construction that have partly transformed other wood wind-instruments. From this reason—and perhaps the necessity of a bassoon-player becoming intimately familiar with his instrument—bassoons by some of the older makers—notably, Savory—are still sought after in preference to more modern ones. The instrument, although with extraordinary advantages in tone, character, and adaptability, that render it valuable to the composer, is yet complicated and capricious for the performer; but its very imperfections remove it from the mechanical tendencies of the age, often damaging to art; and, as the player has to rely very much upon his ear for correct intonation, he gets, in reality, near to the manipulation of the stringed instruments. The bassoons play readily with the violoncellos, their united tone being often advantageous for effect. When not so used it falls back into its natural relationship with the wood wind division of the orchestra. The compass of the bassoon is from B flat, an octave below that in the bass clef, to B flat in the treble clef, a range of three octaves, produced by normal pressure, as far as the bass clef F. The F below the bass clef is the true lowest note, the other seven semitones descending to the B flat being obtained by holes and keys in the long joint and bell. These extra notes are not overblown. The fundamental notes are extended, as in the oboes and flutes, by overblowing to another octave, and afterwards to the twelfth. In modern instruments yet higher notes, by the contrivance of small harmonic holes and cross fingerings, can be secured. Long notes, scales, arpeggios are all practicable on this serviceable instrument, and in full harmony with clarinets, or oboes and horns, it forms part of a rich and beautiful combination. There is a very telling quality in the upper notes of the bassoon of which composers have made use. Structurally, a bassoon consists of several pieces—the wing, butt, long joints, and bell; and when fitted together they form a hollow cone of about 8ft. long, the air column tapering in diameter from $\frac{3}{16}$ths of an inch at the reed to $1\frac{3}{4}$in. at the bell end.

The bending back at the butt joint is pierced in one piece of wood, and the prolongation of the double tube is usually stopped by a flattened oval cork, but in some modern bassoons this is replaced by a properly curved tube. The height is thus reduced to a little over 4ft., and the holes, assisted by the artifice of piercing them obliquely, are brought within reach of the fingers. The crook in the end of which the reed is inserted, is about 12in. long, and is adjusted to the shorter branch.

The contra-bassoon is an octave lower than the bassoon, which implies that it should go down to the double B flat, two octaves below that in the bass clef; but it is customary to do without the lowest as well as the highest notes of this instrument. It is rarely used, but should not be dispensed with. Messrs. Mahillon, of Brussels, produce a reed contra-bass of metal, intended to replace the contra-bassoon of wood, but probably more with the view of completing the military band than for orchestral use. It is a conical brass tube of large proportions, with seventeen lateral holes of wide diameter and in geometrical relation, so that for each sound one key only is required. The compass of this contra-bass lies between D in the double bass octave and the lower F of the treble clef.

The sarrusophones of French invention are a complete family, made in brass, and with conical tubes pierced according to a geometric relation, so that the sarrusophone is more equal than the oboe it copies, and is intended, at least for military music, to replace. Being on a larger scale, the sarrusophones are louder than the corresponding instruments of the oboe family. There are six sarrusophones from the sopranino in E flat to the contra-bass in B flat; and to replace the contra-bassoon in the orchestra there is a lower contra-bass sarrusophone made in C, the compass of which is from the double bass octave B flat to the higher G in the bass clef.

Before leaving the double reed wind-instruments, a few words should be said of a family of instruments in the 16th century as important as the schalmeys, pommers, and bombards, but long since extinct. This was the cromorne, a wooden instrument with cylindrical column of air; the name is considered to remain in the cremona stop of the organ. The lower end is turned up like a shepherd's crook reversed, from whence the French name "tournebout." Cromorne is the German "krummhorn;" there is no English equivalent known. The tone, as in all the reed instruments of the period, was strong and often bleating. The double reed was inclosed in a *pirouette*, or cup, and the keys of the tenor or bass, just the same as with similar flutes and bombards, were hidden by a barrel-shaped cover, pierced with small openings, apparently intended to modify the too searching tone as well as to protect the touch-pieces which moved the keys. The compass was limited to fundamental notes, and from the cylindrical tube and reed was an octave lower in pitch than the length would show. In all these instruments provision was made in the holes and keys for transposition of the hands, according to the player's habit of placing the right or left hand above the other. The unused hole was stopped with wax. There is a fine and complete set of four cromornes in the Museum of the Conservatoire at Brussels.

We have now arrived at the clarinet. Although embodying a very ancient principle—the "squeaker" reed which our little children still make, and continued in the Egyptian arghool—the clarinet is the most recent member of the wood wind-band. The reed initiating the tone by the player's breath is a broad, single, striking, or beating reed, so called because the vibrating tongue touches the edges of the body of the cutting or framing. A cylindrical pipe, as that of the clarinet, drops, approximately, an octave in pitch when the column of air it contains is set up in vibration by such a reed, because the reed virtually closes the pipe at the end where it is inserted, and, like a stopped organ-pipe, acts up a node of maximum condensation or rarefaction at that end. This peculiarity interferes with the resonance of the even-numbered partials of the harmonic scale, and permits only the odd-numbered partials—1, 3, 5, and so on—to sound. The first harmonic, as we find in the clarinet, is, therefore, the third partial, or twelfth of the fundamental note, and not the octave, as in the oboe and flute, In the oboe the shifting of the nodes in a conical tube, open at its base and narrowing to its apex, permits the resonance of the complete series of the harmonic scale, 1, 2, 3, 4, 5, and upwards. The flute has likewise the complete series, because through the blowhole it is a pipe open at both ends. But while stating the law which governs the pitch and harmonic scale of the clarinet, affirmed equally by observation and demonstration, we are left at present with only the former when regarding two very slender, almost cylindrical reed-pipes, discovered in 1889 by Mr. Flinders Petrie, while excavating at Fayoum the tomb of an Egyptian lady named Maket. Mr. Petrie dates these pipes about 1100 B.C., and they were the principal subject of Mr. Southgate's recent lectures upon the Egyptian scale. Now, Mr. J. Finn, who made these ancient pipes sound at these lectures with an arghool reed of straw, was able upon the pipe, which had, by finger-holes, a tetrachord, to repeat that tetrachord a fifth higher by increased pressure of blowing, and thus form an octave scale comprising eight notes! "Against the laws of Nature," says a friend of mine; for the pipe having dropped more than an octave through the reed, was at its fundamental pitch, and should have overblown a twelfth. But Mr. Finn allows me to say with reference to those reeds—perhaps the oldest sounding musical instruments known to exist—that his experiments with straw reeds seem to indicate low, medium, and high octave registers; the first and last difficult to obtain with reeds as made by us. He seeks the fundamental tones of the Maket pipes in the first or low register, an octave below the normal pitch. By this the fifths revert to twelfths. I offer no opinion, but will leave this curious phenomenon to the consideration of my friends Mr. Blaikley, Mr. Victor Mahillon, and Mr. Hermann Smith, acousticians intimate with wind instruments.

The clarinet was invented about A.D. 1700, by Christopher Denner, of Nuremberg. By his invention, an older and smaller instrument—the chalumeau, of eleven notes without producible harmonics—was, by an artifice of raising a key to give access to the air-column at a certain point, endowed with an harmonic series of eleven notes a twelfth higher. The chalumeau being a cylindrical pipe, the upper partials could only be in an odd series; and when Denner made them speak they were consequently not an octave, but a twelfth above the fundamental notes. Thus, an instrument which ranged, with the help of eight finger-holes and two keys, from F in the bass clef to B flat in the treble, had an addition given to it at once of a second register from C in the treble clef to E flat above it. The scale of the original instrument is still called chalumeau by the clarinet player; about the middle of the last century it was extended down to E. The second register of notes, which, by this lengthening of pipe, started from B natural, received the name of clarinet, or clarionet, from the clarino or clarion, the high solo trumpet of the time it was expected that this bright harmonic series would replace.

There are several clarinets of various pitches, and formerly more than are used now, owing to the difficulty in playing except in handy keys. In the modern orchestra the A and B flat clarinets are the most used; in the military band, B flat and E flat. The C clarinet is not much used now. All differ in tone and quality; the A one is softer than the B flat, the C is shrill. The B flat is the virtuoso instrument. In military bands the clarinet takes the place which would be that of the violin in the orchestra, but the tone of it is always characteristically different. Although introduced in the time of Handel and Bach, those composers made no use of it. With Mozart it first became a leading orchestral instrument.

The Basset-horn, which has become the sensuously beautiful alto Clarinet in E flat, is related to the clarinet in the same way that the cor Anglais is to the oboe. Basset is equivalent to Baryton (there is a Basset flute figured in Prætorius), and this instrument appears to have been invented by one Horn, living at Passau, in Bavaria, about 1770. His name given to the instrument has been mistranslated into Italian as Corno di Bassetto. There is a bass clarinet employed with effect by Meyerbeer in the "Huguenots," but the characteristic clarinet tone is less noticeable; it is, however, largely used in military bands. The Basset horn had the deep compass of the bass clarinet which separates it from the present alto clarinet, although it was more like the alto in calibre. The alto clarinet is also used in military bands; and probably what the Basset horn would have been written for, is divided between the present bass and alto clarinets.

Preceding the invention of the sarrusophone, by which a perfected oboe was contrived in a brass instrument, a modified brass instrument, the saxophone, bearing a similar relation to the clarinet, was invented in 1846 by Sax, whose name will occur again and again in connection with important inventions in military band instruments. The saxophone is played like the clarinet with the intervention of a beating reed, but is not cylindrical; it has a conical tube like the oboe. The different shape of the column of air changes the first available harmonic obtained by overblowing to the octave instead of the twelfth; and also in consequence of the greater strength of the even harmonics, distinctly changing the tone-quality. The sarrusophone may fairly be regarded as an oboe or bassoon; but the saxophone is not so closely related to the clarinet. There are four sizes of saxophone now made between high soprano and bass. Starting from the fourth fundamental note, each key can be employed in the next higher octave, by the help of other two keys, which, being opened successively, set up a vibrating loop. The saxophones, although difficult to play, fill an important place in the military music of France and Belgium, and have been employed with advantage in the French orchestra. The fingering of all saxophones is that attributed to Boehm.

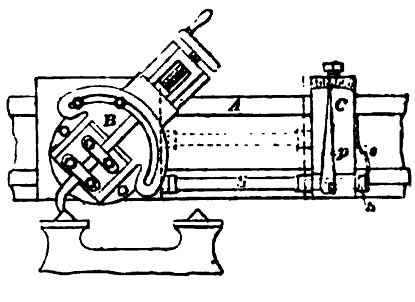
The cup-shaped mouthpiece must now take the place of the reed in our attention. Here the lips fit against a hollow cup-shaped reservoir, and, acting as vibrating membranes, may be compared with the vocal chords of the larynx. They have been described as acting as true reeds. Each instrument in which such a mouthpiece is employed requires a slightly different form of it. The French horn is the most important brass instrument in modern music. It consists of a body of conical shape, about 7ft. long without the crooks, ending in a large bell, which spreads out to a diameter of 15in. The crooks are fitted between the body and the mouthpiece; they are a series of smaller interchangeable tubings, which extend in length as they descend in pitch, and set the instrument in different keys. The mouthpiece is a funnel-shaped tube of metal—by preference, silver; and, in the horn, is exceptionally not cup-shaped, but the reverse. It tapers, as a cone, from three-quarters of an inch diameter to about a minimum of three-sixteenths of an inch, and is a quarter of an inch where the smaller end of the mouthpiece is inserted in the upper opening of the crook. The first horn has a mouthpiece of rather less diameter than the second. The peculiar mouthpiece and narrow tubing have very much to do with the soft voice-like tone-quality of the horn. For convenience of holding, the tubing is bent in a spiral form. There is a tuning-slide attached to the body, and, of late years, valves have been added to the horn similar to those applied to the cornet and other wind instruments. They have, to a considerable extent, superseded hand-stopping, by which expedient the intonation could be altered a semitone or whole tone by depression of the natural notes of the instrument. In brass or other instruments the natural harmonics depend upon the pressure of blowing; and the brass differs entirely from the wood-wind in this respect, that it is rare, or with poor effect, the lowest or fundamental note can be made to sound. Stopping the horn is done by extending the open hand some way up the bore; there is half-stopping and whole stopping according to the interval, the half tone or whole tone required. As may be imagined, the stopped notes are weak and dull compared with the open. On the other hand, the tubing introduced for valves not being quite conformable in curve with the instrument, and hampered with indispensable joins, unless in the best form of modern valve, affects the smoothness of tone. No doubt there has been of late years a great improvement in the manufacture of valves. Many horns are still made with crooks covering an octave from B flat to B flat, 8ft. 6in. to 17ft.; but most players now use only the F crook, and trust to the valves, rather than to change the crooks, so that we lose the fulness of sound of those below F. The natural horn was originally in D, but was not always restricted to that key; there have been horns for F, G, high A, and B flat. This may, however, be said for the valve horn, that it does not limit or restrict composers in writing for the open or natural notes, which are always more beautiful in effect.

(*To be continued.*)

NIST'S PLANING DEVICE.

THE following device, for obtaining accuracy in lathe and planer work, has been patented by Mr. J. W. Nist, of Allegheny, Pennsylvania.

The device will be understood by the accompanying engraving, in which A is part of the cross-rail of a planer, B the head, and C a block which fits over the rail, can be placed in any position on it, and clamped by set-screws to any gib. Passing through the lower part of this block C is a bolt, *b*, which slides freely through the block for a short distance, and is normally kept in its extreme position towards the left by the action of the spring *s*. The standard bars S are placed between the other end of this bolt *b* and the planer-head, sockets being provided for their reception. On the outer face of block C is pivoted a pointer, the upper end of which passes over a scale, as shown, a pin inserted in bolt *b* engaging in a slot in this pointer, and thus causing it to indicate any movement of the bolt. By so adjusting the head for each cut that the pointer is brought to a pre-determined graduation on the scale, exact movements of the head are obtained, corresponding precisely to the length of the various standard bars used. Mr. Nist also proposes to put the scale on the bar itself, when preferred, by making it in two parts, one to slide within the other, with a pointer on one of them passing through a slot in the other, a spring tending always to keep the bar extended to its fullest length.



LIEGE, it is stated, consumes nearly 4,000,000 cartridges and 40 tons of powder a year in testing firearms.

Hydrofluoric Acid and the Health of the Workmen.—The factory inspectors of Graz report that the workmen at certain glass-works, who were occupied in applying acids to the glass, complained repeatedly, both verbally and in writing, that the work was deleterious to their health, as they suffered from vertigo, malaise, and dyspepsia. The pallor of these workmen seemed to confirm their complaints. They are accustomed to slightly touch the glass with a solution of hydrofluoric acid, which is transferred to the glass by means of camel's-hair brushes. The work itself is done by hand inside a wooden box, which is placed on the work-table. This box, which is connected with the chimney by a pipe eight centimètres in circumference, is meant to remove the gases and vapours which develop during the work. The men are also admonished to use the guttapercha gloves supplied. The box is stated by the Government inspectors to be an insufficient protection, as the greater specific gravity of the gas permits it to collect in the work-room in spite of the exit pipe, and to become dangerous to the health of the workman.—*Lancet.*

Tourmaline in the Shan States.—Mr. Noetling, of the Geological Survey of India, who has lately been investigating the Shan districts of Burmah, has made a report on the occurrence of tourmaline in the Mainglon Valley. This valley is of an irregular lozenge shape, and was at one time the bed of a large lake; but now a considerable stream, the Nampai, rushes through it. The present geological formation is a conglomerate, composed of pebbles of quartz and of other rocks of various sizes, with a tough clay above, which in places is 50ft. in depth. The pebbly or boulder formation is rich, for it contains not only pink tourmaline but also gold, which the Chinese worked in former days. Mainglon town stands on the edge of a spur of hills projecting northwards; and not far off, near certain villages, the chief tourmaline mines have been dug. It is said that the mines are to be met with on both sides of the hills, as they slope down to the banks of the stream. These mines are pits excavated so as to secure an ample supply of water for washing the conglomerate and at the same time getting rid of the finer *débris* and the waste water. They are not too high up the hill slopes, for then it would not be easy to obtain water. The workmen are obliged first to remove the red clay till the surface of the pebbles is reached, and then one man begins the search. An examination of the pebbles or boulders showed them to be of various kinds, including quartz and well-rounded pebbles of schorl or black tourmaline, sometimes of the size of a walnut. These are much water-worn, and the pink kind, or rubellite, was very rare. An attempt was made to trace these pebbles to their source, with the result that some extensive deserted workings, large pits, one of some 300ft. in diameter, were found, and the natives say this large one, as well as others higher up, had been worked at one time by the Chinese. Mr. Noetling believes the latter had found a vein, yielding pink tourmaline, which is much like a ruby, and had exploited it. At present the industry is extinct in the district, but it appears that, as red tourmaline is of considerable value, it might be revived with advantage.

BRITISH ASSOCIATION.

ABSTRACTS OF REPORTS, PAPERS, &c.

Measurement of Lenses.

PROF. S. P. THOMPSON, F.R.S., read a paper on "Some Points Connected with the Measurement of Lenses." He said that although lenses were used in so many departments of practical optical work—as, for example, in the making of telescopes, microscopes, spectacles, and cameras—yet there is no uniform system of describing the properties of a lens. Moreover, all the textbooks of the subject refer only to the particular case of thin lenses. He showed how all the properties of a lens could be indicated by specifying the position of four points, the two focal points and the two so-called "Gauss points," where the principal planes of the lens intersect the axis of it. No method has previously been given for the accurate determination of the Gauss points, and Prof. Thompson described an apparatus by means of which he can do this in the case of any lens or combination of lenses. The theory of the apparatus was also explained in detail. The testing of lenses having become a matter of importance in photography, the Kew Observatory has recently instituted a special department for the purpose; but it was not proposed to guarantee any great accuracy (say, within a quarter of an inch or so) in the measured focal lengths. Prof. Thompson hopes that the committee of the British Association, which he has been instrumental in establishing, will communicate with the authorities of the Kew Observatory, and induce them to carry their measurements to a greater degree of accuracy than they have previously contemplated.

New Polariser.

Prof. S. P. Thompson read a paper on "A New Form of Polariser." He explained that owing to the great dearth of Iceland spar large Nicol prisms could not be obtained, and he therefore thought it expedient to devise some means of producing polarised light without its aid. The method proposed consists in reflecting the light from a black glass mirror, whose surface is covered with a plate of clear glass. In this way less light is lost than if black glass alone were used. The light from the lantern is reflected on the mirror by means of a total reflecting prism. After being polarised it is again turned back into its original axis by a second reflecting prism. This latter prism, however, must be very carefully annealed in order that the light may remain plane polarised.

Antarctic Exploration.

Mr. Delmar Morgan read a paper on "Antarctic Exploration," in the course of which he showed that half a century had passed since the expedition under Sir James Ross entered the limits of the South Polar region. The lands discovered by Ross and others were still delineated vaguely on our maps. It was, therefore, desirable that further Antarctic explorations should be undertaken; and although the subject had been as lately before them as 1886, when the Government was urged to send out an expedition, no result had followed. The interest excited at that time in the cause appeared likely to die out. England looked on with indifference, and left the work to be resumed independently of her. In this indifference and opposition to Antarctic exploration he believed that the difficulties had been unduly exaggerated, and the probable results under-estimated. The risks to be incurred were not greater, but less, than those to be met with in expeditions to the opposite pole. He compared the disasters, sufferings, and loss of life attending Arctic with those of Antarctic expeditions, showing that only five of the latter had attempted to enter high southern latitudes, and not a ship had been lost or a life sacrificed; while the results achieved for science were of the utmost importance. At the present moment a Swedish expedition was being fitted out under Dr. Nansen, and an American expedition under Mr. Peary, of the United States Navy. Ross twice crossed the parallel of 78deg. south. To those five expeditions and to the whalers who annually visited those seas they were indebted for all the knowledge they possessed of the Antarctic regions. Ross and D'Urville were the only navigators to land, and Ross would have wintered there if he could have found a harbour for his ships. The first object of the next expedition must be to find such a harbour, and, having established their wintering station—probably on Victoria Land, within sight of Mount Erebus—to take advantage of the clearer atmosphere prevailing during the winter months for carrying out those observations which would be rendered impossible during the summer owing to atmospheric causes. Such an advanced party of explorers would not be cut off from all communication with their fellow men, for the Antarctic region, unlike the Arctic, was surrounded by a belt of ocean 2,000 miles wide, navigable throughout the year, by means of which news and supplies could be conveyed from the nearest ports of Australia, Tasmania, and New Zealand. Should it be said that England declined to aid in a work which would form a fitting close to the 19th Century of discovery and exploration by opening the last remaining gateway to the unknown?

The Channel Tubular Railway.

Sir Edward Reed, K.C.B., read a paper on the proposed tubular railway across the Channel, in which he stated that the tubes would be surrounded by a covering of Portland cement concrete, but from their intrinsic buoyancy they would be practical bridges without any weight of their own to sustain. The approximate cost would be between 12 and 15 millions sterling, while the proposers of the Channel Railway Bridge estimated the cost of their scheme at 34½ millions sterling. He believed that his system put the question of national security beyond all question. The very object of this proposal of a Channel Tubular Railway was to provide railway communication between England and France without the least risk or possibility of the railway being employed for military purposes by an enemy of this country. In the case of the Channel Tunnel, if that were carried out, it would undoubtedly afford a subterranean military road, which, were it once secured by an enemy, might, in the opinion of many, be held in spite of us, because this subterranean road, being deeply situated below the Channel bed, would be completely preserved from attack by the British Navy. The Channel Tubular Railway, on the contrary, was everywhere situated above the bed of the Channel, and could, therefore, be attacked at every point by dynamite. At the same time, it was so constructed and brought up along the foreshore as to be exposed for a length of no less than 3,160ft. to the direct fire of the guns of the ships between the high-water and the low-water limit. It would be constructed at this part so as to be easily penetrable by gunfire, and any breach or hole made in it below high-water mark would, of course, admit the sea at the next tide to the whole interior of the tube. It was inconceivable that a railroad thus open between high and low water to injury by flooding by gunfire, and under water by torpedoes and otherwise, could ever be employed as a military road into this country. In conclusion, he said that a great many members of Parliament who always strongly opposed the Channel Tunnel were quite in favour of his system, and among these were several of such great influence that he has little fear of his Bill being successfully opposed in either House.—Mr. J. H. Greathead, referring to the question of cost, stated that the expense of constructing a submerged tube would be out of all proportion to the amount of work to be done. Moreover, the fact that the tube could be destroyed by dynamite by any lunatic who chose to explode it was in itself a sufficient condemnation of the scheme.

The Cause of an Ice Age.

Sir R. S. Ball, Astronomer Royal for Ireland, read a paper on the cause of the ice age, in which he said that, through what appeared to have been a curious oversight on the part of Herschel, Dr. Croll, who developed his theory from Herschel, had presented a wholly erroneous statement of the matter. A thorough revision of Croll's calculations and his doctrines based thereon became necessary. Had Croll been acquainted with the accurate version of the mathematical facts; he would have been able to show a much stronger case for the astronomical doctrine of the ice age than that which he had actually presented. The mistake had been in computing the number of units of heat received in a hemisphere of earth as being the same in summer and winter. Of 100 units Herschel gave 50 to summer and 50 to the winter. If he had given sufficient attention to the matter he would have seen that the numbers really should be 63 and 37. The distinction was a most important one. As the sun's heat alone prevents the earth from sinking to the temperature of space, a fluctuation in sun, which appeared small in comparison with the total amount, might involve a vast change in climate. Owing to the perturbations of the planets, it would occasionally happen that the eccentricity of the earth's orbit would become larger than it is at present. It seemed that the *maximum* is about sufficient to produce an inequality in the duration of summer and winter of 33 days. They had, therefore, the following possible conditions in a hemisphere—summer 199 days and winter 166 days, or summer 166 days and winter 199 days. In each case it must be borne in mind that 63 heat units arrived in summer, and 37 in winter. If the summer were a long one, and the winter short, then the allotment of heat between the two seasons would be fairly adjusted. The 63 units were distributed over 199 days, and the 37 units over 166 days, and a general inter-glacial state was the result on the hemisphere. If, however, a torrent of heat represented by 63 units was poured in during a brief summer of 166 days, whilst the balance of 37 units is made to stretch itself over 199 days, a brief, intensely hot summer would be followed by a very long and cold winter, and, as this condition lasted for many centuries, seemed sufficient to produce a glacial epoch. O this view there must have been not one, but many glacial epochs throughout geological time; but th doubtless occurred at very irregular intervals, an with wide differences in severity. It was, how ever, noteworthy that the theory required th when the northern hemisphere was glaciated, th southern would be in a genial state, and *vice vers* It was also to be noted that so long as the hig eccentricity of the earth's orbit was maintained, the precession of the equinoxes would cau glaciation to shift fro hemisphere to the oth in a period of 10,500 years. He did not mean th this would always be the interval, but it did seem probable that there might be clusters of two, three, or more ages, the individual members of which would be so divided. Each cluster was separated from the next by a vast period of hundreds of thousands of years.—The Rev. Dr. Crosskey combated a statement as to the interglacial periods, and attributed it greatly to local causes.—Prof. Wright said that, whilst the astronomical calculations were very valuable, there were terrestrial causes which should be taken into consideration, one of which was the changes in the course of the Gulf Stream. —Sir R. Ball, in reply, remarked that he had spoken of astronomical time, to which geological time was a mere trifle, and that astronomers had a field ranging millions of miles from the moon down, and took little note of such questions as weather.

Testing of Safety Lamps.

Prof. F. Clowes gave a report on "An Apparatus for Testing the Sensitiveness of Safety Lamps as Indicators of Firedamp and Inflammable Vapours." He said it was to a greater extent a preliminary report. He was asked some short time ago to examine the relative merits of one or two safety lamps as indicators of firedamp in mines. Although results had been previously published, there was no description of the apparatus used for the tests. The Prussian Government described one apparatus used by them in experimenting; but that was only a vessel through which known quantities of air and firedamp were passed. He had, therefore, to make an apparatus of his own, and use marsh-gas instead of firedamp. The apparatus consists of a wooden box of about 100 litres capacity, made gas-tight by melting paraffin wax over its surface. It is provided with a window in front for watching the flame of the lamp, and with an opening below for introducing the lamp; this opening can be closed by a little tray of water. The gas is introduced in measured quantity at the top of the chamber, and displaces an equal volume of air through an outlet below. The air and gas are rapidly mixed by moving a large flap up and down within the chamber. The surface of the interior of the chamber and of the flap are coloured dead black. The lamp having been introduced into the mixture of gas and air, the appearance and height of the "flame-cap" are observed through the window. The advantages gained by using this test-chamber are great economy of fire-damp or marsh-gas, and rapidity in making the tests. Of the lamps at present experimented upon Ashworth's modified Hepplewhite-Gray lamp, burning benzoline in a sponge reservoir, is the most sensitive. It gave a flame-cap seven millimètres in height when only ½ per cent. of fire-damp was present, and clearly indicated a quarter per cent. of benzoline vapour.

Photography for Explorers.

An instructive address on "Photography applied to Exploration" was then delivered by Mr. J. Thomson, a photographer of 35 years' experience. His object, he explained was two-fold—to point out the growing importance of photography in its application to the sciences, and to urge explorers to avail themselves more fully of its advantages. The camera he described as an instrument of the highest scientific value, portraying, as it did, all visible objects with mathematical accuracy, the practical outcome of which was to be seen in the reproduction to scale of maps, charts, plans, &c., by a single operation, so effecting an incalculable saving of time and labour. Photogrammetry, or surveying by photography, was now in use by American and Continental engineers; but the new departure, valuable as it had proved to be, had made but little headway in this country. To the pioneer whose object it was to map out a new route, portray new scenes, and provide the scientific world at home with perfectly accurate and trustworthy information, photography was of inestimable value. The traveller had only to refer to the photographs taken *en route* to banish doubt, disarm the captious critic, and afford enduring evidence of work faithfully performed. Then astronomical observations made abroad might be verified at home, and positions set down instantaneously for the guidance of others. The making of such observations, and the registering of altitudes above the sea level, required a separate scientific training, but there was much important work to be done in detail in connection with the topography of a region, and such work, he maintained, was within the scope of, and could indeed be better done by, the camera. After suggesting the suitable instrument for photo-surveying, the lecturer proceeded to refer to the services rendered to the explorer by photography in the making of proportionate measurement, and showed, by a sketch, how a perfectly reliable basis could be obtained. The more general scientific use of the photograph might be indicated in taking evidence of the erosion of the drainage of mountain chains; the building up of deltas by the detritus of rivers; the hydraulic force of streams in undermining and altering formations. As an aid to the study of botany and other branches of science proper for military purposes, and many other applications, commercial and scientific, where truth and all that is enduring were concerned, photography was absolutely trustworthy, and the work now being done was but a forecast of future usefulness in every branch of science. Travellers labouring under the mistaken notion that the art could be picked up in the course of an afternoon too often left the photographic part of their training to the last moment. This was a fatal error which he had been combating for years. Personally, he had been on the threshold of the art for upwards of a quarter of a century, and though he had always been ambitious to master its mysteries thoroughly, he felt that he was no nearer the goal. Giving some hints to would-be followers of the "black art," the lecturer reverted to the subject of surveying by photography, suggesting that the surveying of the near future would be done from a captive balloon specially constructed and fitted up for the purpose. The balloon might carry the camera only, to be worked from the ground by electricity, and it should be anchored by three cords from the corners of a triangular space, and its movements over the section of space to be surveyed watched by means of an artificial horizon. The photograph should be taken when the balloon was exactly over the centre of the section. A series of photographs of a city, taken in sections, could be joined together and photographed on one plate to form a complete map of the city. This plate could then, without touch of graver or pencil, be transferred to a metal plate, and printed in the printing press.

Spontaneous Ignition of Coal.

Prof. V. B. Lewes read a paper on "The Spontaneous Ignition of Coal." He observed that ever since Berzelius first suggested that the heat evolved by the oxidation of the pyrites in coal might have an important bearing on spontaneous ignition, it had been adopted as the popular explanation of the phenomenon, and although the researches of Richets and others had gone far to disprove it, this theory was the generally accepted one. It could be proved, however, that the coals most liable to spontaneous ignition often contained as little as 0·8 per cent. of pyrites, and rarely more than 2 per cent., and if this amount were concentrated on one spot instead of being spread over a very large mass, and if it were oxidised with the greatest rapidity instead of taking months, and often years, to complete the action, the total rise of temperature would be quite inadequate to account for the ignition of the coal, which required a temperature of 370° C. to 477° C., according to its characteristics. The liability to spontaneous ignition also did not increase with percentage of pyrites, whilst heaps of pure pyrites, free from carbonaceous matter, never showed any tendency to serious heating. The true explanation of ignition of coal was partly physical and partly chemical. Freshly-won coal had the power of absorbing from 1·5 to 3 times its volume of oxygen from the air, and this being rendered chemically highly active, partly by compression and partly by elimination of nitrogen, attacked some of the bituminous hydrocarbons in the coal, converting them into carbon dioxide and water vapour. Many causes tended to effect the rapidity of that action, which was the real source of the heat, and directly the temperature began to rise, unless the heat evolved could freely diffuse itself, the chemical action was so energetic that ignition quickly followed. Up to 38° C. the absorption of oxygen and consequent chemical action went on so slowly that there was little or no chance of undue heating; but directly that temperature was exceeded with some classes of coal ignition was only a question of time and mass. The action of mass, condition, and temperature could be beautifully traced in the statistics of the spontaneous ignition of coal cargoes, while the bunker fires, which were becoming perilously frequent on the fast liners, were due entirely to rise of temperature from the bunker bulkheads being too close to the hot-air up-cast shafts from the boiler and furnaces.—Sir I. L. Bell said he did not cast one shadow of doubt on the correctness of many of the views of the author of the paper. Having for the last 20 or 30 years been burning something like 2,000 tons of coal per day, he had been placed in a position which would allow him to take observations. He had come across instances where coal had taken fire spontaneously, and on no occasion did he remember that combustion began at the top or any where near it. Radiation and other causes might make the fire rage most furiously below the point where ignition actually took place.—Sir F. Bramwell said that, as an engineer, he was very much interested in the paper. It seemed to him that the author had substantiated his case, and he hoped there would be a supplemental paper to tell them how to avoid the ignition.—Prof. P. P. Bedson said the paper and discussion had been of great interest to him, as he had of late been experimenting with the gases given off from coal-dust. He was of opinion that the cause of explosions in coal-dust was not from pyrites so much as from hydrocarbon or some resinous bodies in the coal. He believed that explosions took place very frequently at ordinary temperature. Given sufficient mass and sufficient time, they could get an explosion of coal-dust at 100° C. or below.—The chairman characterised the discussion as one of the most important that had taken place in the section for some years. Prof. Lewes, in replying, said the question of the ignition of coal was one of the greatest possible interest, and the facts about it were not very largely known. It was of exceeding importance to gas-engineers who had to stock large quantities of coal. With regard to ignition on board ship, he thought that if there was a circulation of sea water between the boiler space and the coal bulkheads the coal could never reach the temperature of ignition. That idea would be a sort of "water jacket," and it would be of great advantage on their ironclads, where the smokeless powders and other explosives were injured by the heat.

Rhythm in Plants.

Mr. Francis Darwin, president of the Biological Section, read a paper by himself and Miss D. F. Pertz on "The Artificial Production of Rhythm in Plants." The paper was illustrated by experiments. The apparatus employed is a new form of klinostat designed by the Cambridge Scientific Company. The plant to be experimented on is fixed to a spindle, which, by means of a clockwork escapement, makes a sudden semi-revolution every half-hour. Thus the plant is subjected to a series of alternate and opposite influences from light or gravitation, as the case may be. To take the case of gravitation, the plant will tend to curve upwards during the first half-hour, and during the second interval (when the horizontal spindle has made half a turn) it will tend to curve geotropically in the opposite direction. Under these conditions it is found that a rhythmic state is induced which closely resembles the periodicity in rate of growth which is set up in plants by the alternation of day and night. A remarkable result is obtained by stopping the clockwork—that is to say, by substituting a continuous for a changing stimulus. The plant continues to curve with an acquired rhythm just as if the clockwork were still in action; it has, in fact, learned and remembered the half-hourly period. This is precisely similar to certain natural rhythms—for instance, to the "sleep" of flowers, which for a short time continue to open and shut although kept constantly in the dark.

A New Method for the Disposal of Sewage.

Mr. C. G. Moor, B.A., read a paper upon a "New Method for the Disposal of Sewage," with some reference to schemes now in use. He observed that in concluding a paper on methods of sewage treatment read at Burlington House at the recent Hygiene and Demography Congress, Dr. Thresh asked this question: "Do any of the processes mentioned, or any combination of such processes, enable us to get rid of our sewage in such a way as to give rise to no nuisance, cause no danger to health, and this at a cost sufficiently reasonable, considering the importance of attaining such results?" In the opinion of most experts at the present day, the only answer that can be given to this inquiry is an emphatic negative. We can see this from a brief consideration of those methods that are now in use. They may be divided into three classes:—1, lime processes; 2, processes in which lime is not used; 3, irrigation. He animadverted upon these different processes, and went on to say: The treatment I have to lay before you has been practically tested by me at experimental sewage works at Leyton. I have no very novel suggestions as to the precipitation of sewage, the originality of my method depending on the manner in which the sludge cake, produced by any precipitation process, may be converted into marketable products. He said, in continuation:—As regards a method of precipitation to go with the method of utilising sludge cake which I have just detailed: It is obvious where a separate system is used for storm water the ash will be worth more, as it will not be so contaminated with silica and other mineral substances from the roads. Of course what is wanted is a means of producing a sludge cake as rich as possible in ammonia and phosphate, at the same time without adding precipitants in any large quantity which would lower the percentage of phosphate in the ash. At the same time the pressing ought to be done without lime; this is possible, as it is done at Kingston. I have not been able to make experiments on this subject; but it seems certain that the use of lime ought to be avoided at all costs, and I should be inclined to try carbonised sludge in powder mixed with salts of alumina and iron, after precipitation running the liquid through a bed of lumps of carbonised sludge. When this bed is too foul to use any longer, it can be burnt in the furnace. I was not successful in preparing carbonised sludge in the same furnace that I have spoken of, though I think it could be done in a larger one. The attempt was made to rake out a portion of the sludge, after being carbonised, but before it was burnt to ash. At any rate, if this cannot be done, the cost of carbonising sludge in closed retorts heated by inflammable gases would not be prohibitive. It seems probable that by using a sufficient quantity of this carbonaceous material (which can so readily be renewed) a considerable degree of purity could be arrived at in the effluent. Any seeds present in the sludge, which are sometimes very numerous, are, of course, destroyed in the furnace, and any vegetable matter reduced to ash, so that potash contained in the solids suspended in the sewage is rendered available.

The Grants.

The following grants in aid of researches were made:—To Prof. Carey Foster, Electrical Standards, £27; Lord M'Laren, Meteorological Observations on Ben Nevis, £50; Mr. G. J. Symons, Photographs of Meteorological Phenomena, £15; Prof. Cayley, Pellian Equation Tables, £15; Lord Rayleigh, Tables of Mathematical Functions, £15; Prof. G. F. FitzGerald, Electrolysis, £5; Prof. Lodge, Discharge of Electricity from Points, £50; Sir W. Thomson, Seismological Phenomena of Japan, £10; Prof. Roberts-Austen, Analysis of Iron and Steel, £8; Prof. H. E. Armstrong, Formation of Haloids from Pure Materials, £25; Prof. W. A. Tilden, Properties of Solutions, £10; Prof. Thorpe, Action of Light upon Dyed Colours, £10; Prof. Prestwich, Erratic Blocks, £15; Rev. T. Wiltshire, Fossil Phyllopoda, £10; Prof. J. Geikie, Photographs of Geological Interest, £20; Dr. H. Woodward, Registration of Type Specimens of British Fossils, £5; Prof. E. Hull, Underground Waters, £10; Mr. J. W. Davis, Investigation of Elbolton Cave, £25; Prof. R. Jones, Faunal Contents of Sowerby's Zone, £10; Dr. J. Evans, Excavations at Oldbury Hill, £25; Dr. H. Woodward, Cretaceous Polyzoa, £10; Dr. P. L. Sclater, Table at the Naples Zoological Station, £100; Mr. E. R. Lankester, Table at Plymouth Biological Laboratory, £17; Prof. A. C. Haddon, Improving a Deep Sea Tow-net, £40; Prof. Newton, Fauna of Sandwich Islands, £100; Dr. P. L. Sclater, Zoology and Botany of the West India Islands, £100; Mr. E. G. Ravenstein, Climatology and Hydrography of Tropical Africa, £75; Prof. Flower, Anthropometric Laboratory, £5; Dr. J. G. Garson, Prehistoric Remains in Mashonaland, £50; Dr. E. B. Tylor, North-Western Tribes of Canada, £100; Sir W. Turner, Habits, Customs, &c., of Natives of India, £10; Prof. Flower, New Edition of Anthropological Notes and Queries, £20; Mr. G. J. Symons, Corresponding Societies' Committee, £25.

Lantern Slides.—Messrs. York and Son, 87, Lancaster-road, Notting-hill, W., have issued a supplemental catalogue which exhibitors with the lantern should procure in order to be ready for the season now approaching. The "mechanical monkey slide" should certainly form a part of the equipment of the lanternist.

Jet Propulsion.—At the Providence, R.I., meeting of the American Society of Mechanical Engineers, Prof. J. Burkitt Webb, of Stevens Institute, presented a communication from Mr. Charles J. Everett, jun., giving an account of some experiments made by him with water jets, to disprove the statement that a stream of water issuing from a nozzle under water re-acts upon the surrounding water, and tends to drive the nozzle in a direction opposite to that of the jet, in the same way that a solid rod, issuing from the same nozzle, would re-act upon a stone wall. The tests were made in a large tank, and the water was supplied by a steam pump at a constant pressure of 100lb. per square inch. The pump had a steam cylinder of 4in. and a water cylinder of $2\frac{3}{16}$in. diameter, and a stroke of $2\frac{1}{2}$in. The nozzle was fastened to the foot of a pendulum 4ft. long, and connected to the pump by a flexible half-inch rubber hose. The hose was hung by strings, so that the stiffness was inappreciable. The pendulum at the nozzle was connected to a spring balance by a cord about 4ft. long. When the jet was flowing the pendulum was brought to the vertical by moving the balance, and in this way every force due to the deflection of the pendulum was eliminated. The pendulum was first hung so that the nozzle was a little above the water, and the reaction found to be 4lb. The pendulum was then lowered, so that the nozzle was about 4in. below the surface of the water, all other conditions being the same, and the reaction was found to be the same—4lb. The only difference was that when the nozzle was under water the balance-hand vibrated a little more.

SCIENTIFIC NEWS.

THE position of Wolf's comet on Sept. 10, Berlin midnight, will be R.A. 3h. 53m. 6s., N. Dec. 22° 19·7′, and brightness about 9 as compared with unity at time of rediscovery. Mr. L. T. Fleming, of Berwick-on-Tweed, says that on the evening of the 28th ult. he picked the comet out as a nebulous mass, "something like a candle shining through a piece of horn," indistinct and requiring a full aperture of 12½in. to see it fairly well.

Another small planet (312) was discovered by Dr. J. Palisa, of Vienna, on August 14.

It is announced that a work comprising a series of sketches in the history of astronomy, from the pen of Prof. Oliver J. Lodge, will shortly be published by Messrs. Macmillan.

As our Notes have informed readers, Jupiter during the present month is well situated for observation, and has attracted much attention from those who do not know what the brilliant star in the south-east of the sky really is. The *Athenæum* says: The planet itself is always an exceedingly interesting object of study; but an American observation has lately directed special attention to the satellites, particularly to the first. Last year Mr. Barnard, whilst observing Jupiter, under very favourable circumstances, with the 12in. telescope at the great Lick Observatory on Mount Hamilton, noticed that that satellite, during its transit over the planet's disc on the 8th of September, presented the appearance, under high powers, of a close double star, the apparent components being in a line nearly vertical to the belts. Mr. Burnham's attention being called to the phenomenon, he also saw it distinctly, and the only explanations possible seem to be either that it was due to a white belt on the satellite parallel to the belts of Jupiter, or that the satellite is really double. Mr. Barnard hopes that all who are possessed of powerful telescopes will examine the satellite during its transits this year (a very favourable one will occur soon after midnight on Sept. 6) for the purpose of obtaining further light on this interesting phenomenon.

The British Association meets next year, under the presidency of Sir A. Geikie, at Edinburgh, in the first week in August. The committee meets on August 3, 1892, in Edinburgh. Nottingham has been selected as the place of meeting for 1893.

The tickets issued during the Cardiff meeting were—old life members, 189; new life members, 23; old annual members, 327; new annual members, 170; associates, 665; ladies (transferable tickets), 102; foreign members, 12; making a total of 1,488 tickets, realising a sum of £1,664.

At a time when so much is said about Koch's cure for tuberculosis, it may be worth while to call attention to the remarks of Mr. G. W. Hambleton at the meeting of the British Association. He pointed out that consumption was a disease of civilisation produced by causes which reduced the standard breathing capacity below a certain level. To prevent this disease it is necessary to use the body to the extent its strength demanded, and to see that the work it had to perform was carried on under conditions favourable to the body. It was also desirable so to arrange habits and surroundings that their tendency as a whole should be to develop the lungs. Close and badly ventilated or heated rooms should be avoided; occupations which involved stooping and cramped positions; corsets; tight-fitting clothes; "nipping" should also be prohibited; as much time as possible should be spent in active exercise in the open air; bedrooms should be well ventilated; wool should be worn next the skin; the body should be held erect; deep inspirations in breathing should be taken through the nose, and the cultivation of all kinds of athletic exercise should be encouraged. But, above all, he considered a great deal depended on prompt and early treatment of the victims of consumption.

The discussion about units at the British Association was lively, if it failed to be conclusive; but it will do much good, and possibly bring about an international agreement, so that it may be known definitely what is meant when any unit is mentioned. The report of the committee on electrical standards was read by Prof. Carey Foster. The committee have made repeated measurements of the electrical resistance of several B.A. coils, and the results show that the coils have remained practically constant since 1885. The report stated that notices have been sent out giving directions for setting up standard Clark cells, and asking that cells set up according to these directions should be sent to them. The object of this is to ascertain to what extent of accuracy different cells may be expected to agree with each other. The joint discussion with the Mechanical Science Section on "Units, and their Nomenclature" was opened by Prof. Oliver Lodge, F.R.S., who said that one practical unit which has not yet received an officially recognised name, and which is nevertheless very largely used, is that of self-induction. Two names have been proposed for it—viz., secohm and quadrant. The first of these is open to the objection that it regards the unit of self-induction as one derived from the ohm, whereas in reality the former is the more fundamental unit, and in ascertaining the value of the ohm the determination of self-induction is necessary. Again, the term "quadrant" is objectionable, because it leads to the idea that the unit of self-induction is a length, thu ignoring the dimensions of magnetic permeability. Mr. Preece suggested that the unit of electromotive force should be increased tenfold, as the present value of the volt is too small for practical use. Dr. G. J. Stoney, F.R.S., said that in 1874, while sitting on the committee which fixed the present units, he objected to making the dyne and erg so small. Siemens objected also to using the centimètre as the unit of length, but no system could be devised in which some of the units were not awkwardly large or small. It was then suggested to use multiples and sub-multiples of the fundamental units, each physicist selecting those which would be most useful for his work. Several representative scientific men took part in the discussion, and possibly we may shortly have a list of standard definitions of what is really meant by the so-called "units."

It is stated in Pittsburg, Pennsylvania, that experiments conducted by Mr. Thomas Harrington, of that city, upon nickel, steel, and manganese bronze have resulted in the discovery of a new alloy. Among other qualities this alloy is described as possessing great tensile strength, and it cannot be corroded by acids, while it can be wrought without difficulty. An exhaustive report on the discovery has, it is said, been made to Washington by Lieut. Cowles, naval inpector; but we shall see by-and-by.

With reference to the remarks of Mr. Forster Brown at the British Association on the exhaustion of the coal-fields, Mr. E. Kimber says that "coal itself could be distilled for oil first and then used for fuel and gas, thus making it go twice as far as it does now, without smoke or any other nuisance. Mr. Brown's paper is a most valuable one if it only teaches Englishmen true economy, and points out to them the disgraceful waste of their resources which they now perpetrate in every direction. The time is coming when ships and locomotives will be driven by oil instead of coal, and in that case there need be no fear of the coal giving out. Whatever oil cannot be obtained here can easily be obtained abroad in limitless quantities."

It is stated that a locomotive is being built in Milwaukee, Wisconsin, having ten wheels, three of which on each side rest upon the rails and are surmounted by two others, the tires of which have frictional contact with the tires of the wheels below. Then surmounting these two wheels is the driving-wheel of the locomotive, the wheel arrangement on each side being that of a pyramid, with the driving-wheel on top. As the lower sets of wheels are of much smaller diameter than the driving-wheels which transmit motion to them, it is claimed that the ordinary speed of a locomotive can be doubled by the use of this gearing.

Dr. F. A. Philippi, of Nieheim, says that his experience in the vicinity of Cassel taught him that women became bald earlier than men, and he attributes it to the effect of the head-gear. It consists of a pasteboard cone covered with black silk or some other stuff, and is too small at its base to allow of its being pushed down over the head as far as an ordinary hat, so that it has to be secured by ribbons tied firmly under the chin, while the hair is pulled up from all sides of the head and twisted into a tight knot at the top. Naturally a good deal of friction is caused in this manner, and it would seem not improbable that the growth of the hair may be considerably impaired thereby. The thinning was most conspicuous on the forehead and temples. I give this note for what it is worth, but I cannot help being struck with the fact that I have nowhere seen so many bald-headed women as in the province of Hessia.

It is stated that a new line of steamships is to be put on between Glasgow and the Canadian and American ports. The speed is to be "very high," which will mean considerable extra expense.

LETTERS TO THE EDITOR.

[*We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.*]

All communications should be addressed to the Editor *of the* English Mechanic, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> "I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
> —*Montaigne's Essays.*

THE STELLAR CLUSTER χ PERSEI—DOUBLINGS OF LINES AND LAKES, MARTIAL AND PARTIAL—METEOR RADIANTS—STAR MAGNITUDES—EYEPIECES: CELESTIAL, TERRESTRIAL, AND PANCRATIC, AND THE BARLOW LENS—THE STRUCTURE OF THE SIDEREAL UNIVERSE—FARRAGO ORATIONIS—LUNAR STREAKS—SOLAR ALTITUDE—COMET CROSSING THE SUN—SOURCE OF LIGHT OF COMETS; THEORY OF THEIR ORIGIN; AND MR. EDDIE'S REMARKABLE SPECIMEN OF ONE.

[32659.]—Every possessor of an astronomical telescope must have turned it upon that most glorious cluster, the so-called "Sword Handle of Perseus," and assuredly accompanied his first view of it by an audible exclamation of delight and wonder. As is well-known, this cluster really comprises two masses of stars, and from time to time efforts have been made (by Lamont, Liapunoff, and Bredichin among others) to map this region, or rather the preceding group of the two, and in 1860-62 Prof. Krüger, at Bonn, employed the heliometer there in determining with great exactness the places of 43 of the largest stars in this group. But the following part of the cluster, the χ Persei of the books, had been so far neglected, until, in 1870, Mr. O. A. L. Pihl, of Christiania, commenced a systematic survey of this region by the aid of a 3½in. achromatic, furnished with a bar micrometer (and also a rarely-used ring micrometer), and after twenty years of intermittent work, has now given the results of his labours to the world in a fine quarto volume, having determined the places of no less than 236 stars in this asterism, descending to the 11·7 magnitude. It is certainly a monument of the most patient and unwearied labour, and a perusal of Mr. Pihl's preface, which gives an account of the elaborate precaution adopted to eliminate error, cannot but give confidence in the high accuracy of his results. When I reflect that such a standard book as this is destined to become, is the result of the labour of a gentleman most busily occupied in pursuits far removed from those of the professional astronomer, I only find yet another illustration of the fact that an overwhelming proportion of our very best scientific work is now performed, as it has been in the past, *not* by the genteel cadger who whines to have his "research" endowed; but by the single-hearted servant of science, whose sole object is to attain the truth, and not fill his own pocket at the cost of the ignorant, the gullible, and the apathetic.

"But neither so did their witness agree together," for while we find that Dr. Terby sometimes had to persevere for a whole hour before he succeeded in "corroborating" the Areographical marvels discovered at Milan, now we have Mr. Stanley Williams telling us (in letter 32624, Vol. LIII. p. 574), in connection with the duplicate canals on Mars, that "it is . . . absolutely necessary that the eye should be perfectly fresh for their successful observation." No man's eye can be "perfectly fresh" after having been strained (even intermittently and with intervals of rest) by an hour's observation; and I confess that I should attach more weight and importance to anything perceived by Mr. Williams within three minutes of the first application of his eye to the telescope than I should to what was seen by an observer who had to persist for an hour before he could pick up what he particularly wished to see. I do not profess to account for "Nilokeras" (whatever that may be) geminating, while "Jamuna" so obstinately remained in a state of single blessedness; but there is one thing very notable indeed in all this, and that is, that all the most astonishing discoveries have been made on Mars, *not* when the planet was so peculiarly favourably situated for terrestrial observation as he was during the Opposition of 1877; but when he has been in his worst position for the observer, low down in the sky, receding from the earth, and with his disc subtending a very small angle. Mr. Green has given a possible reason for the appearance of duplication (the perception of which seems to me to be largely a question of idiosyncrasy) in the case of "canals"; but when we come to that of *lakes*, one is reminded of the conundrum of one's infancy: "Why is a girls' school out walking like a penny trumpet?—Because it goes two-two-two." For really the doubling of sheets of water covering hundreds of thousands of square miles is "too too," in the strongest sense of that quondam piece of fashionable slang. I must respectfully beg leave to differ from even so indisputably high an authority as Mr. Stanley Williams in his assumption that "it is clear that the same reasoning should apply to these streaks" (on Jupiter) "as to the dark streaks observed on Mars, known by the name of 'canals,'" though I should speak with even more confidence were I quite certain as to the particular kind of Jovian markings to which he refers. Assuredly people with astigmatic eyes (and their name is legion) have often seen a quasi-duplication of the shadows of the satellites in transit. Moreover, the markings on Jupiter are atmospheric, sharply defined, and superficial; those on Mars are viewed through a considerable depth of atmosphere, and require much patient attention for their detection. Many hundreds, perhaps even thousands, of observers have seen and drawn Jovian detail, and are practically in entire agreement as to its character. A four-wheeled cab would hold those to whom we are indebted for our information concerning the surprising phenomena alleged to be presented by Mars.

I much regret my inability to furnish the reply asked for by Mr. Milligan (in letter 32625) on p. 575 of your last volume. I did not answer the query to which he refers, because my own observations of meteor-showers have been too desultory and intermittent to enable me to form any opinion as to the permanency—or otherwise—of their radiants; and I would rather say nothing than give a merely second-hand opinion on so vexed a question.

"A. C." (query 75123, Vol. LIII. p. 581) may well be puzzled at the discordance in statements about star magnitudes. Sir William Herschel used very high numbers, calling the very faintest stars perceptible in his large reflector 20th magnitude ones. Piazzi would seem to have adopted something of his unmethodical numeration, and was followed in this by Smyth. The elder Struve was the first to classify the stars (I mean telescopic ones), according to some more or less philosophical system; but it was reserved for Sir John Herschel to definitely enounce that the light of any given star was about 2½ times of that of one of the next inferior magnitude. In 1856 Pogson suggested a reform of Sir John's classification to the extent of making the light ratio $\sqrt[5]{100}$. And this has been adopted in the Oxford "Uranometria" and in that of Harvard. Supposing that a telescope *just* shows a star of a given magnitude, then to show one of the next smaller magnitude, its aperture must be increased in the ratio of $\sqrt{2\cdot512}:1$. Hence every tenfold increase in the diameter of an objective will render stars visible five magnitudes lower. It is the merest stuff and nonsense to speak of Mimas as being of the (standard) 17th magnitude. It is really of about the 13th. No wonder beginners get bewildered when they find that a star rated by Smyth as of the 14th magnitude appears in Struve as of the 10·9th; in Sir John Herschel as of the 13·3rd, and in Argelander as of the 11·8th! [Since these lines were written, and were presumably in type, I have seen Mr. Ranyard's letter (32640) on p. 14. Of course, he is right as to the impossibility of rigidly determining the apparent "magnitude" of a minute point of light in such close proximity to the limb and rings of a large and bright planet.]

In reply to "J. W." (query 75148, Vol. LIII. p. 581), the astronomical eyepieces made for a telescope of 2¼in. in aperture will do perfectly for one with a 3in. object-glass, with which they will afford magnifying powers proportional to the increased focal length of the objective. With reference to the concluding part of this query, there can be no such a thing as an "average" distance for a Barlow lens to be placed in front of the eyepiece. For, supposing we have an eyepiece magnifying 20 diameters, and a Barlow lens of 8in. (negative) focus; well, in this case, the Barlow lens being placed at half its own (negative) focal length—i.e., 4in. within the principal focus of the object-glass—will give a power of 40, and so on. A Barlow lens is only legitimately employed in double-star measurements, as it increases the power of the telescope without thickening the images of the spider lines in the filar micrometer; but a more useless adjunct to an ordinary telescope I am not acquainted with.

I may tell "Tyro" (query 75149 p. 581) that a pancratic eyepiece is nothing but an ordinary four-lens terrestrial eyepiece, in which the second and third lenses are separable by a sliding tube; the further they are moved apart the higher being the resulting magnifying power. It has every *disadvantage* over the Huyghenian form for the purposes of astronomical observation. Here is a formula of Fraunhofer's for a four-lens eyepiece, which, with "Tyro's" object-glass, would give a power of between 22 and 23. Calling the focus of the lens next the object-glass f, that of the second one f', &c., and D, D', and D'', the distances respectively between the first and second, the second and third, and the third and fourth lenses respectively, we have:—

f	f'	f''	f'''	D	D'	D''
in.	in.	in.	in.	in.	in.	in.
1·56	1·91	2·18	1·20	2·23	3·58	1·84

If we increase the distance D' (3·58in.), we increase the magnifying power by an amount which must be experimentally determined; but an objective of the size of "Tyro's" would not admit advantageously of much more amplification for terrestrial purposes.

Starting with the assumption that all visible stars were practically of the same size, and that the observed differences in their magnitudes were chiefly, if not entirely, referable to corresponding differences in their distances, Sir William Herschel and others evolved from their own observations, what we now know to be a wholly untenable hypothesis as to the structure of the visible stellar universe: a hypothesis which held its own in works on astronomy until within the last thirty years or so. Many young astronomers even must remember the engravings of the cloven disc or grindstone which was popularly supposed to represent the Milky Way, and which formed such a standing dish in all popular astronomical books. In the light of more recent research, we now know that while the majority of the stars are contained within a disc-like area, they are very far indeed from being uniformly scattered over it, but are aggregated into clusters and masses quite separated from each other. Hence the disc does not represent the *shape* of the stellar system, but only the limits within which it is, to a very considerable extent, confined. Our sun is somewhere near the middle of this space, and the brighter, or naked-eye stars are scattered over it in a fairly uniform manner. Now very careful and accurate observation has revealed the fact that some actual physical connection must exist between bodies separated in space by incalculable intervals, and Proctor was among the first to point out the indications of this afforded by star-streams.

At the meeting of the Royal Astronomical Society held on April 11, 1890, an abstract of a paper by that well-known observer, Mr. T. W. Backhouse, of Sunderland, was read, giving the results of an elaborate scrutiny of that small area of the heavens, bounded by 15, 13, and 8 Monocerotis, α Orionis, ζ Tauri, and 5, μ and ξ Geminorum. The observations have extended over the last nine years, and have been prosecuted chiefly by the aid of a field-glass of 2·05in. aperture, giving a power of 3·8, with the occasional aid of a 4½in. achromatic, generally with an amplification of 20. I have said that an abstract of Mr. Backhouse's investigations was read before the Royal Astronomical Society; but he has just published his observations and results in extenso under the title of "The Structure of the Sidereal Universe," forming part I. of the Publications of the Hendon House Observatory, and a very valuable record of earnest and useful work it forms. Now here is a fresh branch of observation open to the possessor of merely a star atlas and a good field-glass; who, if he will pick out some small region of the sky, and (taking Mr. Backhouse's excellent book for a model) will go carefully over it, and align and map the various well-defined star streams and wisps he will surely find visible, he may do real service to science. In commending Mr. Backhouse's book to all who are interested in the higher problems of astronomy, I may add that it is published by Hills and Co., of Sunderland.

I am sure that anyone reading Prof. Lodge's address delivered before the Mathematical and Physical Section of the British Association, and reported by you on p. 10, will be tempted to think that, if it is to be regarded as a representative one, then, indeed, the allegation in your "Scientific News" (p. 13) that "the British Association does not seem to have been very successful this year from a scientific point of view," must be true au pied de la lettre. For a more extraordinarily discrete hash than this oration I have not recently come across, for it seems to range from that wretched mendicant whine for a huge endowed "physical laboratory," to which South Kensington has accustomed us, to telepathy! "For what the Section over which Prof. Lodge presided has received" . . . . the rest can be supplied from the ordinary form of "grace after meat."

Apropos of papers read at Cardiff, I presume that your correspondent, Mr. Peal, will obtain and carefully study that by Dr. Copeland, of which you give a précis on p. 13.

I would venture to point out that, in the absence of the letters L and M in Mr. Crommelin's diagram (reply 74981, p. 18), "R. G. W." may, just conceivably, find the accompanying description absolutely unintelligible. That gentleman cannot do better than stick to the method of obtaining solar altitude by the aid of a celestial globe which I described on p. 527 of your last volume.

I can give "E. R. B." (query 75187, p. 22) no details as to the passage of either of the comets in 1826 over the sun, as no such transit is recorded in any of the books to which I have access; but in 1819 Pastorff did actually detect a comet *in transitu* over the solar disc, and a facsimile of his sketch of this phenomenon will be found in the latest edition of Webb's "Celestial Objects for Common Telescopes," facing p. 40. The great comet of 1882 was observed on Sept. 17th in that year at the Cape of Good Hope by Dr. Elkin and Mr. Finlay, actually *in contact* with the sun's limb; but the most careful scrutiny failed to reveal its presence on the disc of the sun itself. In answer to (2), the question of the source of light of comets is still obscure; perhaps the nucleus is self-luminous, and the tail shines by reflected light. (3) I do not possess Proctor's "Other Suns Than Ours," and hence am ignorant whether he propounded any fresh hypothesis of the origin of comets in that work. There is no theory which can be held at present to be "accepted." One may say of the question, with Horace, "Et adhuc sub judice lis est." (4) Most decidedly there has been *no* "corroborative evidence received with regard to the alleged observation of a comet by Mr. Eddie at Grahamstown;" and I may add, in confidence, that there most assuredly never will be.

A Fellow of the Royal Astronomical Society.

STAR MAGNITUDES.

[32660.]—The subject of star magnitudes and the connected one of the distribution of the stars in respect of magnitude no doubt interests many of your readers besides your correspondent "A. C." I may perhaps say in reply to that gentleman, in the first place, that in dealing with the space-penetrating power of telescopes we can only speak of average results, and not of what can be effected with an unusually good instrument of its size, with an unusually keen-sighted observer, or with an unusually clear night. Moreover, it is notoriously easier to see what has been already discovered, and what we know exactly where to look for, than to make the discovery in the first instance. A more important question, however, is whether our eye estimates of magnitude are in substantial agreement with the photometric scale, according to which the light diminishes in the proportion of 2·512 to 1 for each magnitude. It is known that different astronomers have differed considerably in their estimates of the magnitudes of very faint stars. Tables have even been made professing to give the magnitudes according to one author which correspond with those of another, and I am not aware of any considerable number of photometric measurements of the light of very faint stars. Prof. Pickering's discussion of his lately-published results may go some distance towards solving this question; but as the result of a cursory inspection, I think the fainter stars in the *Durchmusterung* are brighter according to Argelànder than according to Pickering. If this difference continues down to the 17th magnitude, a star thus rated by the eye would probably be photometrically of the 18th or 19th. But I confess that I think this unlikely, and rather expect that the star rated as 17 by the eye will turn out to be perhaps 15 on the photometric scale. Further measures, however, are very desirable.

The deficiency of star-light will partly turn on this question. Adopting the photometric scale, if the stars were equally distributed in all directions around us, the stars of any given magnitude should on the average be nearly four times as numerous as those of the magnitude next below it. This is, of course, on the assumption that there is no loss of light; but the deficiency (which no doubt does exist, though it is doubtful at what stage it commences) may arise from a different cause. If we divide the heavens into a rich and a poor star-region—the former embracing the Galaxy and the latter the extra-Galactic region—and if the successive spheres drawn with the earth as centre, and with constantly increasing radii, include a smaller proportion of the rich region, and a large proportion of the poor one, the theoretical ratio would not be realised. This would be the case, for instance, if the Galaxy is, roughly speaking, disc-shaped, with the sun situated in one of the comparative vacuities which are undoubtedly to be found in it. This disc theory has, I think, fallen into unmerited disrepute because it was at first advocated in an untenable form. The ring theory, and even the spiral theory, would, however, after a time, give similar results, even though the distribution of the stars both within and without the Galaxy were sensibly uniform. Our outer spheres would ultimately give us a larger proportion of the poorer region, and a smaller proportion of the rich one.

Portrush, Aug. 24. **W. H. S. Monck.**

JUPITER.

[32661.]—I have repeatedly noticed lately a sharply-defined dark part of the second south dusky belt of Jupiter. When central it occupies about one-fifth of its parallel, and takes about 38 minutes in crossing the central meridian. Assuming the times of passage of the red spot from Mr. Marth's ephemeris, my observations gave central position to this dark part of belt on July 27th, August 18th, and August 27th, at intervals of 4h. 45m. 41s., 4h. 31m. 21s., and 4h. 24m. 36s. after the passages of the red spot. Thus the dark part of belt is gaining on the red spot, which is in contact with the belt on its northern edge. Between July 27th, 7h. 28m. 36s., and August 27th, 7h. 57m. 48s., there were exactly 75 revolutions of the red spot. The *apparent* rotation of this spot is thus 9h. 55m. 35·36s. The gain of the dark spot of belt is 16·86s. each rotation. If the dark part of belt continued to advance at the same rate, it will overtake the red spot, and be just south of it, *next year* about September. On July 20th the dark spot, being near the entering limb of Jupiter, was preceded by a bright elongated ellipse, which was just within the bounds of the second south dusky belt.

A. Freeman.

Murston Rectory, Kent, August 29.

GREEN RAY, &c.

[32662.]—On the 19th inst., about 7 p.m., there appeared here one of the most brilliant rainbows I have ever seen, the secondary bow being exceptionally bright; but what made the phenomenon more interesting was the band of very dark purple grey between the two arcs, forming a strange contrast to the other part of the sky near the bow. About 8 p.m., we had also a fine display of the "solar glow," or "red glow," about which so much was written in 1883. This evening there was a perfectly straight vertical rift in the centre of the rosy patch of light, which appeared of a decided green by contrast. The diameter of this vertical rift was about 45′ by estimation. This is doubtless what Mr. Blakeley (32643) observed.

T. R. Clapham, F.R.A.S.

[32663.]—E. Reginald Blakeley does not say from where it was he observed the phenomenon he describes as "a green ray"; but if Dewsbury, whence he writes, were the place of observation, it is evident that he could not there have had an ocean horizon. This consideration, as well as the length of its duration, leads me to conclude that the phenomenon he witnessed was not that of which "Verne has written about," though, from its continuance and apparent upward motion, it is not unlikely to have been a reflection of the veritable green ray.

In letter 30289 (p. 11, Vol. L.) I drew attention to repeated observations of the "green ray," and in a subsequent letter, on p. 58 of the same volume, I mentioned that I had never succeeded in observing it from on board ship at sea.

Since then I have had the satisfaction of seeing it at sea, and in what I believe to be a somewhat unusual way.

Just within the Tropic of Capricorn, in the South Atlantic, a favourable evening for observation presented itself, and while the dinner-bell summoned most of the passengers below I lingered on the hurricane deck to see the last of the setting sun. The sky was clear and cloudless, the sun of a bright golden colour, and the sea unbroken, but swelling in great easy rolls.

Noticing a fellow-passenger pacing the deck, I asked him to observe closely the sun as he set completely beneath the horizon, and notify to me any unusual or unexpected phenomenon, and he readily agreed. About six paces apart, we independently watched the fast-disappearing orb.

No sooner had the last limb of the sun disappeared beneath the horizon than the brilliant green coruscation flashed out for a second and then disappeared. I turned hastily, and had an approving nod from my co-observer. Instantly my eyes were again on the spot, as were his also, and we were rewarded with the momentary reappearance of the ray as brilliant as before. Though we looked steadfastly, a third visitation was not vouchsafed to us; but my co-observer, who had never before seen the phenomenon—and I had not prejudiced him by telling him what to expect—assured me he had seen the ray, its disappearance, and momentary reappearance, and that its colour was a brilliant light green rather than blue.

I have not the least doubt but that the explanation of the phenomenon given by "E. L. G." (letter 30324) is the correct one, and E. Reginald Blakeley probably saw the reflection on the clouds of a series of rays, the direct ray being visible, from a practically fixed point, only momentarily.

H. B. F.

THE DIRECT ACTION OF SOLAR DISTURBANCES ON TERRESTRIAL MAGNETISM.

[32664.]—In the English Mechanic for July 24 I notice a comment by your correspondent "A Fellow of the Royal Astronomical Society" on an article I recently published in the *Sidereal Messenger*, and which you reprinted in your issue of July 17. Your correspondent wonders whether I ever heard of the observation of Carrington and Hodgson in 1859, or of Prof. Young's in 1871, &c. In answer to this I would say that I wrote the article in question (in the first instance) at the suggestion of Prof. C. A. Young himself! It was not intended as a history of the well-known fact that there is a connection between solar activity and terrestrial magnetic changes, but was the announcement of my discovery of a new fact—namely, that the disturbing energy is, like light, propagated in a straight line. The discovery shows, in the words of Prof. Young, "a distinct connection between the visibility of a solar disturbance from the earth and its effect upon the earth's magnetism; that is, that when an active sun-spot or solar prominence is brought by the sun's rotation to our side of the solar globe, then an effect is immediately felt which was not felt so long as the disturbed area, however active, was out of sight on the other side of the sun. This seems to indicate that the disturbing energy, whatever its mode of operation, is propagated like light—a result entirely in harmony with the recent remarkable experiments of Herz and others upon the transmission of electric induction."

The second paper announced in my article will contain a due reference to the work performed by my fellow-countrymen, General Sabine, Carrington, Hodgson, &c., and of that of the Continental and American astronomers and physicists mentioned by your well-known correspondent.

T. S. H. Shearmen.

Brantford, Canada, Aug. 17.

LIGHTNING.

[32665.]—What is a flash of lightning? Cannot any of our professors give us a true definition of this simple query? Of course, everyone knows that it is caused by an electric current passing between the earth and the clouds, or perhaps an interchange of currents, vibratory if you will. That the flash is caused by the burning of the air and its contents as the current passes seems probable, and during the craze about dark flashes having been found on the photographs of lightning, one of our most learned professors propounded the idea that they were occasioned by the burning of the air in the path of the flash, thereby producing a gas of a different refractive power from the air. This view would lead to what we may suppose to be a fact—that the air and its contents are really consumed by the current as it passes, for we know that a flash of the same character does not take place in a vacuum where there is nothing to consume.

The next question I should like to ask is—What does a lightning-flash do, and how does it do it? The popular belief is that a house or other object is *struck* by lightning, the damage to buildings, trees, loss of life, &c., being a consequence of this *striking*. Some of the accounts of these accidents are given with wonderful precision: the lightning having entered the house by a chimney, crept along a bell-wire, jumped from room to room, and, after having done an immensity of mischief, passed out through a window or hall door in a most deliberate manner. Chimneys are the favourite point of entrance, bell-wires and rain-pipes being seriously affected, and in a recent case the lightning is supposed to have leaped from a lightning-rod on to an eaves-shoot; but whatever its course may be, it is popularly said that the *lightning-stroke* has performed all these curious feats.

Now, considering the flash to be a tape-like stream of fire descending from the cloud, it is difficult to understand how the great variety of effects are produced—e.g., twenty or thirty sheep killed in a flock, while many more escape injury; the middle part of a ship's mast is blown into splinters, while the top and bottom portions escape unhurt; a bell wire in a house not only melted but deflagrated; a man having his clothes torn off without receiving bodily injury; the bark stripped off trees, with thousands of equally mysterious results.

My idea is that the flash, *per se*, is innocent of the many charges brought against it, and that were it possible to put the different events of the storm in their proper sequence, the flash would be the last of all, being itself an effect of the one great cause.

The mystery connected with different actions attributed to the so-called *stroke* is, to my view, very much cleared away if we consider these events caused by an electric current of immense velocity, passing through conductors of less or more capacity and resistance. I could cite many examples which I fancy go a great way towards confirming this view, but before doing so should be much pleased to have the opinion of those who would put the matter in the plain, common-sense way that Mr. Sprague is so usefully doing at present; but, of course, mainly confined to static electricities.

To those who have given much thought to the subject, there is but little new in what I state. I write more for those who take what I have called the popular view, and to whom the idea must appear strange that lightning is not a *cause*, but an *effect*, and that all the mischief is done before the flash is seen.

London, Aug 26. **Robt. J. Lecky.**

ELECTRICAL.

[32666.]—I am afraid that any "explanation" I can give in a letter will not be of much use to Mr. Benjamin (p. 17); he wants a textbook. I have not contradicted myself at all. The word "current" is in common use to denote the passage of electricity in a conductor, but it is not to be supposed that electricity flows along a wire like water in a pipe. As a fact, we know very little about it, and "current" is as good a term as one can find to use. In a liquid, however, we do know what takes place, viz., a transference of atoms from molecule to molecule, each element receiving a charge of different sign. For a complete exposition of this matter, let Mr. B. read such a book as Cumming's "Electricity," or even Ganot, or Deschanel. It requires an illustration to explain it properly. When I speak of the "current passing," I make use of the term, not in a scientific, but a popular sense, and if Mr. B. had been an *electrician*, he would have understood my meaning. **Sm.**

THE ORIGIN AND INFLUENCE OF DISEASE.

[32667.]—"Vita" is an extraordinary scientist (see Aug. 7, 14, and 21). He has completely established (in his own mind) the identity of yeast and the white blood-cells. His foundation for asserting this to be a fact is that you find yeast in the brewer's vat, and that you find the white blood-cell in the human blood. What more is needed in the way of a proof? All minor details, such as the different temperatures that they respectively grow at, the difference in their culture media (none has been found for the leucocyte), the difference in their powers of movement, and in the way they absorb food, is of no account to "Vita." He says they are the same organism, and therefore they must be so.

What unexpected statements from one holding such advanced views on scientific exactness as given in letter 32594! "If we desire to gain any exact information . . . . . we must bear in mind those essential and primary truths which form the basis of all knowledge."

Has "Vita" ever made pure cultivations of yeast? Has he ever made pure cultivations of white corpuscles from the human or any other animal body? If he has done the latter successfully, would he kindly communicate his results and methods? Has he ever seen white corpuscles in vaccine lymph? I never have. Has he ever read a work on bacteriology, and become acquainted with the modern means of research adopted in this science? If not, I would advise him to do so before rushing into print again. If so, I only need apply to him his own words. He evidently labours under "that peculiar state of the human understanding which prevents the acceptance of new ideas" (I should have been inclined to write "correct ideas"). It is a simple thing to state that all scientists are wrong; it is another thing entirely to prove them to be so.

"Vita" is wrong in his premises; therefore, the holders of the old theory can breathe freely again. They have not yet been overthrown, even by the man who finds yeast in tumours, brains, blood, and small-pox.

To systematically correct the incorrect statements in one page of "Vita's" letters would be useless labour. He evidently has an idea of his own which is worth to him all the wisdom of the world at large, and it would be unkindness to deprive him of it. **C. E. G. Simons, M B., C.M.**

[32668.]—The statement propounded by "Vita," in his communication (32615), calls for further explanation. Are we to understand, as he actually states, that the bodies from the brewer's vat, the similar bodies in the blood, and those of the pus matter, are one and the same animalcule? If so, he will undoubtedly bring forth absolute proof to substantiate this astonishing statement. I am willing to admit the three forms of life act much in the same manner by causing a splitting-up of their respective plasma, but that they are *not* "one and the same" I am prepared to prove absolutely.

If we take the first mentioned by "Vita"—namely, yeast—we find it to be essentially a vegetable growth, or cell, capable of existing and reproduction in so-called fermentation, *id est*, the conversion by dissolution of starchy substances into alcohol and carbonic acid gas. This fermentative process ceases, as far as alcohol is concerned, when the fluid acting as its plasma contains 14 per cent. of absolute alcohol. A full description of the Saccharomyces cerevisiæ may be found in any work upon elementary biology. But, arriving at the second point—namely, the white corpuscles, of the blood—we should find these bodies are actually incapable of existing in alcohol at all; in fact, they cease to exist the moment alcohol comes in contact with them. Again, the white corpuscles or amœboid bodies in the blood are capable of motion, known scientifically as amœboid motion—that is, extending certain portions of their substance into so-called pseudopodia, and adapting themselves to the various vicissitudes necessary in the course of the blood's circulation. May I ask "Vita" if the fungoid growth—namely, yeast—is capable of the same thing? He must remember yeast is distinctly a *plant*, whilst the white corpuscle is distinctly *animal*.

With regard to the third point, the organism of "pus matter from the ulcer, boil, or pustule," Dr. Klein and other bacteriologists have definitely proven this organism to be a form of bacteria peculiar to pus formation, and certainly not yeast. In precisely the same manner we find the various zymotic diseases have forms of bacteria entirely peculiar to themselves, and capable of development under certain circumstances only. In speaking of blood corpuscles, "Vita" states if these be examined microscopically we shall find them to have identically the same appearance as the yeast, I would advise "Vita" to try the experiment. He will find there are many points of difference internally, the white blood corpuscles being possessed of various darkened spots which are altogether wanting in the Saccharomyces cerevisiæ.

To proceed, however. Later on in his paper "Vita" states the "yeast animalcule to be present in our bodies," and to have arrived there by taking "food which contains the yeast animalcule . . . and the minute size of the corpuscles (*i.e.*, cells) caused them to be readily taken up by the absorbents, and thus pass into the blood current;" and proceeds to add that if the blood be examined microscopically after food large numbers of yeast cells will be found in the blood. I admit a large number of white corpuscles are found in the blood after food, but certainly not yeast cells. It is an observed fact by the most profound physiologists that these white corpuscles are more numerous after food, and it is also generally understood these leucocytes, &c., are developed by the thymus, thyroid, spleen, and other glands, but how they are produced is unknown. "Vita" has settled this important question for us by stating them to be of fungoid origin (?).

But, unfortunately for "Vita," chemistry comes to our aid, and analysis proves the white corpuscles to consist of principally myosin (a globulin), fat particles, cholestrine, protagon, glycogen, and nuclein. If the protoplasm of the white corpuscles be treated with chloride of sodium (common salt 10 per cent. solution), it dissolves, with the exception of the nuclei; it is also a fact proven by experiments that corpuscles taken from one animal and injected into another quickly become altered beyond recognition, and eventually absorbed; it is presumed this breaking down takes place principally in the spleen. May I ask "Vita" if the torula of cerevisiæ is capable of acting in the same manner if treated similarly?.

Pus cells also contain a large quantity (33 per cent.) of nuclein in addition to fat and lecithin.

Frederick Davis.

26 and 28, Newington-causeway.

[32669.]—May I ask "Vita" whether, in comparing the mortality in 1871 with that of the previous nine years, he was aware that there had been an epidemic of cholera during that period? Also if he was aware that in London the year 1874 had a much lower death rate than 1871, in spite of there having been no small-pox to eliminate the yeast animalcule? **Lavant.**

BALL BEARINGS.

[32670.]—At the time "Vulcan's" letter appeared I had so much to do that, though I began a reply, I could not finish it, and then afterwards I forgot it. However, as the substance of "Balls'" reply is much the same as what I had written, I will only add a few lines on a matter he has not touched on.

People, when attacking ball bearings, will invariably point to an "ordinary" bicycle fitted with parallel ones for comparison with heavy machinery subject to severe strains. Now, I hold that the strains on an ordinary are small in comparison to those on a tricycle or safety. These latter machines have, in addition to the usual driving strain, a compression strain set up by the pull on the chain. (The pull can amount to anything to 500lb.) Ball bearing will resist this well for several thousand miles if properly made and looked after; but parallel bearings will, notwithstanding the utmost care, go to pieces long before half the distance is run.

Engineers are under the impression that many rows of balls would be necessary to carry, say, the crank-shaft of a locomotive. This I hold to be wrong, for I cannot find that a multiplicity of rows run or last any better than two single rows placed far apart.

I fail to see "Vulcan's" argument *re* the limited width of loco. bearings. With inside frames the width is practically unlimited. If a loco. was designed to run on balls there would be no difficulty in making the eccentrics and valve stand nearer the centre if it was necessary; but I think it would be found that two rows of 1½in. or 2in. balls, 8in. or 9in. apart, centre to centre, would be quite sufficient.

Prejudiced people, more or less unacquainted with the subject, are always bringing accusations against the bearing, which vanish as soon as one begins the practical construction of the article.

A. F. Shakespear.

Materniestrasse, 3, Dresden, Aug. 23.

[32671.]—In answer to letter 32650, it seems to me as if "Vulcan" does not understand the action of ball-bearings, as he says when all oil is squeezed out between contact surfaces, that friction and cutting must ensue. I admit that this does occur, to a certain extent, but is very small indeed compared with that which takes place in a plain bearing, as there is not any rubbing surface in ball-bearings, as they are in rolling contact similar to an engine wheel on rails, therefore greatly reduced ball surface will keep cool under the same weight as plain bearings. **E. F.**

THE PHYSICAL BASIS OF MUSIC.

[32672.]—The letter under this heading by Mr. Purday (p. 15), and several other communications which have lately appeared in the "E.M.," lead me to think that some words of explanation on this subject may be acceptable to many of your readers. Commenting on the annoucement of the invention of a new instrument with twenty notes to the octave, Mr. Purday remarks that it is not stated that the intervals from note to note are equal. Were this the case, the scale would be one of equal temperament, and probably in many respects as imperfect as is our tempered scale of twelve notes. Respecting Mr. Purday's scheme of twenty notes, it will be seen that no two intervals are alike: the interval between notes 1 and 1½ being $\frac{1050}{1000}$, and that between 10½ and 1 $\frac{2000}{1950}$. Then the next octave must make a sudden jump in the magnitude of the interval, and progress by a difference of 0·100 instead of 0·050, or we should get forty notes in the next octave. This, at any rate, would happen if I read Mr. Purday's letter aright. Again through the inequality of the intervals, no note but No. 1 could be taken as the key-note; modulation and transposition would be impossible. Many other objections present themselves. A piano is tuned by ear, the consonant intervals of octave, major third, and fifth being constanly used to gauge the correctness of pitch; the proper allowance for temperament is readily learned and applied, whereas nobody could tune a series of discordant intervals without a series of tuning-forks constructed under the like difficulty of tuning; and no voice could sing nor violinist play the inharmonious series of sounds.

So far from considering our equal temperament system of tuning irrational and unscientific, some professors of high authority consider it as the very "salvation" of music; and though I do not share this opinion, it seems to me more tenable than the unqualified condemnation meted by Mr. Purday.

While on the subject of tuning, I would advise anyone who is dissatisfied with equal temperament to try the scale invented by the late Sir John Herschel, and published some 25 years ago. It is wholly untempered, and thus very easy to apply. For simplicity, let us tune a piano in C major.

First, determine the pitch of the middle C and its octave. Next, tune the chords C E G, F A C, D G B. The diatonic scale of C is thus perfectly determined. Next, tune a series of fifths, or of fourths downwards and fifths upwards from B, thus:—B F sharp, F sharp C sharp, C sharp G sharp, G sharp D sharp, D sharp A sharp; the next fifth, from A sharp to E sharp, will bring us so close to F as to be quite indistinguishable from it, and the fitting in of this last fifth with the previously tuned F is a check on the whole of the tuning. The whole diatonic scale of C major and the chromatics, *F* sharp and *C* sharp, are thus in perfect tune; the thirds of the other chords are not much more out of tune than those given by the equal temperament scale, and the fifths are all perfect but one, that between D and A. The worst key is, of course, that of which D and A form part of the tonic chord—that is to say, the key of D; next that of which they form the dominant or sub-dominant—that is, G and A; still less inconvenient are those keys of which the D is a third below or a third above the tonic—i.e., F, F sharp, B flat, B. Practically, however, it seems sufficient to avoid the keys of D and G. As there are keys prominently in use, the remedy is not to tune in C, but to select some other key, so as to throw the "wolf" into keys seldom used. An interesting question here arises: seeing that in the key of C the interval D A (or its inversion, A D) is by no means a perfect concord, being flat by a comma, $\frac{80}{81}$, what will be the effect of this discordcordant interval in the chord of the added sixth on the sub-dominant F A C . D, or its elliptical form, F A . D? To my surprise, I found on experiment that these chords sounded just what I felt they should sound, the added sixth chord possessing a roundness and truth I have never before heard equalled, and its leading character manifested with the greatest distinctness and certainty. This fact, I have since found, yields evidence on some doubtful points in the principles of harmony.

After correctly laying out the diatonic scale of C, Mr. Purday points out that in order to use D as keynote, the F and C must be sharpened to fall into the new scale. Here, however, occurs an error. They must not be sharpened a chromatic semitone, $\frac{25}{24}$, as stated, but by the *acute chromatic* $\frac{25}{24} \times \frac{81}{80}$, in order to make them the major third and leading note in the new scale.

For the major third ($\frac{5}{4}$) of D ($\frac{9}{8}$) is $\frac{9}{8}$ of $\frac{5}{4} = \frac{45}{32}$, which is the acute chromatic ($\frac{81}{80} \times \frac{25}{24}$) of F ($\frac{4}{3}$), or $\frac{81}{80}$ of $\frac{25}{24}$ of $\frac{4}{3}$ = also $\frac{45}{32}$. The same is true as regards the C sharp. On the other hand, if we sharpen G by a chromatic semitone, $\frac{25}{24}$, it becomes the true leading-note in A minor, and on applying the same interval to C and F we get the true diatonic scale of A major.

The problem is more complicated than it at first appeared. We have to deal with the acute (or grave) chromatic, $\frac{81}{80}$ $\frac{25}{24}$, as well as the chromatic semitone $\frac{25}{24}$, and no mere raising or depressing of each note in the diatonic scale by this latter will give a true list of the sounds which ought theoretically to be obtained from a perfect keyboard. The commatic difference cannot be ignored. The equally-tempered scale is true within much narrower limits, and if this scale cause dissatisfaction, much more will the scale headed "Just Intonation," on p. 16.

Again, this table of "Just Intonation" is confessedly formed, with its 21 degrees, in order to admit of any note of the diatonic scale of C being taken as a new key-note; but, in like manner, any of the new notes—say G sharp, for instance—may be taken as a key-note, which will necessitate another new note, F double-sharp, and so on. In fact, although double sharps and flats are of frequent occurrence in musical writings, the above-named list makes no mention of them.

Once more, the interpolated sharps and flats having their origin in tonics other than C, their use in the key of C remains unexplained; but no chromatic passage is written or imagined except as in connection with some given tonic, and referred to some definite scale, major or minor, for its justification. Further, no other notes than those represented (however imperfectly) by the keys of the piano could take part in a chromatic run without the conviction that they were out of place, out of tune, nondescript foreign importations.

The harmonic theory of concordance, though backed by names of high authority, cannot, in my opinion, bear strict scrutiny without signs of weakness. What are the facts and assumptions of this theory? The facts are that if a number of strings tuned to C, or any octaves of C be sounded together, they give rise to harmonics of which the most prominent are C's, G's, and E's, other harmonics, all of them dissonant, being more faintly produced. The assumption is that, therefore, and therefore *only*, the sounds E and G are consonant with C. Further, and what is of more consequence, it is assumed that therefore C E and G are in concord when sounded together. Why the line should be drawn at these two harmonics, and not at the first or the *n*th, we are not informed, nor can I guess what reasoning could decide the question. An equally serious criticism is that this theory utterly fails to account for the concordance of C E flat and G, as the note E flat is not a harmonic of C, nor even is C a harmonic of E flat. Of course, C E flat G are harmonics of some other fundamental—to wit A flat; but this in no way accounts for their concordance, nor has anyone, as far as I am aware, had the hardihood to advance it as an explanation of the origin of the minor triad.

Again, it may be asked why we should pin our faith to what strings, artificially stretched, do, seeing that other things—metal plates, for example—behave so differently? With these, the most prominent harmonics are exclusively dissonant; and some assert, though I doubt it, that the same is true of bells.

For the above reasons I look with suspicion on the theories postulating a "physical basis" of music; but if Mr. Purday can refer me to any of the list of authors he names, who can conclusively refute my criticisms, I shall be obliged for the information. It would be beyond my leisure, however, to read the whole of half a dozen of these books to find out whether some one of them does or does not confute what I have advanced.

If my leisure allows, I will again bring the matter forward, on grounds which appear to me intelligible and convincing.

Arts Club, Manchester. **R. C. Phillips.**

MAGIC SQUARES.

[32673.]—THE construction of magic squares in four compartments in a manner somewhat similar to Mr. Cram's method may be effected by means of only one preliminary scheme, and without subsequent corrections. The method for roots which are oddly even, that is, the double of odd numbers, is somewhat different for the following three cases:

(1) When the half of the root is a multiple of 3, that is, 3, 9, 15, &c.

(2) When the half of the root increased by one is a multiple of 3, as 5, 11, 17, &c.

(3) When the half of the root is greater by one than a multiple of 3, as 7, 13, 19, &c.

(1) $\frac{n}{2}$ *a Multiple of Three.*—Fill the four quarters of the square as a magic square with root one half that of the cubic square, by any of the usual methods, and let all four be alike except that those on the right of the mid-vertical have the numbers in each row reversed. For a square of six this will give such an arrangement as the following:—

4	9	2	2	9	4
3	5	7	7	5	3
8	1	6	6	1	8
4	9	2	2	9	4
3	5	7	7	5	3
8	1	6	6	1	8

Now prefix to each number in the upper quarter on the left the number 2, separating it from the other number by a dot. In the upper quarter on the right, let each row take the number 3 as many times as will make, when added to the twos on the left, $3 \times \frac{n}{2}$. For the square of 6, therefore, one 3 will be needed in each row. Moreover, each diagonal in this same quarter must have as many threes as will make the sum of the prefixed numbers in the whole diagonal $3 \times \frac{n}{2}$. Now, as the lower quarters take 1 in place of 2 on the left, and 3 on the right in places where there was no prefix in the upper quarter, the complete square will present some such appearance as the following:—

2·4	2·9	2·2	2	9	3·4
2·3	2·5	2·7	7	3·5	3
2·8	2·1	2·6	6	1	3·8
1·4	1·9	1·2	3·2	3·9	4
1·3	1·5	1·7	3·7	5	3·3
1·8	1·1	1·6	3·6	3·1	8

On multiplying each prefixed number by 9, the square of $\frac{n}{2}$, and adding to the product the number to which it is prefixed, we get the following square of six:—

	1	3	5	6	4	2
1	22	27	20	2	9	31
3	21	23	25	7	32	3
5	26	19	24	6	1	35
2	13	18	11	29	36	4
4	12	14	16	34	5	30
6	17	10	15	33	28	8

If, now, this be written out so that the rows shall follow the order of the consecutive numbers on the left, and the numbers in each row that of the head numbers, the above becomes transformed into the following, which also is magic:—

	1	2	3	4	5	6
1	22	31	27	9	20	2
2	13	4	18	36	11	29
3	21	3	23	32	25	7
4	12	30	14	5	16	34
5	26	35	19	1	24	6
6	17	8	10	28	15	33

(2) $\frac{n}{2}$ *increased by One a Multiple of Three.*—Fill the four quarters as before with a magic square, having $\frac{n}{2}$ for its root; then prefix in the upper left quarter 1 in one cell of each row and each diagonal, and two in the remaining cells, and place as many threes in the upper right quarter as are required by the rule for the first case, and complete, as before, by putting in the lower quarters 1 for 2, 2 for 1, 0 for 3, and 3 for 0. We thus get, for example, the following square of 10:—

	1	3	5	7	9	10	8	6	4	2
1	2·11	1·24	2·7	2·20	2 3	3	20	3·7	24	3·11
3	1·4	2·12	2.25	2·8	2·16	3·16	8	25	3 12	4
5	2·17	2·5	1·13	2·21	2·9	9	21	3·13	5	3·17
7	2·10	2·18	2·1	2·14	1 22	3·22	14	1	3·18	10
9	2·23	2·6	2·19	1·2	2·15	15	3·2	19	6	3·23
2	1·11	2·24	1·7	1·20	1·3	3·3	3·20	7	3 24	11
4	2·4	1·12	1·25	1·8	1·16	16	3·8	3·25	12	3 4
6	1·17	1·5	2·13	1·21	1·9	3·9	3·21	13	3·5	17
8	1·10	1·18	1·1	1·14	2·22	22	3·14	3 1	18	3·10
10	1 23	1·6	1·19	2·2	1·15	3·15	2	3·19	3 6	23

On multiplying the prefixed numbers by 25 $\left(\text{the square of } \frac{n}{2}\right)$ and adding the number to which they are prefixed, we get a square of 10, which may be transformed, like the square of 6, by following the indications of the marginal figures.

(3) $\frac{n}{2}$ *greater by* 1 *than a Multiple of Three.*—The only difference to be made in this case is that there must be two cells in each row and diagonal of the upper left quarter in which the prefix is 1. Hence, for example, the following square of 14, in which the prefixed numbers denote so many times 49.

2·22	2·47	2·16	2·41	1·10	2·35	1·4	·4	3·35	·10	·41	3·16	·47	3·22
1·5	2·23	2·48	2·17	2·42	1·11	2·29	·29	·11	3·42	3·17	·48	3·23	·5
2·30	1·6	2·24	2·49	2·18	2·36	1·12	·12	3·36	·18	·49	3·24	·6	3·30
1·13	2·31	1·7	2·25	2·43	2·19	2 37	3·37	19	43	3·25	7	3·31	13
2·38	1·14	2·32	1·1	2·26	2·44	2·20	20	3·44	26	1	3·32	14	3·38
2·21	2·39	1·8	2·33	2·2	1·27	2·45	3·45	27	3·2	33	8	3·39	21
2·46	2·15	2·40	1·9	2·34	2·3	1·28	23	3·3	34	3·9	40	15	3·46
1·22	1·47	1·16	1·41	2·10	1·35	2·4	3·4	·35	3·10	3·41	16	3·47	22
2·5	1·23	1·48	1·17	1·42	2·11	1·29	3·29	3·11	42	17	3·48	23	3·5
1·30	2 6	1·24	1·49	1·18	1·36	2·12	3·12	36	3·18	3 49	24	3 6	30
2·13	1·31	2 7	1·25	1·43	1·19	1·37	37	3·19	3·43	25	3·7	31	3·13
1·38	2·14	1·32	2·1	1·26	1·44	1·20	3·20	44	3·26	3·1	32	3·14	38
1·21	1·39	2·8	1·33	1·2	2·27	1·45	45	3·27	2	3·33	3·8	39	3·21
1·46	1·15	1·40	2·9	1·34	1·3	2·28	3·28	3	3·34	9	3·40	3·15	46

Expressed in this form, this square is easily seen to contain all the numbers from 1 to 14^2, and to yield the same sum in the rows, columns, and diagonals. The conversion into quartets of the last two squares, and the expression of the numbers in the decimal notation is left to the reader.

J. Willis.

PHOTO. OPTICS, &c.

[32674.]—ALL optical readers will, I am sure, read with pleasure Mr. Caplatzi's letter (32658). Why will not some of the skilled opticians who read the "E. M." contribute a series of papers, with dimensioned figures such as those of "J. H.," on the construction of telescopes, microscopes, photo. lens, spectroscopes, and kindred mathematical instruments? Such a series would have a very wide interest, and would, I should think, be afterwards called for in book form; for a thoroughly practical treatise on optics is, as far as I am aware, unknown.

And here I should like to ask whether any moderately large object-glasses (say over 3½in.), made with the new Abbe-Schott glass, are in use by any of the readers of the "E. M."? If so, will they kindly describe the in- and out-of-focus appearances of a star disc? **Orderic Vital.**

IS THE BRITISH ASSOCIATION TO BE ALLOWED TO PERISH?

[32675.]—EVERYONE must have been struck with the little attention which the Press has this year devoted to the proceedings of the British Association. The fact is, that this once-vigorous body is moribund, and that unless resuscitated it will exist, if at all, merely as a "semi-scientific picnic." Perhaps, one of the measures necessary for its revival would be the amputation of the "Statistical and Economic Section," a step which has been recommended long ago. Surely statistics must be viewed not as a science, but as a method which may be applied with greater or less advantage in several sciences.

As for Economics, there are not a few objections to its introduction at the meetings of the Association. Except the chairman is both strong and judicious, it is sure to degenerate into party politics. The subject also finds ample room elsewhere—e.g., at the meetings of Chambers of Commerce. I am far from contending that the excision of this obnoxious section would suffice to restore the Association to health; but it would be at least a step in that direction. It will be also necessary to suppress the growing attempts of some men to "advertise their particular branch of business," which one of your contemporaries calls a "laudable object." **J. W. Slater.**

36, Wray-crescent, Tollington Park, N.

THE PHYSICAL BASIS OF MUSIC.—ERRATUM.—Letter 32651, p. 16, col. 2. The line immediately below the table of vibrations should be the first line at the top of the column—viz., "diagram will help to render this clear. The letters," should have been at head of the column preceding the line "representing the scale are placed relatively to each."—T. M. P.

FOR the whole of Germany the annual consumption of beer per head amounts to 88 litres; but for Bavaria it is 209 litres. It is said that disease of the heart is very prevalent in Munich, where the consumption of beer amounts, on the average, to 565 litres per head annually.

A BIOLOGICAL station, something on the plan of Prof. Dohru's station at Naples, is to be erected in Heligoland.

IT has been found by experiment that as regards chemical composition, the susceptibility of iron to become brittle by pickling and rusting is least in cast iron and silicon steel, and highest in wrought iron, and, according to Büdecker, in high carbon steel. Combined carbon appears to increase the action, and silicon to diminish it. The influence of manganese in either direction has not as yet been determined.

REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[74856.]—**Knot and Nautical Mile.**—"G." is sarcastic. May I, as an old salt, try to explain that the knot and the nautical mile are two distinct things? The nautical mile is nearly 6,079ft.; the length of the log line is 720ft., or, as we generally say, 120 fathoms; the log glass is a sand glass, running either 28sec. or 14sec. The length of a knot bears the same proportion to a nautical mile that the time measured by the log glass does to an hour. Approximately, the length of a knot for a 14sec. glass is 23ft. 4in.; therefore "G." may safely reckon that if the ship is going 10 knots, "M. H. W. L." and his crew will not be more than 10 minutes at the outside in heaving the log and hauling it in, especially if the log is hove at eight bells, and the watch is anxious to get below. If 10 knots of the line are run out in the time that the sand in the glass has taken to run out, then we say that the ship is going 10 knots—we mean that the ship is going at the rate of 10 miles in the hour, or, I ought to say, 10 nautical miles of 6,079ft.

H. P. G. D., Master Mariner.

[74873.]—**Horological.**—As no one better up in the subject has answered this query, I will give "Fallow Pivot" the best help I can. First, the collet must be of soft metal, preferably a small piece of gold. Second, it should be turned a little hollow on face (to rub over). Third, the wheel should be countersunk the very least shade only, and carefully starred round with a fine-pointed graver (to prevent wheel turning round). To finish off, after rubbing on with a round burnished hard steel point, take all off flat with one cut of the graver, and lightly burnish.

F. J. G.

[74927.]—**Dynamo.**—Looking at the enormous number of replies about dynamos which have been published, I should think that the querist would have little difficulty in answering his questions; but as the query is addressed personally to a correspondent, I hesitate, as many others do, to offer advice. Why do querists address their queries personally? The person may be out of town, away on his holidays, or not have time to answer. In the present case the querist can find all he wants in back numbers, which perhaps accounts for the fact that his question has not yet been answered. Why should people write and post answers to those who will not, or do not, take the trouble to look?

Quibus.

[74932.]—**Artificial Foot.**—Strengthen the leather either by sewing a stout piece of leather over the parts that give, or by riveting light steel rods to it. See that the leather belt fits the leg accurately.

C. E. G. Simons, M.B., C.M.

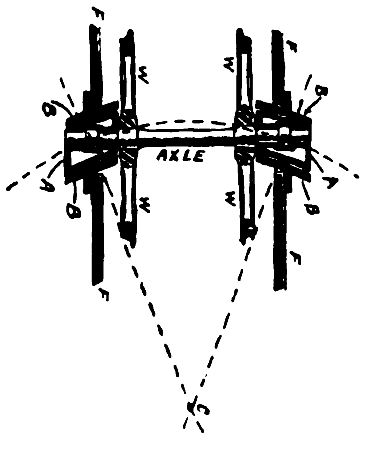
[75043.]—**Standard Angle for Lathe Centres.**—In reply to "Vulcan" and "Ohm," I venture to say that there is a standard angle for lathe centres, but of course it is a customary standard, and not a legal one—just as the screw-thread is a customary standard, and not a legal one. And they will find on sale in the principal ironmongers' shops in Manchester a cast-steel plate centre-gauge, measuring 70°. I don't think "Vulcan" and "Ohm" will find many centres to fit an angle of 60°, except very small ones for clockwork.

H. M. G.

[75091.]—**Increasing Power of Engine.**—To "Vulcan."—I note the exact size of engine and cut-off. My advice is, to apply a low-pressure cylinder 9¼in. bore, and same stroke as the high-pressure cylinder—viz., 9½in. My reason is that a cylinder of that size for a small engine possesses a marked advantage. At present, and when compounded, the governor appears to control by the throttle-valve only. There you do not make the best of the power at command. If, therefore, the governors have sufficient power, why not arrange them to give an automatic expansion cut-off, and thus get the very best result obtainable short of a condenser. The existing eccentric can be utilised, and at a small cost a very large daily gain can be obtained. If you like to go into the question of fitting on an automatic expansion, and think of adopting it, if you will send me a scale sketch of the side of the engine and eccentric as it now is, I would send you my ideas and a sketch showing how best accomplished. If this was done, you would get such an advantage that you might always run at one speed—either 120 or 145, as you like—if you require two speeds, and could enable you to get a still further benefit when running at 145 revolutions. If you like to advertise your address I would gladly help you promptly, as it would take up too much time to do so through the "E.M.," besides the space it must necessarily occupy. If ease of starting is a consideration, then let the cranks be at right angles. If the highest degree of economy is sought, then let the cranks be opposite. Do not forget, either, that if the cranks are at right angles, that the exhaust-pipe and low-pressure steam-chest must have a capacity not less than the volume of the low-pressure cylinder, and my practice is to make it as much as 1·25 of the volume of the low pressure. If you wish to have an engine without dead centres this is the plan, and all details of the by-pass, &c., I would, with pleasure, explain. If you place the cranks opposite, then the exhaust-pipe (which must be of ample area) is sufficient; but you must then pull the engines over the centres at starting. But the condensation is, no doubt, less, and resultant economy in working greater. When we come to the boiler, it is, according to my practice, a little small. I should, for such an engine, have supplied a boiler 6ft. by 2ft. 6in., which would have made steam most easily. I do not say your present boiler is small, but it should have been larger for the sake of economy; yet you will be all right when the engine is compounded, I think.

Vulcan.

[75108.]—**Radial Axle-boxes.**—I send a rough sketch of these, which I hope will suit. In the sketch F F are the frame-plates of the engine, and to which are bolted the guide-castings B B B B. The axle-boxes A A slide in these guides, the faces of which are finished with a definite curve. The radius of this must bear a proportionate ratio to the wheel base of the engine. The drawing I send is, of course, totally disproportionate; but I have not time just now to send a better. If "M. B." wants more, however, I will send a scale drawing with dimensions.



F. E. P.

[75120.]—**Harmony.**—I don't know much of harmony myself, but some time ago, being interested in the subject, I picked up on a bookstall a little book for 6d., entitled, "A Treatise on the Science of Music," by an "Amateur," published by J. H. Parker and Son, Strand. I have been informed by a musical friend that one or two ideas in it are a little old. But, anyway, it shows very clearly, and in an interesting manner, how to harmonise melodies, so that anyone with a fair knowledge of written music, and sufficient patience, may be started on the right road.

F. J. G.

[75122.]—**Epilepsy.**—To P. W. Stanley.—Charity impels one to hope that bromide of potassium, or some other such mental-disturbing drug, led to poor Brown-Sequard's somewhat recent remarkable prescription for "re-vivifying senility," as described in most medical periodicals of the time, amongst others (but in a very different *animus*) the *Homœopathic Review*, and again in one of the extremely instructive pamphlets of the League of Homœopathy—a prescription intimately described (as to its source) in one of the earliest books or sections of Holy Writ—i.e., that one narrative affording, of all others of such character, to spinsters, young and old, the most absorbing amount of inquisitive speculation—so disgusting, immoral, debasing, constitutionally injurious, and so actually wicked as to warrant me in offering to Mr. Stanley the friendly advice of never again to quote in the columns of "Ours," poor Brown-Sequard as an authority in therapeusis. As to the drug itself (K,Br) and its two elementary bodies, kalium (potassium) and bromine, all analysts would admit that, introduced into the poor, much-enduring human body, they still under any and all conditions (as to mixture, combination, &c.) remain essentially elementary, and ready to effect their peculiar disturbing morbific influences—unless Mr. Stanley can show, as a savant, that the human body possesses chemical, analytical, splitting-up powers of annihilation never yet discovered by chemical art.

The Lydney Dispenser.

[75124.]—**Magnets: How to Make Strong Ones.**—Shape best magnet or cast steel to the desired form; harden and temper same to suit the kind of steel and the magnetising power at command (an operation best acquired by practice and judgment of colour, which few ordinary smiths and engineers can execute); then magnetise by drawing them *slowly* and *evenly* in one direction over the suitably-distanced poles of a powerful permanent or electro-magnet a few times; or, better still, draw them between the poles of two such magnets placed with reversed poles opposite to each other. The textbook methods of winding helices on your magnets and passing a current through are not practical ones. As soon as the current ceases the magnetism is gone.

A. Caplatzi.

[75125.]—**Ruby Pin in English Lever.**—Remove roller, stick it on a blunt-pointed piece of thick copper or brass wire; heat the wire in a flame till the shellac runs. Any other process will blue or soften the roller or staff, or perhaps both.

F. J. G.

[75129.]—**Wild's Electrical Candle.**—This lamp, like the Jablochkoff and scores of other *patent lamps*, has been killed by the patent, and become crowded out by later comers. Extremely simple in construction, it might have been improved and rendered practicable—at least, for small currents—and in an improved form I often use it with six and more bichromate quart cells for small lights. On a large scale it is better suited for alternate than for *uni*direction currents, because, though you use pencils of different thicknesses with *straight* currents, one consumes faster than the other. As originally constructed, the carbons point upwards, and their slight separation often becomes bridged over lower down by the burnt particles falling from the crater above, and the arc follows. This fault is easily remedied by inverting the candle.

A. Caplatzi.

[75130.]—**Dry Plate Developer.**—We are unacquainted with the exact formula employed by Mayfield, and so would rather not reply to this. It is somewhat similar to the one we gave.

Clark and Montigue.

[75131.]—**Piano.**—To Mr. Schucht.—The piano is a cottage, 7oct., all wood frame, vertical strung, 3ft. 9in. high, bichord. I have planed and glued up soundboard, and want to know how to fix it, and stiffen it, and fix on bridge.

A. M.

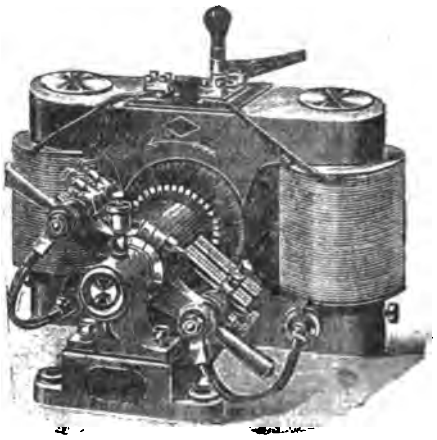
[75135.]—**Water Motor.**—As 1-30H.P. is the utmost "W. S. P." can get from his water supply, he cannot expect it to drive a very large dynamo. Most towns have a water pressure considerably above 50ft. head. Where such a pressure exists the rotary motor on the jet principle will be found to be best, especially when the prime cost is a consideration. For more than ½H.P. a well-made cylinder motor is more economical, but much more costly.

Hydraulic.

[75136.]—**Tape Machine.**—Secret and patent, and so cannot be given. We are doubtful if there is any place where you will be allowed to examine, except at the Patent Office.

Clark and Montigue.

[75137.]—**Dynamo to Charge 150 Accumulators.**—To Mr. Bottone.—A dynamo to charge 150 accumulators in series should have an E.M.F. of 375 volts, and must be capable of delivering a current of 40 to 45 ampères—in other words, it must give 16,875 watts, or be a 16½ unit machine. This means a dynamo of the Manchester type, weighing about 24cwt., standing 1ft. 10in. high, 3ft. 4in. wide, and 4ft. 7½in. long, including pulley, and absorbing about 27H.P. to drive. The diameter of the armature about 12in., the length about 10in., wound with 30lb. No. 10 wire. The field-magnets should be shunt-wound with about 175lb. No. 16. I inclose cut of the type of dynamo which I should employ. You will need 56 cells of the L 23 type to give you 16 hours' current to supply fifty 16c.p. lamps of 110 volts, taking 0·5 of an ampère each.



S. Bottone.

[75138.]—**Negatives.**—"Bruin" does not say whether the negatives were stained by the developer, or whether the stains appeared some time after the fixing. If the former is the case, I should recommend him to try the effect of a rather weak solution of alum and citric acid, having first soaked the negative. This must be well washed after it has been cleared. If the stains are due to imperfect washing after fixing, or to imperfect fixing, I am afraid there is not much hope for you. F. E. P.

[75169.]—**Electric Lighting.**—If the river can be utilised to pump the water up to the reservoir in sufficient quantity, this water might be employed to drive the dynamos; but is this not a roundabout method of going to work? Don't you think it would be better to use the river to drive the dynamos direct? If your river is not a tidal one, so that you always have water power, no doubt it is the cheapest method to light a town by electricity. It is not essential that the water power be close at hand, as the electricity can be conveyed by mains a considerable distance; but if yours is a tidal river, then it can only be used at certain times, and as storage is expensive, I fear it will not do.

Ecnal.

[75171.]—**Keeping Milk.**—Borax is generally the substance used to preserve milk; salicylic acid is an antiseptic for meat. Whether the use of these bodies is sanctioned by law, I am not aware.

S. Bottone.

[75171.]—**Keeping Milk and Meat.**—The solution used for this purpose is made by dissolving 1oz. of powdered boric acid in a pint of hot water. This quantity is sufficient for ten gallons of milk.

Henry Ebbage.

[75173.]—**Skin Eruption.**—I have no doubt whatever that this eruption is the result of impure blood, and if "Richmond" has anything like a fairly good constitution, and will follow my advice, I feel sure he will be benefited. Take Epsom salts 1oz., powdered magnesia 1oz., and put in a jug; pour one pint of boiling water on it, let cool, then pour the whole into a glass bottle; dose, about a wine-glass full fasting in the morning, two or three times a week; as the taste is not nice it is well to take a piece of orange or tomato after it. This medicine acts on the blood, not on the bowels, as one might expect. We all know that salts or magnesia alone act on the bowels; but very few persons seem to know that when they are put together they do not act on the bowels at all, or but very little at most, but on the blood, and it is wonderful how soon this medicine will take effect. I have recommended it to many, and all who have tried it have been benefited by it. One bottle of this, costing only 2d., is worth more than a "guinea" as a purifying medicine; must be shaken before taken. Then in case the bowels should be disturbed, the best thing is about a dessert spoonful of powdered charcoal mixed in a little water, or milk, and sugar, make into a paste first, or else it will float. This is one of the finest things possible for quieting and comforting the stomach, and is very valuable in a case of diarrhœa, and if the case is a bad one a little brandy added will have a good effect in keeping down any pain. These two medicines have saved me and my family much suffering, and also a good deal of expense. They are perfectly safe under any circumstances, and cost next to nothing. Let anyone who has a cut that will not heal try salts and magnesia: it will soon begin to heal. If he is fairly strong he might take a dose every morning. I write this as the result of about 20 years' experience. I have never known it to fail. Mallett.

[75173.]—**Skin Eruption.**—If "Richmond" desires to learn how to treat his disordered health by homœopathy, its literature is cheap, and is written in language simple as concise. Dr. Clarke's "Dictionary of Homœopathy," 3s. 6d.; "The Uses of the Sixteen Principal Medicines of Homœopathy," 2s. 6d.; Dr. Gutteredge's "Epitome," 5s., at Leath's, 5, St. Paul's-churchyard, London, or at Gould's, 59, Moorgate-street, London; either of these works would put him on the right track. But as "Richmond" is within most easy access of the London Homœopathic Hospital, he would, on Thursdays at 2.30 p.m., receive there the best of treatment, advice, and medicine, four weeks for 1s. As to sulphur, its action curative ceases *pro temp.* after seven days' use; but not so its action causative, if taken in its crude, large-dose allopathic form; while if the skin affection is an outlet or relief to a gouty tendency, then the lesser is the preferable of the two evils, one would imagine. When a boy I used often to see a lump of roll sulphur in the waterpan in dog-kennels, at the memory of which I, when a tiro in chemistry, used heartily to laugh; but yet that sulphuric presence was in strict accord with homœopathy's teaching, for although after many years continuous presence in the said trough, out of which many hogsheads of water had been drunk by the dogs, that identical piece of sulphur had practically lost no weight, and still had medicated all water put therein, just as the water in the smithy trough used by the smith for cooling his red-hot iron tools, &c., although chemical analysis can detect therein no iron, yet the beautiful shrub hydrangea has its innate faculty for producing red (its natural) blossoms permanently changed for blue, after the shrub had been watered by that out of the said smith's trough, an instance visible in my own gardens at the present moment. Now, which would one conclude to be the most sensitive to chemical, &c., action? the inanimate shrub or the animate human body? That the human body should be influenced by such imponderable atoms (or call it what you may), this is a melancholy subject for contemplation; and yet, while homœopathy cures disease by imponderables, the scientific (*cui bono?* as to disease) chemist's one great aim is to concentrate those very drugs—of the vegetable kingdom at least—which the homœopath dilutes, and this sometimes apparently *ad infinitum*, under the world's present insane prodigality with narcotics, nerve stimulants, nerve quieters (?). Need wonder be felt at the brain equilibrium becoming disturbed, and the train of its consequences?

The Lydney Dispenser.

[75175.]—**Magnetic Polarity.**—Supposing a voltaic pile belt be placed round a person's loins, with the zinc end on the left side and the copper on the right side, and the circuit completed by wires across the abdomen, the current would *not* travel from the zinc to the copper in the direction of the motion of the hands of the watch, but just the other way. Hence, were the patient made of iron or other magnetisable metal, his head would become a north-seeking pole and his feet south-seeking. But no human being is naturally magnetic—*id est*, takes when suspended any fixed position with regard to the poles if freely suspended; and never under the influence of the infinitesimally small current generated by these belts evinces any polarity whatever. Therefore, it is practically indifferent which way they are worn. The best solution to keep moist is a dilute solution of chloride of zinc. S. Bottone.

[75176.]—**Nickel Plating.**—There should be a slight evolution of gas. If the solution is too dense, the appearance you mention would occur; or too great battery power. I am thinking you mean fine, bright crystalline spots. This can be avoided by having the solution of the proper density. This should be from 1·050 to 1·075, containing 8oz. of nickel to the gallon of solution. The anode surface may be too large or too near the articles to be plated. Filter the solution through calico stretched on a frame, or allow it to become settled and decant or siphon off the clear liquid, or pass siphon to bottom of solution and carefully siphon off the sediment.

S. Robert Bonney, Electro-plater, &c.

[75178.]—**Pianoforte Playing.**—Five-finger exercises are the best gymnastics you can get; but at your age, unless you have been engaged on some occupation where the fingers are kept specially supple, you will never be able to play sufficiently well to please yourself.

Plymouth. B.Sc.

[75178.]—**Pianoforte Playing.**—There is a little five-noted dumb piano, occupying a space of about 5in. by 3in. by 5in., which is fitted with strong spring notes, on which you can perform continuously, even when speaking, reading, &c., and which will give strength and independence to the fingers. It is known as the "Digitorium."

S. Bottone.

[75179.]—**Photographing Diagrams.**—Special plates are made for lantern slides; but you can use any cheap plate, such as the Oxford. A thick film is not wanted for this work. I prefer oxalate development for slides, because you cannot over-develop with pyro. Sm.

[75179.]—**Photographing Diagrams.**—This is rather a difficult work for an amateur, but I think it well worth the trouble. The best plates, I feel sure, for this purpose, are the Ilford ordinary. Give a full exposure—say a minute in a well-lighted room. Develop with the Ilford formula hydrokinone. In developing use less soda hydrate than that given in the formula, and lengthen the development. Be careful to thoroughly clear the negative in the hypo. bath, or you will never get a good lantern slide from it. F. E. P.

[75179.]—**Photographing Diagrams.**—Copy your diagrams by means of the collodion process, using a good, ripe negative collodion for your negatives, developing with the following solution—viz., sulphate of iron, 120 grains; water, 8oz.; glacial acetic acid, 2 drachms; alcohol, 2 drachms. When all the detail is well out, wash, flood with a weak sherry-coloured aqueous solution of iodine, wash again, and intensify with pyro solution 3 grains to the ounce, to which has been added ½ drachm glacial acetic acid, and 3 or 4 drops of nitrate of silver solution. Fix as usual. Print by contact on Edwards's lantern plates.

S. Bottone.

[75179.]—**Photographing Diagrams.**—The diagrams must be fastened against a flat piece of board, and set up near a window, so as to b evenly and strongly illuminated. The camera mus then be placed opposite and focussed, taking car that the front of the camera is perfectly squar and in a parallel plane with the board upon whic the diagram is fastened. A small stop will be required in the lens to secure good definition, sa about $\frac{F}{64}$. Take care that no shadows are ca upon the diagrams by the camera or anything els Any dry plate giving good density will do; but the best results are desired a slow plate especiall made for the purpose of copying should be use such a one as our K.O. or Kingston Ordinary bra with which great density may be easily obtaine A hydrokinone developer or ordinary pyrogall may be used. "Pyro" is probably acquaint with the latter from his *nom de plume.* The negatives must be correctly exposed so as to get densi whilst still leaving the lines of the diagram qui clear: otherwise it will be difficult to make goo lantern slides from the negatives when made.

Fry Manufacturing Co.

[75181.]—**Medical Coils.**—Unless you rigg up some device whereby the contacts of bo primaries were broken by the vibration of the c clapper, your plan would not work at all. arranged so as to work, it would be necessary join both secondaries in series to increase t tension (the shocking power). But your quick way to increase the power of your coil, as it stand is to increase the battery power. Supposing y are now using one cell, if you connect two cells series, you will double the power. A well-ma medical coil will bear as many as three half-pi chromic-acid cells. S. Bottone.

[75182.]—**Ice-Making.**—I presume you allud to Carré's industrial ice-machine, based on th forced evaporation of liquids. Briefly, we have cylindrical leaden boiler, one-third filled wi strongest sulphuric acid. At one end of boiler w have a tube communicating with an air-pump, th other end of boiler is in connection with the vessel con taining the liquid to be frozen, known as the freezer. The motion of the pump-handle is also utilised to work a little stirrer, whereby the acid is in continual agitation. The boiler, in addition, is fitted with dome, manhole, and gauge. The theory of the machine is perfectly simple. By means of the air-pump a partial vacuum is created in the cylinder, and, of course, also in freezer. Now the molecules of water vapour are restrained by the following obstacles from rising: (1) weight of liquid above molecule, (2) surface tension of liquid, (3) pressure of atmosphere upon liquid, of which the third is by far the most important. We release the pressure then, and as a result we have a very rapid ebullition. The aqueous vapour, as fast as it escapes, is absorbed by the sulphuric acid, so that we always have a partial vacuum. Now as the water boils, it must have heat; but since we give it no external heat it must draw it from the only possible source—its own heat. This heat, though it does not affect the thermometer, and hence is called latent heat, nevertheless exists in the energy required to keep the molecules in that rotary motion of the particles which distinguishes the liquid from the solid; hence if the liquid steals this latent energy from itself, it is no longer able to support its molecular rotary motion, and as a result becomes a solid—i.e., it freezes. I expect the reason why you are unable to freeze the water (practically), as one would infer from your query, is because you do not absorb the aqueous vapour as fast as it forms, or have not a good air-pump. With a good air-pump and a good absorbent, there is no reason whatever for failure.

R. S. P.

[75184.]—**Electrical Testing.**—Your query is so peculiarly worded, and the data given so insufficient, that I am afraid I cannot be of any service to you. The constant of a galvanometer is, as you are doubtless aware, the number by which its indications must be multiplied, to convert them to ampères, milliampères, or microampères, as the case may be. If, therefore, your constant is 55, then the deflection of 200° would indicate the passage of 200 × 55 = 11,000 of current, and 250° would point to the passage of 250 × 55 = 13,750 such amounts of current. But it seems to me that you are working in a vicious circle.

S. Bottone.

[75185.]—**Weather Glass.**—Buy an aneroid: i will be much cheaper and more satisfactory than home-made barometer, for which you can only us a mercurial tube. Aneroids are cheap now. Sm.

[75186.]—**Compression Type Gas-engine.**—I would always gladly assist "Ohm" or anyone else in this direction, so long as success was pretty certain; but before I advised him as to the ignition it is essential to know something of the arrangements for indrawing the charge, or my endeavours to help "Ohm" would most probably result in landing him into a failure, which it is certainly not my wish to do. The relation to the inlet arrangement of the charge of the firing is a matter of more importance than is supposed, and the success of th engines I have had to do with is largely due to this and to the careful consideration to its laws. If "Ohm" will let me have details of the charging-valve and its position in the cylinder, either through the "E. M." or if he prefers to advertise his address, I will place at his disposal the very best advice I can give him. VULCAN.

[75187.]—**Astronomical.**—Webb, in his "Celestial Objects," gives a lengthy list of suspected planetary or cometary bodies that have been seen in transit over the sun. The Rev. E. Ledger is also stated by Chambers to have dealt with the matter exhaustively. Webb says that, on July 31, 1826, Canon Stark, of Augsburg, saw a suspicious spot in transit. ARTHUR MEE.

[75189.]—**Dynamics.**—Multiply the velocity by the entire weight of the man.
C. E. G. SIMONS, M.B., C.M.

[75189.]—**Dynamics.**—Decidedly take into account the entire weight of the man, since, obviously, he does not drop without his head. Also, in calculating the final momentum you require not only to know weight and length of drop, but also time of falling. R. S. P.

[75190.]—**Magneto-Electric Machine.**—To MR. BOTTONE.—Some kind of collector you must use. If you want simply alternate currents without shocks, all you need do is to place two insulated metal rings over the bobbin shaft, and connect the beginning of the bobbin wire to one, and the ending wire to the other; having two springs, one to press on each ring, which serve to collect the current. If you want the ordinary "shocking" arrangement, consult my book, "Electrical Instrument Making for Amateurs," where you will find, fully described and figured, the mode of fitting up. If a compound magnet be used, the same bobbins will serve; but if the magnet were very thick, it would be better to employ the Siemens' form of armature, since it is much more efficacious. This is also figured and described in the work above referred to. S. BOTTONE.

[75191.]—**Brazing Cycle Joints.**—Use brass spelter (coarse) to put inside tubes. First mix it with borax and water into a paste, and put in with a teaspoon. Outside the joint wind soft brass binding wire, and cover with wet borax. Heat till the wire runs, slowly, of course, and the spelter inside will by that time have run also. Rivet joints before putting in fire. F. J. G.

[75196.]—**Boiler.**—Drawing a boiler means taking out the fire simply. As to the condition of the plates, very few but practical men can speak as to that. If you open the manhole you can for yourself see if the furnace is covered with scale. If it is, it must be removed from the top of the tube. If you can get inside, a scaling hammer will soon remove the scale, and once clean keep it so by the use of soda or Morgan's Compound. VULCAN.

[75197.]—**Battery for Making Wire Red-hot.**—A small accumulator, such as we supply to doctors, is most suitable, always ready, and compact. The cells are joined in parallel, to give quantity of current. For 30 seconds, a lithanode accumulator can be practically short-circuited, and give its fullest power without harm to the cells. A Leclanché will not do, and all primary cells have too high a resistance to be satisfactory, unless you use very large cells.
CATHCART, PETO, AND RADFORD.

[75197.]—**Battery for Incandescing Wire.**—No. 24 platinum wire takes about 20 ampères of current to incandesce it. As a piece 3in. long presents a resistance of 0·017 ,of an ohm, it would require 12 cells of Leclanché, each having an E.M.F. of 1·5 volt, and an internal resistance of 0 75 ohm, coupled in parallel (all zincs together, and all carbons together), to supply the needed current. The result could be better attained with 4 cells, by employing the E.S. dry cells, the internal resistance of which is less than 0·25 ohm per cell. But if chromic-acid cells are admissible, these are very much better, since each cell gives an E.M.F. of 2 volts, and, with elements, presenting 16sq.in. of carbon surface, an internal resistance of 0·08 of an ohm only, which means on the short circuit, a current of 25 ampères. Hence one large chromic-acid cell, or, at most, two or three small ones joined in parallel, will give much more satisfactory results, since the current is much steadier than that from any form of Leclanché, which so soon polarises. If fitted with lifting arrangement the chromic-acid cell will give three hours continuous work, or an equivalent time in shorter intervals, with one charge.
S. BOTTONE.

[75198.]—**Testing Battery.**—If you will advertise, or send us your address, we will forward our new lists just published, with particulars of the new lithanode cell. Lithanode is peroxide of lead made up in solid form into slabs or plates. In a voltaic battery with zinc it acts, as you remark, as a depolariser, and gives up its oxygen. It is revived by recharging the cell with an electric current, which splits up the H_2O again, and the lithanode receives its oxygen back again. Dilute H_2SO_4 is the best liquid, as far as we know. The E.M.F. of such a cell would be 2·5 volts on open circuit, and 2·35 volts on closed circuit. The current would be constant, with 4 to 5 ohms in external circuit, for about four hours. For using as an E.M.F. testing cell, good results can be obtained on high resistance. The E.M.F. will remain constant for months. We can supply a portable testing battery, giving 40 volts, that will not polarise, measuring 4in. by 7in., larger sizes in proportion. Of course, such a battery is not meant to give quantity of current, and is only used on high resistances. The zinc used is chemically pure.
CATHCART, PETO, AND RADFORD.

[75200.]—**Strength of Springs.**—The pressure varies directly as the length of lever. Thus, with weight at 2ft. it is double the pressure at 1ft.; at 1ft. 6in. it is one and a half times pressure at 1ft., and so on. Pressure at 10ft. would be 10cwt.
F. J. G.

[75200.]—**Strength of Springs.**—Each time you shift the 1cwt. 6in. you will increase the load on spring by ¼cwt. Thus, when over the spring, the pressure on the latter will be 1cwt., plus the load due to the weight of the lever; 6in. further from hinge the weight produces a load on the spring of 1¼cwt., plus load due to weight of lever, and so on.
GLATTON.

[75201.]—**Cancer in the Stomach.**—Avoid all irritants or stimulants; feed on milk, cream, raw eggs, essence of beef. B.Sc.

[75202.]—**Blue Copying Process.**—Your failure was partly due, no doubt, to the use of too much water. Use one ounce instead of two in future. Are you sure you exposed the print long enough? The paper wants a very long exposure. Why not get some proper thin blue tracing paper? It is cheap enough, and I think you will find it better than your own. Perhaps you washed the blue print too long in the water. Ten minutes is usually quite long enough. F. E. P.

[75202.]—**Blue Copying Process for Plans, &c.**—I am writing away from my books, so cannot compare your recipe with the one I have used—that in "Molesworth"—and with which I have obtained excellent results. Probably you have not exposed long enough. Put a few slips of ferro-paper under the tracing at the same time as the photo, and wash them one at a time when you think exposure is sufficient, so as to try the colour. A weak solution of sulphuric acid will act as an intensifier. GLATTON.

[75204.]—**Dynamo.**—Presuming your armature is carefully wound and thoroughly insulated, you should get the desired 50 volts at 1,875 revs. per minute. As the internal resistance of the dynamo is only 1·4 ohm, you will get a current on the short circuit of 35 ampères, and with the lamp in circuit, amply sufficient to light it well. S. BOTTONE.

[75208.]—**Condensing.**—You can use a similar form of condenser to that shown at p. 578. If the present exhaust-pipe is 2in. bore, let the smallest area of the nozzle C be 1⅝in. bore. The smallest part of D should be 1¾in., and a similar nozzle below it again with a minimum aperture of 1½in. Let E be 2½in. diameter in the throat, opening out at the end to, say, 3½in. You must place a back-pressure valve of ample area on the exhaust-pipe, or the cylinder will fill with water. As to position, much depends on the way the exhaust-pipe leads; but the most satisfactory way would be to place it horizontally, and about a foot from bottom of tank, so as to be always immersed in cold water, and also, when the top water has become warm, to be well below it; the inlet may be as short as 6in. long, and, say, 3¾in. bore. No doubt in your case the best way of all would be to fix it inverted—i.e., with the outlet nozzle pointing upwards. You would then get the hot water for the feed from a point just over the discharge: hence from the warmest place. If placed horizontally you would not get warm water so soon, as the tendency of this ejector is to uniformly heat up the whole volume of the contained water. There is another way by which you could get hot water at once almost; but unless I had a plan of the tank I could not advise you with any certainty. You would find this would heat the water, and without noise. VULCAN.

[75209.]—**Dynamo.**—To MR. BOTTONE.—Best core for armature, circular plain charcoal iron punchings. Two layers only of wire are the best. Four pounds No. 14 will give on an armature about 4in. diam. 8in. long, will give 20 ampères at 60 volts pressure at a speed of 1,250 revs. per minute. The field magnets should be shunt-wound with about 30lb. No. 16. This will absorb about 2H.P. to drive it. S. BOTTONE.

[75211.]—**No Rent.**—From your statement it appears that the trustees are the parties who should collect the rents and distribute them among the family, and to them you should make your claim. As it is probable they will pay no attention to your letters, you should employ a respectable solicitor; it will be cheaper for you in the end.
Plymouth. B.Sc.

[75212.]—**Cyanide of Gold.**—Melt your gold with an equal quantity of silver, stir well, and pour in a thin stream into water. This forms it into grains. Dissolve the whole in dilute nitric acid (1 part acid, 2 of water), heating to assist it. The remainder after this process is gold. Wash it, and re-melt; beat it out flat, use as a gilding anode, and arrange as follows: Outer jar, cyanide of potassium and water; porous pot, ditto. Suspend gold in outer jar as a gilding anode, put piece of copper in porous pot, and connect both up to battery. The outer solution gradually acquires gold in the form of cyanide of gold, and becomes a good gilding solution. The contents of porous pot must be thrown away. There are other methods besides above. F. J. G.

[75212.]—**Cyanide of Gold.**—Dissolve the gold in aqua regia (1 part nitric acid to 3 parts hydrochloric acid), put this in a porcelain dish and heat gently. The gold will readily dissolve in this solution. The fumes given off during this process are very poisonous, and the job should be done in the open air or in a properly ventilated cupboard with a chimney to carry off the fumes. After the gold has been dissolved, pour off the clear liquid and washings of any residue, evaporate off the free acid, and precipitate the gold by protosulphate of iron, about five times the weight of the gold. The gold will be found after standing for about one to two hours at the bottom as a dark-brown powder. Dissolve this powder in aqua regia, drive off free acid; be careful not to apply too much heat, but gently evaporate. This can now be treated in the usual manner for making cyanide of gold from pure gold. Watt's book, 9s., or the "Electro-plater's Handbook," 3s., should be read if you intend doing anything of use.
S. ROBERT BONNEY, Electro-plater, &c.

[75213.]—**Watch Pivot Drills.**—Pieces of broken broaches make good drills. File one down (after softening) nearly parallel towards the end, and a little smaller than required hole; hold it between finger and thumb on the edge of the vice, tap it with flat-faced hammer to spread it (one tap each side sufficient); then, using eyeglass, file it to shape on blade. To harden, heat in spirit lamp flame to full red, and "flirt" it—that is, draw it out suddenly by a sharp jerk of the wrist. It is thus hardened in the air. For brass, temper to deep blue. For steel, leave hard. I always open hair-springs with tweezers for verge watches.
F. J. G.

[75215.]—**Gilding Solution.**—To MESSRS. BONNEY AND CO., OR MR. BOTTONE.—Cyanide of potassium, 95 per cent. 3 parts, pure gold 5 parts. A good gilding solution is one containing 1½dwts. gold per pint. As cyanide of potassium loses its strength when exposed to the atmosphere, it may be advisable to add more after you have got all the gold in solution. This addition of cyanide of potassium must be done cautiously until the gold deposited is a nice gold colour. In making up by battery process, use a porous cell (clean). Fill this with the cyanide solution, put the cell in a larger vessel of glass or enamelled iron, also filled with cyanide of potassium. Hang in this outer solution a strip of pure gold; and also a narrow strip or wire of pure gold in the porous cell. This must be all heated gently up to 160° Fahr. One-quart cell will be sufficient to work a small quantity of solution. The porous cell with its strip will form the cathode; the other strip of gold in outer vessel the anode. Get a book and read up the subject.
S. ROBERT BONNEY, Electroplater, &c.

[75216.]—**Gold Refining.**—This is not an easy matter unless you have a good furnace. I should not advocate doing it; but rather, exchange for pure gold, or treat as stated in 75212. You might use the 18c. chain for making up a 18c. gold bath by battery process; or you could use both the 18c. and 9c. together in equal weights to make a 12c. bath. Use this as a first gilding, and flash off in the pure gold bath.
S. ROBERT BONNEY, Electroplater, &c.

[75220.]—**House Flies.**—1. Flies, like all other insects which go through the larval, chrysalis, and perfect insect stages, never grow after once leaving the chrysalis. 2. Kirby and Spence's "Entomology." S. BOTTONE.

[75220.]—**House Flies.**—"The Anatomy, Physiology, Morphology, and Development of the Blow-Fly," by B. Thompson Lowne (R. H. Porter), will give as much information on the subject as most people would care to gain. It also contains very interesting reading with regard to other insects. C. E. G. SIMONS, M.B., C.M.

ONE of the large Chicago structures, known as the Fair Building, is to have a chimney 250ft. high. It will be made of steel ⅜in. thick at the bottom, gradually thinning until at the top it is about 5/32in. in thickness. The Leither building, another now under construction in Chicago, will also have a steel chimney, which will be about 200ft. high, and slightly over 10ft. in diameter on the outside.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

74723. Meteor Radiants, p. 391.
74734. Boiler, 392.
74739. Electric, 392.
74746. Electrical, 392.
74748. Aneroid Barometer, 392.
74749. Theatrical Paints, 392.
74755. Gem Photos, 392.
74756. Gear Wanted, 392.

74915. Copyright Music, p. 485.
74918. Stone or Buff Colouring on Brickwork, 485.
74919. Tempering Tools, 485.
74922. Turbine, 485.
74926. Gregorian Tones, 485.
74933. Medical, 486.
74942. Heel Ball, 486.
74945. Gear on Worm, 486.
74946. Fastening Covers of Creasote Tanks, 486.
74948. Trumpeter Clock, 486.
74953. Tie-Making Contrivance, 486.
74957. Opals, 486.

QUERIES.

[75221.]—**Epilepsy.**—I have cut out the answer to question 75122; but now find that I have not cut out the name of the gentleman who answered—I think it was the "Lydney Dispenser." Referring to the drug bromide of potassium, "please study in the Materia Medica of Homœopathy the secondary actions of each of the elementary bodies of that extremely powerful drug, and also of the salt itself." I have, under medical advice, taken considerable quantities of this drug, and should like to read a short account of its secondary effects; but being a layman, I have not access to the Materia Medica. Would the "Lydney Dispenser" kindly give a short account of what he hints at?—J. Foskett.

[75222.]—**Leyden Jars.**—Will some of "ours" answer the following? A number of jars of capacity K are each charged to potential V; they are insulated, and knob of No. 1 connected to outer coating of No. 2, knob of No. 2 to coating of No. 3, and so on (this being done by insulating tongs). What is the potential of n jars and the capacity of the battery, and is not the total quantity $(Q) = n\,KV$; if not, why not? Give full particulars. Can understand terms.—Puzzled.

[75223.]—**Sharpening Wire.**—I shall feel obliged if any one will inform me the best way to sharpen wire like the ends of wire nails. Is there a tool used for that purpose? If so, please explain it.—Wire.

[75224.]—**Permanent Magnets.**—I have a few permanent magnets, and I wish to have them strongly magnetised. Would "Sigma," Mr. Bottone, or others kindly put me in the way of getting some done in as simple a manner and at as little cost as possible.—Permanent Magnet.

[75225.]—**To Mr. Bottone.**—Kindly give me sketch, with dimensions, size, and weight of wire for a motor of about 1¼ man-power, also quantity of Leclanché cells (agglomerate form) it will take to drive it? As I am in Brazil, and left all my back numbers of the "E M." in England, I am at a great disadvantage. All those I have received since I've been in Brazil have nothing to help me. Thanking you in anticipation.—Brazil.

[75226.]—**Browning Brass.**—I have a sheet of brass which I wish to turn a deep brown or copper colour. Can any reader tell me of a chemical mixture to effect this? I should lacquer it in the usual manner.—E. S. Peak.

[75227.]—**Gas Fires.**—Will readers of the "E. M." who have had experience with gas fires for domestic purposes, kindly advise me as to best kind of same for warming a room, 9ft. by 9ft. by 13ft.? Are gas fires healthy and effective?—Gloster.

[75228.]—**Bending Gauge-Tubes.**—Will any of "ours" tell me how the tubes are bent for bourdon steam-gauges? I have read the instructions given in the "E. M." about four months; but I have heard of makers bending them under iron rollers, and heating them after. Will any reader tell me whether this is right?—Amateur.

[75229.]—**Frosting.**—Would any of our readers help me in the following? I have some brass plates to freeze over similar to that on the centre of a long case-clock face. I can do it with a freezing punch (which is about three-eighths on the face); but it warps the plates, takes such a long time, and looks very uneven when it is done. If anyone could tell me a better and a quicker way, I should be very much obliged.—Disheartened.

[75230.]—**Electrical.**—Would anyone kindly oblige by giving me a simple method of determining the proper strength of spring for the contact breaker of a spark coil, and also an easy way of attaching vacuum tubes to an electro-motor for rotation.—Anglo-Saxon.

[75231.]—**Model Steam Port.**—I have unfortunately, while making steam port, pushed the tool clean through into the cylinder (⅜in. bore brass). Can this be filled up by "brazing," or other method? If so, can you give me particulars of the process, and very much oblige?—Amateur.

[75232.]—**Hydraulic Presses.**—Will some courteous reader give me the following particulars? (*a*) What is the greatest pressure in pounds per square inch used in hydraulic presses. (*b*) Is this maximum pressure limited by practical reasons? (*c*) If so, what are the reasons?—Hydraulics.

[75233.]—**Folding Metre Rules.**—I shall be greatly obliged if some kind reader will give me (by simple sketches, if necessary) the forms used for folding rules of the mètre system.—Metric.

[75234.]—**Engine Query.**—Many thanks to "Vulcan" and "J. H." for the particulars given in query 75111, No. 1378; but I would like to have the thickness of copper to be used for the boiler and firebox, where to put stays, and what pressure it would carry with brazed joints. As I am rather pinched for room, if I made the boiler 8in. by 3in., and deepened the firebox, say, about ¾in., could I make the firebox any shorter?—An Amateur.

[75235.]—**London and North-Western Locos.**—Would "St. Aubyn" oblige me with sketch of last tank engines built at Crewe works with outside cylinders?—Draughtsman.

[75236.]—**Electrical Lighting.**—Will some kind reader inform me how many cells are required to work a lamp? The lamp is numbered $\frac{278}{8015}$, Edison and Swan. What chemicals and all particulars to work the above will greatly oblige an old reader.—J. Draper.

[75237.]—**Photographic-Blue Prints.**—I have been told there is a process to turn these black. I shall be greatly obliged if any of "ours" will inform me how it is done?—George Johnson.

[75238.]—**Testing Rape-Seed Oil.**—How can I test rape-seed oil to see if any mineral oil has been mixed with it?—Colza.

[75239.]—**Astro. Telescopes.**—To "F.R.A.S." or others.—I have lately come into the possession of two telescopes, and should be glad of a little information concerning them. One is a Gregorian reflector by Adams, London. Between what dates was he in business, and was he an optician of repute? Also, I should be glad to know how to calculate the magnifying power. The large mirror has a solar focus of 17in., the smaller one of the two specula a focus of 1⅜in., and when adjusted on a star they are 18in. apart. The high power e.p is about 1½in. focus. All the specula are in fine condition, and although the instrument is only 24in. long with a 4in. mirror, the combination with small speculum and 1½in. e.p. gives a power of about 140 apparently, and easily divides ε Boötis, showing the discs perfectly separated. What is the objection to this form of instrument? The only drawback I have noticed is its partial failure at nebulæ on account of not giving a sufficiently dark background. Can this fault be remedied, or is it peculiar to this form of instrument? The other telescope is by Tulley and Sons, Islington, London. When did this firm flourish? The focal length is unusually great for so small an instrument, being 8ft. 6in. with a 5in. o.g. The body of telescope is of brass, and screws apart in the middle. The e.p.'s, which are very massive, all have the diaphragm much nearer the field-lens than the eye-lens, the ratio of foci being from 2 to 2½ to 1 instead of the modern 3 to 1, and the highest only gives a power of about 200. I am sure the instrument would stand another 100. Would it be advisable to have a similar e.p. made, or would a modern 3 to 1 be suitable? Definition is perfect with 200.—H. Wake.

[75240.]—**Transformer.**—To Mr. Bottone.—I want to construct an induction coil to give a large current at 2,500 volts pressure, ¼ to ⅛ of an ampère. If possible I want it arranged so that it can be worked from five or six accumulators, or put in series with a 200c p. lamp on a 100-volt electric-light circuit. I want to know how I am to wind the primary so that I can do this; also what would be the sizes to use for primary and secondary, and the amount? Would it be necessary to wind two primaries on in parallel, so that it could be worked either with the accumulators or electric-light circuit, or what? I propose having the core made of soft annealed iron wire, No. 18, and making it into a bundle to about 1½in. diameter, and bending each end back over the coil so as to get as great an inductive effect as possible. Of course, I shall use a separate contact-breaker. I shall be glad for any information how to make a condenser for same, and any instructions as to the manufacture of coil throughout, or could any reader suggest a better one to give the same output.—S.

[75241.]—**Dynamo.**—I have a dynamo which should give 5 amps. 50 volts, but am not satisfied with its working. Is it possible to have too great a weight of iron in F.M. cores? The two F.M. cores weigh about 86lb. each, of soft iron, and with 39lb. of wire on each. The armature is of the drum type, with 12lb. of wire. Will any reader kindly suggest any improvement, and oblige?—Volt.

[75242.]—**Truffles.**—How are these prepared for eating? I have come into the possession of a bottle of them, and have looked in several books, but cannot find any directions for cooking them.—J. C. S.

[75243.]—**Gas Cylinders.**—Are these adaptable for working gas-engines where no gas is laid on? What is the capacity of these cylinders—i.e., how many cubic feet of gas can be stored in a cylinder?—Gas Engine.

[75244.]—**Catenary Curve.**—When a uniform flexible chain is suspended from two fixed points above a plane of limited extent, it takes the form of the catenary, gravity acting perpendicular to a straight line between the points of suspension. What would be the form of the curve if the two points of suspension at a height above the ground equal to the radius of the earth were distant a quarter of the circumference of the globe from one another, gravity no longer acting perpendicular to the line between the points of suspension, but converging to a point (centre of the earth) under the middle of the line between the points.—Kinetic.

[75245.]—**Cat.**—I have a favourite cat, which I believe to be troubled with worms. Wanted, a simple and efficacious means of treatment.—A. M.

[75246.]—**Markings on Mars.**—Would "F.R.A.S." or Mr. Denning tell me the names of the markings on Mars as drawn by De la Rue and copied into "Lockyer's Lessons"? I refer to the hour-glass marking and a large semicircular marking extending more than half the circumference of the planet as seen in De la Rue's drawing.—H. A.

[75247.]—**Steam Boiling.**—I have a boiling-pan which is heated by a 4½in. copper steam-coil, which is fed with steam through a 2in. pipe from the boiler; steam pressure, 40lb. I find that when the pan is filled with water and steam turned on, the pressure in the 4½ coil sinks to 0, and that even when the water is boiling rapidly there is always a difference of 20lb. between the coil and the boiler. Naturally the 2in. pipe is not large enough to give a full supply. I should be glad if any of your engineering readers can tell me if there is a loss of heat in this plan—whether, in fact, there is a loss of heat in expanding the steam in the coil.—Wm. Hardcastle.

[75248.]—**Outside Painting.**—My cottage is of the Chalet breed, with much outside woodwork which requires frequent painting. I shall feel obliged if any reader will say what kind of paint would be most serviceable, or if there is anything better than paint for the purpose?—Carl Sheldon.

[75249.]—**Japanning Round Wire.**—Will someone inform me how to japan neatly and quickly 15in. lengths of No. 14 round wire. I have tried warming them on a hot plate, and dipping them in black japan varnish, but it leaves an irregular and sticky surface. I have also tried drawing them when warm through a cloth saturated with japan varnish, but I cannot get a dry or hard thin surface. A better method, or the name of any other neat coating to prevent rust, will very much oblige.—Brotherhood.

[75250.]—**Japanning.**—I am going to try to japan some ironwork. Will any of our correspondents oblige me as to the best japan, and the stoving, and the degree of heat required to bake same?—A. B.

[75251.]—**Refrigeration.**—How is liquefied carbolic acid gas used to produce intense cold? say to cool a tank of water, or reduce the temperature of an ordinary refrigerator or ice-chest?—Duffer.

[75252.]—**Electric Lighting.**—My sale shop is situate about 2 0 yards from my factory, where I have a 2H.P. gas-engine. By the aid of this engine, together with a dynamo, can I convey direct electricity sufficient to light up my dark shop, say about 10 lights?—If so, will my present telephone wire answer, or must I put up a new one?—Karl.

[75253.]—**Electric Engine for Boat.**—Will you kindly inform me what is the smallest electrical apparatus I can get to drive a model steamer. 9in. wide, 8in. deep, and 6ft. long? The paddles are 6½in. diameter, and 3½in. wide. I should not want so much power as a sewing-machine, I think. Some one told me you had spoken of a new kind of battery. The space being so small, to get at the work when the boat has all the fittings in, it must necessarily be small, though I should have a good length, say about 12in. or 18in.—Steamer.

[75254.]—**Space of Four Dimensions.**—What is the term "space of four dimensions" intended to mean? Also how past and future time can be always existing?" as stated by Prof. Lodge in address on mathematics at the British Association meeting.—Har.

[75255.]—**Valley and Hip Tiles.**—Would any of our geometrical readers kindly describe the method of setting out the angles of above, when the pitch of intersecting roofs is given?—Iota.

[75256.]—**River Punt.**—I want to build myself a punt. Will some kind reader give me dimensions for one 16ft. long? What shape are they, and could I put in launch engine and screw propeller?—if so, what size screw?—Brewer.

[75257.]—**Electrical.**—I have a large electrical cylinder machine, the cylinder of which is 11in. long in massive brass frame, but there is no conductor to it. There are two large brass bars fixed on the top bar of the frame, and reach out about 18in. Could I attach a conductor to them? If so, how would be the best way to insulate it, and about the size tube it would require, or could I get one ready made? Also what size spark ought I to get from it? The rubber is 10in long working on a slide in the bottom of the frame similar to the T-rest of a lathe? also the way to make the amalgam for the rubber? I have two bottles filled with brass turnings with hook at the top—are they Leyden jars?—Uranus.

[75258.]—**"Pulse" Tubes.**—What is the nature of that coloured liquid I have seen inside a glass tube? When held in the hand it will boil up, caused by the heat.—H. S.

[75259.]—**Camera Obscura.**—Will anyone tell me how I can make, at small expense, a portable camera obscura?—Art Student.

[75260.]—**Pitch of Roof.**—What is the lowest pitch for slated roof to secure that rain will not be blown up underneath? I have a roof whose pitch is only 15°, and being afraid that was too little for slates, I used corrugated iron, which has been an intolerable nuisance ever since. First, the wet came in at the nail-holes; these I covered in canvas steeped in tar. Wet next came in under the laps. This was cured with strips of tarred canvas, but only after a great deal of trouble; but then the condensed moisture inside was nearly as bad. Is there any other roofing material which would be more satisfactory, and which would be free from the condensation annoyance?—F. Carre.

[75261.]—**Paper Wood.**—Will any reader kindly give information, or say how I can get information about a material which is taking the place of wood in buildings and metal in wheels for railway carriages? It is said to be made from paper.—Oak.

[75262.]—**Gramophone.**—Will anyone state whether a cheap microphone or telephone will increase the speaking power or sound of gramophone or talking machine?—H. S.

[75263.]—**Grape-Juice.**—Can any chemical reader give me the composition of grape-juice, and state whether it is possible to prevent it fermenting without adding substances which may be hurtful to those who drink the juice?—Paten.

[75264.]—**Yeast.**—Is yeast a plant or an animal, and where is the line drawn between vegetable and animal?—F. R. S.

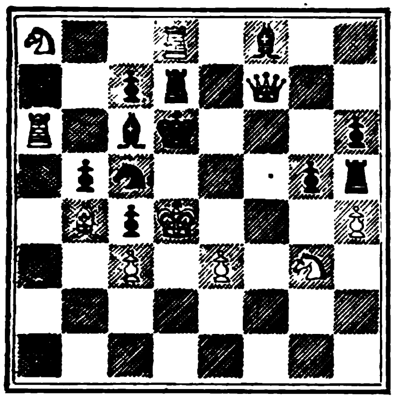
The total length of railways in operation in Canada on July 1st of last year was 13,256 miles.

CHESS.

ALL communications for this department must be addressed to "J. PIERCE, Knollside, Yawl, Lyme Regis, Dorset."

PROBLEM MCCLXX.—BY JAMES RAYNER.

Black.



White. [10 + 11

White to play and force Black to mate in two moves.

SOLUTION TO 1268.

White.	*Black.*
1. Kt Q 6.	1. Any.
2. R or Kt mates.	

NOTICES TO CORRESPONDENTS.

CORRECT solutions to 1268 by G. Collins, H. Fellows, A. Fellows, W. Jay, W. L. Martin, S. R. H. (very good), Bisma, F. J. Wardale, W. T. Hurley, R. W. Houghton, T. Guest, F. H. Guest, and C. S. Bright; to 1267 by S. R. H. (second solution), W. Jay (2), and C. S. Bright (second solution), T. Guest (ditto and quintuple), F. H. Guest (ditto and quintuple); to 1266 and 1265 by C. S. Bright (name duly entered).

W. L. MARTIN.—An omission which we regret. It has been rectified.

F. H. GUEST.—Duals do not count in two movers, nor in three movers after Black's second move.

T. GUEST.—If a competitor in Solution Tourney has a problem inserted, his solution of it will, of course, count, as also second solution or duals if such should exist, and he should send them before the fortnight after the publication of the problem has expired. As the same duals occur in 1267, whether Black move P to Kt 3 or 4 they do not count more than once.

VINEGAR is regarded by an American physician, Dr. S. J. Bumstead, as a valuable therapeutic agent in catarrhal and membranous croup. Employed in the form of inhalation, it is, he considers, of first importance in the management of the disease, though he also employs internal medication. His method of procedure in cases of inhalation is to pour the vinegar into a pan, and then put in the pan bricks or flat irons heated in the stove. The room thus soon becomes filled with a cloud of acetic vapour. A German doctor reports the use of etherisation with good results in the case of a child aged 13 months, who was apparently dead when he was called in.

The Largest Plank in the World.—The *N. W. Lumberman* gives an engraving from a photograph of a redwood plank that is 16ft. 5in. wide, 12ft. 9in. long, and 5in. thick, and is about 90 per cent. clear. It was taken from a tree 35ft. diameter and 300ft. high. According to its rings, it was more than 1500 years old. The tree was cut 28ft. from the ground, and the plank was hewed out of the stump, representing a section taken from near the heart to the bark. After it was displaced it was lowered by block and tackle, with a locomotive for power. In the way of labour its cost represents the time of two men for a month, simply to prepare it in the rough for shipment. To this the cost of transportation must be added, making a total of about 3,000dols. It was moved by water to San Francisco. After being on exhibition some time, a car was specially prepared to transport it Chicago. This was done by cutting a slot in the centre of a flat car, in which stirrups were pendent. The plank was placed on edge in the slot, its lower edge being within a foot of the ties. The plank was cut on the lands of the Elk River Mill and Lumber Company, in Humboldt County, Cal., is the property of J. L. Harpster, of Eureka, and B. F. Noyes, of San Francisco, and is on exhibition in Detroit, Mich., whence it may be sent to East Saginaw and elsewhere, to finally bring up in Chicago at the World's Fair. The plank shows evenness of growth, with richness of figure, and a finish such as the highest quality of material and the best efforts of Berry Brothers, the varnish manufacturers, of Detroit, can secure.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, September 2, and unacknowledged elsewhere:—

R. BREWIN.—W. Sharp.—A. D.—Trial.—Spring.—M. A.—Ira G. Leek.—Nan.—W. H. Milligan.—A. B. C.—E. E. E.—Tyro.—C. R.—Pedals.—W. H. S. Monck.—X. Y.—A. E. Mackett.—Jas. Ferriday.

A. M. M. (The air used in playing pipe-organs may be said to be "compressed," as the bellows is weighted, and must supply the wind at a steady pressure, varying with the kind of pipes it has to blow—much more for reeds than for flue-pipes; but it must be steady. In the harmonium and the American organ, the air is only such pressure as can be imparted by the player's foot; in fact, much of the art of really "playing" the harmonium depends on the skill of the musician in working the treadles to supply the wind. The "machine for compressing air" which you have designed is not wanted for any of the instruments which come under the title "organ." In a pipe-organ, the pressure of wind varies from, say, 2½in. to 10in., but separate bellows have to be used for the different pressures, as pipes voiced and tuned on a low pressure of wind would go altogether wrong—be over-blown—on higher pressures.—J. R. S. (Dr. Percy's work on Iron and Steel, John Murray, will give all the information needed about malleable iron. Lockwood and Son and Collins and Son also publish works at a lower price, which contain the description of such metal. As to the practical operations of casting and annealing, much information may be found in back volumes.)—CUBE. (The work is already done in tables to be found in the pocket books. Multiply the sectional area by the length, and you have the content; but what do you mean by "cubic capacity" in such a question? Is it a puzzle?)—WEISSKOPF. (Both.)—W. F. M. H. (Please see indices for electric scarf-pins, and suitable batteries for use with them.)—DAY BAT RY (See indices for references to many descriptions of suitable batteries. The ordinary Leclanché is good enough for most installations of electric bells; but if it must be a dry battery, full information will be found in back volumes.)—ONE IN DARKNESS. (Please consult the index to be published next week. You will find references to pages on which all the information you require can be found. The chromic-acid battery is about the best to give a light for so long as ten minutes: the Leclanché will do it for a minute or two.)—F. W. W. (Cannot you find what you require in the articles on Telephones we have recently given? You will not need more than two line wires.)—APPRENTICE. (Do not understand the "triangular barrel." What sort of a thing is it, and what has "steam" to do with it? You cannot be too definite in asking questions. Why not have sent a sketch or diagram of the "triangular barrel" which is said to burst on revolving it? Have you made one and tried the experiment?)—BAROS. (Description given not long ago A piece of twisted catgut acted on by the air moves the figures. It swells in moist air and shrinks when the air is dry. See indices.)—AN AMATEURE. (Presumably you mean lacquer. It is put on after the metal is polished, and acts as a preservative against the action of the air.)—E. B. (You give as an address the Tower of London, within easy walking distance of the very district in which you can purchase all you want—though it is not quite certain what that is. All electrotypers' materials can be obtained in Clerkenwell; but please read the 'Hints to Correspondents" printed above.)—R. G. (If the engraving is damped thoroughly and "ironed out" with a warm flat iron over paper or cloth, the creases will come out as well as can be expected.)—STAMMERER. (It is mainly a matter of will power, unless there is some disease, which is evidently not your case. Speak slowly—that is all.)—W. G. C. (See indices for references to the subject in back volumes, and procure a textbook. The stronger current is the better. 2. Throughout the whole substance, and vanishes when the exciting current is removed as you can see in an electric bell. Steel is required for making permanent magnets. 3. Roughly the conductivity of aluminium wire is about half that of copper, rather more—say as 50 to 90. 4. No; quicksilver is kept in iron bottles.)—OMEGA. (It is not an examination—merely an admission to an institution. Apply to the Secretary, at 10, Victoria-chambers, S.W., for particulars as to membership of the Institution of Mechanical Engineers.)—PERPLEXED HOUSEWIFE. (The marble will most likely require grinding and re-polishing, but try the effect of a "paste" of quicklime for a few minutes, and then rub with a rag moistened with benzoline.)—TRAED CYMRO. (There are several pedal attachments to pianos in the market, which any musical instrument dealer ought to be able to supply. As to books, procure catalogues from such publishers as Novello, Boosey, and others.)—EXTINGUISH. (We do not know what is meant by the patent extinguisher. Surely it has some other name. Possibly it is Defries. The majority of such lamps are made in Birmingham, with the exception of those which come from abroad. The question is of no interest to readers. Probably an advertisement in the Wanted Column would bring you the information required.)—MECHANIC. (At any of the dealers in clockwork in Clerkenwell. See "Hints" above.)—THOMAS PAINE. (Instruct a broker to invest it in watever stock you prefer. You cannot do what you suggest.)—WHEELER AND SON. (We do not know, and the matter is not of sufficient interest to insert the query. We do not know where to find statistics about the number of different kinds of railway-waggon wheels manufactured in England yearly.)—HARMONY. (A boy of eleven will have no difficulty in learning to play an ordinary cornet, as far as size is concerned.)—A CONSTANT READER. (Please see indices. Full directions have been frequently given.)—F. E. C. C. (You must state exactly what you mean. The bottle bichromate battery has been described many times.)—VITA, C. A. M. (In type.)

Gentlemen,—If your constitutions are enfeebled through overwork or worry, one of Mr. Harness' Electropathic Belts will speedily restore you to health, strength, and vigour. The mild continuous currents of electricity, which they are guaranteed to imperceptibly generate, will most assuredly vitalise every organ, nerve, and muscle of the body. These are not rash statements, but are actual facts based on many years practical experience, and can be confirmed by thousands of living witnesses. The Medical Battery Company, Limited, publish (gratis) a book containing hundreds of unsolicited testimonials, the originals of which may be personally inspected at their Electropathic and Zander Institute, 52, Oxford-street, London, W. They have been written by all classes of men and women, who have been completely cured of nervous and rheumatic affections, liver and kidney disorders, organic and other derangements, by simply wearing these invigorating, health-restoring appliances. All who are able to call and avail themselves of a free personal consultation, should do so as soon as possible, and those who cannot call should write at once for descriptive pamphlet and book of testimonials, which will be sent gratis and post paid to any address on application. All communications are regarded as private and confidential.

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*** It must be borne in mind that no Displayed Advertisements can appear in the "Sixpenny Sale Column." All Advertisements must be prepaid; no reduction is made on repeated insertions, and in cases where the amount sent exceeds One Shilling, the Publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O.'s.

The address is included as part of the Advertisement, and charged for

Advertisements must reach the Office by 1 p.m. on Wednesday to insure insertion in the following Friday's number.

TERMS OF SUBSCRIPTION.

PAYABLE IN ADVANCE.

6s. 6d. for Six Months and 11s. for Twelve Months, post free to any part of the United Kingdom. For the United States, 13s., or 3dol. 16c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (via Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

The remittance should be made by Post Office Order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 4d. each to cover extra postage.

Messrs. JAMES W. QUEEN and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 3d. each copy, to cover extra postage

Vols. XXIV., XXX., XXXII., XXXVI., XXXIX., XL., XLII., XLIII., XLIV., XLV., XLVI., XLVIII., XLIX., L., LI., LII., and LIII., bound in cloth, 7s. each. Post free, 7s. 9d.

All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post free from the office (except Index numbers, which are 3d. each, or post free, 3½d.)

Indexes to Vol. XLIX., and to subsequent vols., 3d. each, or post free 3½d. Cases for binding, 1s. 6d. each.

NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a PINK WRAPPER, as an intimation that a fresh remittance is necessary if it is desired to continue the subscription.

Rupture.—Dr. Kurley writes an Enquirer:—"If you are ruptured by all means consult J. A. SHERMAN, the Hernia Specialist. He has the most perfect treatment I have ever met with." He can be seen daily at his Consultation Offices, 64, Chancery-lane, London. Would advise you to write for his Book on Rupture, post free, 7d.

Holloway's Pills clear the furred tongue, and act as a wholesome stimulant to the liver, and as a gentle aperient to the bowels. They are the best known antidotes for want of appetite, nausea, flatulency, heartburn, languor, depression, and that apathy so characteristic of chronic derangement of the digestion.

LECTURES ON MECHANICAL ENGINEERING AND WORKSHOP TRAINING.—The EVENING CLASSES at King's College (Strand), London, adjoining Somerset House, RE-OPEN on OCTOBER 5 for above, and for General, Commercial, and University Education. Send for prospectus to the Secretary—J. W. CUNNINGHAM.

OUR EXCHANGE COLUMN.

The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.

Stamp Collection wanted. Will give good exchange. Also will exchange Duplicates with collector.—Edward W. Drury, 146, Coltman-street, Hull.

A strong **Treadle Lathe,** 6½ centre, 3ft. 7½in. bed. Universal chuck, two tools. Exchange.—C. L. G., 66, High Cross-street, Leicester.

Three 5in. **Cylinders,** 6in. stroke, all bored and faced for piston valves, for Launch Engine or Boiler.—Leith, 6, Trafalgar-street, Greenock.

Correct Trade Formula for Fruit Preserving in Bottles. Exchange for Books, Tools, Clothing, anything useful.—Macbain, 120, Globe-road, Mile-end, London, E.

Wanted, 2½in. **Slide-rest,** modern tool, in good condition. Exchange Books on Electricity.—Smith, 3, Bowling Green-row, Woolwich.

Complete Set of **Patterns** for pair of 1½in. by 2½in. Horizontal Engines. What offers? Wanted, Autoharp; will give little cash.—F. Bamford, Woodnetts, Woodsend-road, Flixton.

Blacksmith's **Bellows** to exchange for Portable Forge, or offers.—Manning, 99½, Camberwell-grove.

Large quantity of first-class **Electrical Apparatus** and Small Lathe for exchange. Wanted, Dress Suit, 52in. Ordinary, or Safety, Jewelry; or what offers?—Hubert Smith, 85, Manor-road, Stoke Newington, N.

Chamber Organ for exchange. To be seen at—14, Islip-street, Kentish Town.

Wanted, self-acting **Screw-cutting Lathe,** about 3½in. centres. Exchange diamond frame cushion-tire Safety, nearly new.—Walker, 41, St. Helen's, Ipswich.

315 numbers of **"English Mechanic."** What offers in exchange? Also "Work" and others. List and particulars.—W., 241, Lenton Boulevard, Nottingham.

Microscopic — Wanted, mounted and unmounted, Objects of every description; especially Cockchafers, Crickets, Saw-flies, Hornets, Locusts. Foreign exchanges invited. — Henry Ebbilom, Framlingham, Suffolk.

Wanted, **"Chemical Industry Society's** Journal," first nine vols., "Chemical Journal," some early vols., "Mind," Vols. I. to VIII.—Gray, 42, Union-street, Aberdeen.

Safety Bicycle, in good condition. Will exchange for good Lathe, about 3in. centre, with iron bed.—J. May, Smart's Hill, Penshurst, near Tonbridge, Kent.

Wimshurst Machine, 17in. discs, pretty pattern, four jars, taken first prize at the recent exhibition, Agricultural Hall. Offers to £4 value.—Randle, Crown-street, Kettering.

Wanted, a three or four-jaw **Chuck** to fit 1½ Whitworth's thread, and Stocks and Dies, ⅛ to ⅜.—Mather, Rhallt House, Welshpool.

What offers for eight-celled **Bichromate Battery?** eight zincs, 16 carbons, size each 10in. by 6in by ¼in., guttapercha cells. Value £5.—J. Nichol, Parton, Cumberland.

22lb. Chlorate Potash, Lime-Light Burner, Electric Bell and Battery, Ammeter, large Electro-Magnet. Fletcher's Foot Bellows and Blow-pipe, 60 Mechanic's Tools, 100 Coppered Carbons, heavy turned Pulley, 10 by 6, Glaziers' Diamond. What offers?—Clark, Braunstone-gate, Leicester.

New Medical Coil, complete, 1lb. 34 S.C. Wire, Electro-Motor, &c. Offers to—F. Dyer, 2, Paul's-terrace, Truro.

Will exchange **Electrical Locomotive,** scale 1½in. motor-connecting rods, &c., total weight 175lb., made in steel, for good Tricycle—Humber or Rudge's—in perfect condition. Write for particulars.—E. H. M., 18, Maison Dieu-road, Dover.

53in. Ordinary, balls front wheel, hollow parts, strong machine. Musical or other exchange to value of 25s.—9, Catherina-terrace, Lansdowne-road, Clapham.

Electrical Cylinder Machine, Leyden jars and accessories, Induction Coil, Batteries, and Motor. Exchange Safety Bicyle, or offers.—H., 31, Cardigan-road, Old Ford, E.

Lathe wanted, with slide-rest. Exchange diamond Safety, solid tired, balls all over, except head; or offers.—Bicycle, 41, Goldney-road, Harrow-road, W.

Wanted, good Screw-cutting and Turning Lathe. Exchange Safety Bicycle, cushion tires, balls throughout, value £6 10s.—10, Ratcliffe-road, Romford-road, Forest Gate.

Wanted, Harmonium, American Organ, or Musical Box out of repair; cheap. Exchange.—Harding, 196, Holloway-road.

London made **Lever Calendar Watch,** handsome design, with compensating balance working in face, centre seconds, flat crystal glass, with gold garter at back of case; cost £20. Wanted, 4½in. Screw-cutting Lathe.—Stephens, 87, Elderfield-road, Clapton.

Coil and Battery. Exchange offers.—E., Heavitree Park Lodge, near Exeter.

Voltmeter, 100 volts; Ampère-meter, 20 ampères. Exchange for Engine or Lathe Castings, or offers.—James Gibbons, Haseley, Tetsworth, Oxon.

Correct Trade Formula for Fruit Preserving in Bottles. Exchange for Books, Tools, &c.—Macbain, 120, Globe-road, Mile End, London, E.

What offers 21 vols. of **"English Mechanic."** uniformly bound, 20 vols. "Mechanic's Magazine," ditto, Knight's "Dictionary of Mechanics," also a small library of Astronomical Works.—228, Humberstone-road, Leicester.

Small **Spark Coil** in exchange for lot of Organette Music or Small Dynamo.—William Taylor, 17, Bishop-street, Dublin.

Wanted, set **Gas-Engine Castings** in exchange for 4½ centre Lathe Heads, Rest, and 3ft. bed. Planed.—Harcourt, 129, Lordship-lane, Dulwich.

100 plain **Photo. Lantern Slides,** including sweep and whitewasher, life-boat, &c. Offers.—H. E. Shrimpton, 4, Hill-side-road, Tulse Hill.

Fret-saw Machine, fitted with hand wheel. Will fit on any table. Offer to exchange Dynamo.—Pride, 22, Fernhead-road, Paddington, London.

Electric Lamps.—Three dozen 1 to 4 volts; four, 6 volts. Carbon filament. New. Offers wanted for lot.—Pride, 22, Fernhead-road, Paddington, London.

Dulcimer, 84 wires, well-made and perfect instrument. Exchange for Dynamo or offers.—Pride, 22, Fernhead-road, Paddington, London.

Exchange crystal faced **Silver Geneva Watch,** good order, for Sewing-Machine, Carpet, Couch, Table, or Chairs; or other offers.—111, Latchmere-road, Battersea.

Splendid **Screw Propeller,** three blades, 22in diameter, 16in. pitch. Will exchange Safety or Tricycle, or offers.—Edward Gloucm, 2, East-street, Hereford.

Gent's Silver Watch, hunter, fully jewelled. Exchange Poultry. Also steam Donkey Pump, 3in. ram. Offers.—W., 36, Lower-road, Rotherhithe.

Good Student's Microscope wanted, in exchange for a combined Photographic Camera and Enlarging Lantern.—Harold H. Woolidge, 30, Howson-road, Brockley, London, S.E.

Wanted, a Magic Lantern without Lenses for 4¼ Condenser; also 4 or 5 wick Lamp. State wants.—Photographer, Raunds, Northants.

Wanted, small Lathe. Exchange Electric Alarum Clock, complete, with electric lamp and cells. Wakes sleeper and lights up bedroom, value 65s.—Beesley, Langley, Slough.

Two vols. **Burns' Poems,** first edition, 1794, 15 vols. Bell's "British Theatre," 3 vols. "Shakespeare and His Friends." What offers?—Garforth, Chemist, Brook-hill, Sheffield.

Beale's **"How to Work with the Microscope,"** last edition, cost 20s. Exchange for Field Glass or offers.—Chas. Shotton, Low Streetgate, Gateshead.

Microscope wanted to value of about £5. Will offer good exchange and part cash to the above amount.—Address, 35, High-street, Hill Top, West Bromwich.

Sewing Machine, powerful, Singer treadle, suitable for heavy work. Want boys' clothing, house linen, or anything useful.—Jas. Rees, 37, Peel-street, Birmingham.

"English Mechanic, Vols. XXXIII. to LII., complete with index, unbound, good condition. Exchange for Star Microscope.—Middleton, 4, Dolcliffe-road, Mexborough.

Small **Rifle,** takes 380 cartridge, used three times, in waterproof bag, cost 85s. Also small Horizontal Engine, 2½in. bore, 4in. stroke, on heavy metal bedplate, turned flywheel, two brass piston rings. What offers?—A. Bacon, Intake, Sheffield.

What offers **Ruhmkorff Coil and Battery,** with condenser, cost £4 4s., also nearly new Weir Sewing Machine, perfect working order. Exchange anything useful.—Gannon, Chelmsford.

Exchange **Induction Coil,** ¼in. spark, two quart Bunsen cells, new, small slow combustion Stove, new, Electric Bell and Battery, all in good condition. Wanted, 12in. Grindstone, or offers.—Rossell, Castle Donington, Derby.

52in. **Earlsdon Bicycle,** Coventry machine, balls both wheels, bent handle bars; also 54in. Road Racer, double ball-bearings, oval backbone, T-handles. Would exchange either, or both the above, for Foot-Lathe, about 5 or 6in. centres. Send full particulars to—Roberts, 37, Mount Stuart-square, Cardiff.

Wanted, light Safety. Will exchange either **Tricycle,** Violins, Boiler, Photographic, Dynamo, or other offers.—165, Derby-road, Nottingham.

Slide-rest, suit 4 or 4½in. lathe. 20c.p. Dynamo, complete; both nearly new. Exchange to value 50s.—Wm. Holt, Earl-street, Skerton, Lancaster.

Exchange **Box Iron and Two Heaters,** also Charcoal Iron, for anything Electrical. Silver Watch for 40ft. 2in. Belting.—Beardsall, Sheerness.

Seven years, **"Engineers."** Exchange for Harmonium, Organ, Lathe, or anything useful. What offers?—Wikman, 6, Manby Park-road, London, E.

Lot of ⅝in. **Photo. Lantern Slides** to clear, cheap. Views and other effects. What offers?—W. Finlay, 11, Bothwell-street, Glasgow.

Six vols. **"Boy's Own Paper,"** two vols. Beeton's "Boy's Magazine," three vols. "British Manufactures," half roan, two Gas Stoves, eyelet-hole Machine, three Assegais, ½-plate Camera and Magic Lantern combined. Exchange, photographic preferred.—George, 1, Albert-terrace, Cloudesley-road, Islington.

Pair **Dissolving Lanterns,** with 6ft. sheet, 14 coloured slides and 4 moving ditto, in strong wood box. Exchange, photographic preferred.—As above.

Brass **Vertical Boiler,** 7 by 12, 1½in. centre flue glass water gauge; also Launch Engine, ¾ by ⅞. Exchange or offers.—E. Brown, 414, Wandsworth-road.

Lathe, screw-cutting, 5 or 6in. centre, by good maker,—S., 3, West-street, Soho.

Porous Cells, 5 by 2⅝, 5 by 3 by 1½, 12 by 12 by 3, 12 by 10 by 2½. Offers. Also

Silk-covered Wire, No. 40, 6lb., for telephones, 3 doz. round Telephone Magnets; also

Bichromate of Potash, 3lb., Carbon Rods, ½ by 6 long, 200.—Kendall, 119, Hill-street, Walworth.

Elmore Plating Dynamo, in first-class condition, copy of list size C, speed 1,500, output 25oz silver per hour, price £100. Offers for a new Safety Bicycle or £12 cash; worth double.—H. Jones, 14, High-street, Lambeth, S.E.

THE SIXPENNY SALE COLUMN.

Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.

New Illustrated Price List of Screws, Bolts and Nuts for Model Work, drawn to actual size, sent on receipt of stamp.—Morris Cohen, 132, Kirkgate, Leeds.

Millar's Electric Depot, 14, Deansgate, Manchester.—Best of everything electrical. Large stock. Low prices. Catalogues 3d.

Wheel-cutting and Dividing to 12 inches diameter, in brass only.—Close, Belinda-street, Hunslet, Leeds.

Dr. Allinson writes:—"Consult Fournet re Eyesight and Spectacles." Fee 5s.—18, Bentinck-street, Manchester-square.

102 **Family Recipes,** with useful information, post free.—Address Higson, Box 581, Mansfield-road, Nottingham.

Manchester Electrical Stores.—Bentley and Co., 17, Newton-street. Bells, Cells, Wires, Fittings. Best and cheapest.

Geo. F. Chutter, Engineer, Birmingham, oldest established works in the trade. Electro plating and Polishing Plants.

"Heat is Simply an Overflow from the Earth." Post 2d.—Humphreys, Camoria-street, King's-road, Fulham.

Mackies, Limited, Sole Manufacturers of Mackie's Patent Spring Pulleys, 70,000 in use. Berks Iron Works, Reading.

Kidney Complaints, stone, gravel, inflammation, Botanic receipt, and full instructions 7 stamps.—Botanic, 158, Stockwell-road, S.W.

J. Leaney and Son, Moulding Letter Manufacturers 16, Langton-road, Brixton.

Military Moustache rapidly and secretly produced. Valuable recipe, post free, 7d.—Harris, Hightown, Crewe.

Piles Cured First Application. — Palmer's Indian Ointment, boxes 1s. 1½d., post free.—Chapel-terrace, West Auckland, Co. Durham.

Dynamos, highest efficiency, vats, fittings, and every requisite for Plating and Polishing all metals. Estimates free.

Lathe Chuck, 4s., self-centring, marvel of productions, takes ⅛ wire to a large drill.—Below.

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Catalogue, largest in the trade, sent with discounts on receipt of 4d. and trade card.

Illustrated **"Electric Bell Fitter's Instruction Book,"** new edition, 1s. 1d., free.—Baughan and Co., Electricians, &c., Charlbury, Oxfordshire.

Write for **King, Mendham, and Co.'s** (Bristol) new Illustrated Catalogue, 6d. Acknowledged to be invaluable to amateurs. See front page.

"The Wimshurst Machine," by W. P. Mendham, gives theory of action and many experiments. Post free, 1½d.—King, Mendham, and Co.

Telephones, Carbon Transmitters, and parts of same.—King, Mendham and Co., Bristol (see front page).

E.S. Dry Battery.—See Mr. Bottone's opinion on page IV. Best and cheapest battery yet produced.

Watkin's Exposure Meter, a thoroughly reliable instrument for photographers, price 15s.—Field, Suffolk-street, Birmingham.

Watkin's Meter. Send for particulars and testimonials from experienced photographers in all parts of the world.

Brass Name Plate, 9 by 4½in., engraved, 4s. 6d. Any size to order.—Gilkes' Engraving Works, Reading.

Brass Window Plate Manufacturer.—Any shape or style engraved, complete. Lowest prices.—Gilkes' Engraving Works, Reading.

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Lathes, Tools, Chucks, and appliances for plain and ornamental turning.—Frost, Berner's Mews, Castle street, W.

Dynamo, 10 candles, 20s.; 20 candles, 25s.; 30 candles, 28s. List, one stamp.—D. Walton, Hebden Bridge.

Dynamo 60 candle, 45s.; 80 candles, 70s.; 120 candles, 90s.; 200 candles, 160s. List, one stamp.

Dynamo, Manchester type, ringarmature, 300 candles, £14; 400 candles, £18; 500 candles, £22. List, one stamp.

Patent Equilibrium Arc Lamp, 100 candles and upwards from 50s. List and engravings, one stamp.

Dynamo Wire from 1s. per pound; Lamps from 3s. each; Punchings, &c.—D. Walton, Engineer, Hebden Bridge.

"Sheet Metal Worker's Instructor" (Warn's). Few copies cheap, 6s. Covers slightly soiled.—37, Marquis-road, N.

Dynamo Castings (Siemens and Gramme), wholesale prices from 2s. 6d., 5c.p. These prices only guaranteed for this month. List 1d. stamp.—Beardsall, Sheerness.

Unpublished Manufacturing Recipes (without plant). Profits enormous. 7,500 testimonials. Lists free.—Stanley (Box 1), Billson-street, Poplar, London.

Dancer's **Microphotos.** List (500) and sample free 1s. 2d.—22, Greame-street, Moss-side, Manchester.

One-man Bisschopp **Gas-Engine,** good working order, new gas bags, £10. Carriage paid London.—Below.

100-watt **Dynamo** (Austin's "Infant"), first-class finish, nearly new, £3.—Tudor House, Burgess-hill, Sussex.

Screw-cutting Lathe, 5in. centres, 4ft. bed, chucks, £14. Bargain. Offers.—22, Elgin-road, Croydon.

Electric Light Installation for sale, comprising Roper's series wound dynamo with spare armature complete, also 13 of the above maker's 2,000c.p. lamps, 14mm. carbons, all in thorough working order. Can be seen by appointment any time.—Frederick Illingworth, Caledonia Works, Bradford.

Machinists' and Amateurs' Lathes, straight or gap beds, plain or screw-cutting. List, see below.—Jarratt.

Fans, Slide-rests, Machine Vices, Hand Rests, Beds, Standards, &c. List, 2d.—Jarratt, Queen-street, Leicester.

For sale.—**Vice,** Bench, four dozen New Files, and a lot of tools, £2.—32, Morton-road, New North-road.

Astronomical.—Object-glasses and general optical glazing for the trade.—Clarkson, 28, Bartlett's-buildings, Holborn Circus.

Astronomical Telescope, by Dollond, four eye-pieces, on brass table stand. Cost £22, price £12 10s.—Clarkson.

Astronomical Telescope, Solomon's, £5 telescope, one day and one astro. eyepiece, £3 10s.—Clarkson.

Universal Equatorial, by Horne and Thornthwaite, suit 6in. telescope, £10; smaller one, £3 15s.—Clarkson.

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Astronomical Telescope, with 4in. object-glass, by the old W. Wray, £25.—Clarkson.

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Theodolites and Levels, by Troughton and Simms and others, for sale. Some lent on hire.—Clarkson.

Microscopes, binocular and student's, several by Beck, Ross, Crouch; also objectives and apparatus.—Clarkson.

J. Brandon Medland, 53, Borough, will shortly remove, and is clearing stock at large discounts. Write requirements.

Griffith's genuine **Hand Camera,** cash 17s. 6d.; Magazine ditto, 31s. 6d., cash 26s. 6d. Only a few left.—Medland.

Ready toned **Sensitised Paper,** only requires fixing, brilliant prints. Sheet 22 by 17, free, 1s.—Brandon Medland.

Instantaneous Lenses for detective cameras—¼, 6s. 3d.; ½, 7s. 9d., free. These are the lenses mentioned by S. R. Bottone. Sample print, 3 stamps.—Brandon Medland.

Photographic Apparatus, best London make, lowest prices 10s. each. Catalogues free.—Brandon Medland, 53, Borough, London.

Dynamo Wire, high conductivity, double cotton covered. Sample, 1d.—F. E. Holloway, 35, Summerfield-crescent, Birmingham.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, SEPTEMBER 11, 1891.

SMALL BOXES.

SO far as cost is concerned, small boxes are not worth making, for they are now so cheap, and can be had in so many shapes, that we can easily find what we need at the fancy shops. Boxes also for post parcels are specially made, and may generally be purchased at any country post-office, such offices being usually associated with a stationery business. But there is no article in which neatness is more necessary, and which presents more scope for ingenuity, and therefore none better suited to form the subject of amateur handiwork. It is no use to attempt these articles unless it is possible to obtain suitable material—clean, dry deal, free from knots, and from ¼in. to ⅜in. thick; also some still thinner, ⅛in. As regards width, all deals are wide enough, as they generally run 9in., and a board of that width may be sawn lengthwise into two strips of 4½in., or three of 3in. These will be quite wide enough for the kind of work we are contemplating. Tools required are simple enough, but all must be in good order; the saw, a fine tenon or mitre, and, for the smallest work, none can be more suitable than the very small ones with brass backs, about 4in. long, sold now at all tool-shops. They will cut a very fine, clean surface, but when once blunted it is not easy to get them sharpened. Planes and chisels are needed, of course, keen as they can be, and of the latter one may be required not more than ¼in. wide, or even ⅛in. if it can be had. But Parcel Post has now brought the London tool-shops so near that it is seldom neccessary to buy of a country dealer, who rarely has a sufficient stock of any but the larger and coarser kind of tools. Not much else is needed, unless it be a mitre-box or small mitre shooting board, small bradawls or archimedean drill, and gluepot, with the usual carpenter's rule, square, and a supply of small wire nails. These are now made in all sizes down to that of pins, and are just what are required for small work which is not to be made up with mitre or glued joints. One special reason why such work as this is suitable for amateurs—especially young ones—is, that it is easier to plane stuff 2in. or 3in. wide than wider boards, and that there is no need of a larger bench than that supplied, with its vice complete, at £1 1s. It is made of beech 1½in. thick, and is about 3ft. 6in. long by 18in. wide. If a commencement is made with the purchase of a piece of board 6ft. long by 9in. wide by ⅜in. thick, it may be sawn lengthwise into two strips 4½in. wide, and one of these again into two strips, 2¼in., which will plane up to 2in. For greater ease of planing, cut this across so as to get three pieces, each 2ft. long. Such strips as these may be entirely worked with a smoothing plane, although a longer one makes more certain the necessary accuracy of surface.

Short bits will be often needed to form the ends of small boxes, but never plane these up separately, as it is exceedingly difficult to do so, the plane not having a sufficien bearing, and in many cases covering entirely and concealing the piece from view. Always plane a long strip, and then cut it up to the sizes actually needed. The strip we are supposed to have sawn out for present use is 2ft. long, 2¼in. wide, ⅜in. thick, and this is to be faced up as truly as possible, and edged squarely. It must be kept carefully to an equal thickness, or trouble will be in store at a later stage. ⅜in. is rather too thick, but a beginner is sure to waste a good deal in reducing the surfaces to two parallel planes. A practised hand will make a good job of a piece 5/16in. thick, and will, even then, leave it a full ¼in. thick. Having a piece of this determined size, economy suggests a box which will cause as little waste as possible. We may, therefore, first saw lengthwise, at three-quarters of an inch from one side, which will give us two strips, one of which will be ¾in. and the other 1½in. wide, each being one foot long. Cutting each across the middle, we get four pieces—enough for front and back of box and cover, the box being supposed, in this case, to be 6in. long by 2¼in. deep, inclusive of the cover. Besides the longer, uncut strips, we still have two pieces left, each of one foot in length by 2¼in. wide. One of these, sawn across, will therefore provide top and bottom pieces, 6in. long by 2¼in. wide, which will do very well. Out of the third piece we get the ends of box and cover, still leaving some 6in. or 7in. for other purposes. Anyone unused to carpentry would be surprised at the quantity of stuff needed for a comparatively small job. We have, however, in this case left, of the original 9in. board, one piece 6ft. by 4½, and one piece 6ft. by 2¼, besides the odd bit 6in. by 2¼in., so we have not cut it to waste. I have drawn the pieces to scale, but have also marked each in figures to prevent mistakes, as it is easy to miscalculate quantities when writing a description of such articles. Having thus cut out and accurately squared and planed up all edges correctly, we have a very considerable choice of jointing by which to put our box together. First the wire nails, which, for stuff planed to ¼in. thick, should be ¾in. long. These nails drive easily without splitting the wood if they are not too thick. In this case they should be no thicker than a stout pin. They have the one fault of heads, which are very visible, and not easily imbedded to allow of putty and paint. But there is no reason for hiding them. If used at all, it is just as well to let them be seen.

Before putting the box together, however, stand the pieces upon edge on a level bench, and see if the pieces left for the bottom and for the top of the cover will be large enough. These ought to overlap a trifle all round. If not, take a little off the other pieces to reduce their length a little, using a sharp chisel or the very fine saw, and do not rest satisfied till the fit is exact, even though it take time and trouble. Note how true and squarely-built a bought box is, that may have cost but a copper or two. It is merely a question of care and patience in trueing up the several pieces before putting them together. Always scribe a guide-line before using saw or chisel, and cut up to it, but not so as to obliterate it. In this case scribe *both* sides to insure a square edge. Remember that if a chisel is used to pare a piece of wood, with the *back* towards it, it has a tendency to draw in. If the bevel is

Fig 1

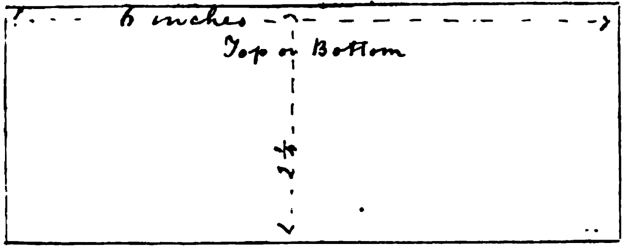


Fig 2

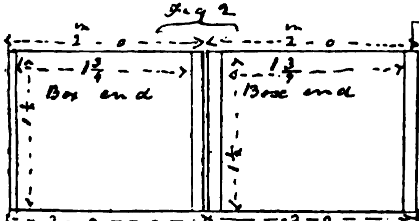


Fig 3

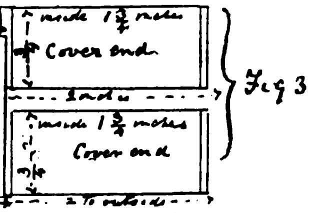


Fig 4

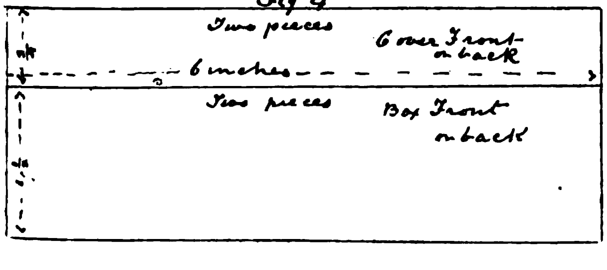


Fig 5

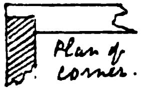


Fig 6

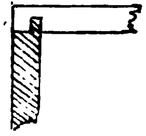


Fig 9

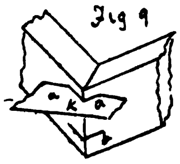


Fig 7

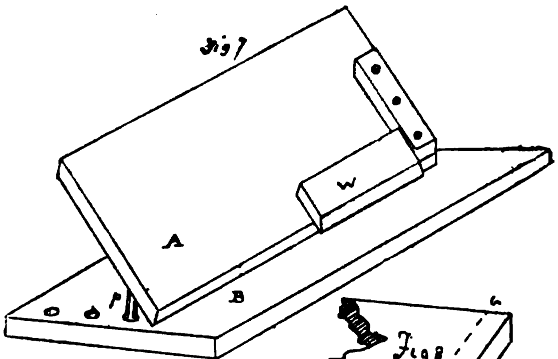
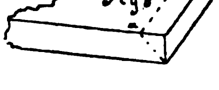


Fig 8



against the work, the tendency is to draw itself out of cut. Try this experiment upon any odd bit, as the lesson is worth learning. Suppose all is now found to be exactly true, the frames are first to be nailed up—i.e., put together the sides and ends of the box before putting on the cover or bottom piece. It will be noted in the drawing that the end pieces are ½in. shorter than the width of the top and bottom—viz., 1¾in., because they are to be nailed inside or between the front and back pieces. If this is not done, the frames would be ½in. too wide for the top and bottom of the box. Set up one of the end pieces in the chops of the wooden bench-vice, rest one of the long pieces on it, and gently tap in a nail with a very light hammer. Do not drive it home until careful examination shows the pieces to be placed with perfect accuracy, with the nail so placed that it will go centrally into the thickness of the end piece. This will of course be the case if it is driven at the distance of ⅛in. from the extremity of the longer piece. The cover being but ¾in. deep will only need one nail at each angle, but the box will take at least two. After one short piece is thus nailed inside a long one, take it out of the vice and replace it by the other short piece. Nail this, and then, setting up the parts so attached upon the bench, complete the frame by nailing on the second long strip. Test its squareness by a square, and press it into accuracy if not already true. And lastly, nail on the top or bottom, as the case may be. The two parts should thus fit with perfect accuracy on each other, to form box and cover. The attachment of the cover by hinges or otherwise will be treated presently, but it was partly to introduce other methods of joining up boxes without the clumsy expedient of nails that this paper was commenced; so we will proceed forthwith to that part of the subject. In a box now before me, 8in. long, 2in. wide, and 1½in. deep (including the cover), fitted for pencils, pens, and indiarubber, the angles are cut as in the plan Fig. 5, and are glued up without nails. The wood is ¼in. thick, and, by this means, appears but ⅛in. where its end grain is necessarily in view. The surfaces to be held by glue are also increased in area, and though each joint has no special holding power apart from that afforded by the glue, it is quite strong enough, as I have tested by forcibly pulling at it. The end of a box thus made is much neater than if it showed the full ¼in. thickness of the end grain of front and back, which was the case with the nailed one. To make such joint, nothing is better than the small saw previously mentioned. With it both the cuts may easily be taken close to scribed lines. If an ordinary saw only is at hand, a sharp pocket knife, guided by a ruler, will cut across the grain on the face of such small work; while a sharp chisel will split it out in the other direction; but it is essential to make both cuts quite clean, so as to leave a perfectly true rectangular rebate. There is not much difficulty in glueing up such small work if a small brush is used—a bit of cane beaten out into fibres being quite the best—and to hold it till dry, a string tied round it, with two or three wedges inserted, is as good as a clamp, and allows a little adjustment of the pieces. When a large number of such boxes are needed, a board with blocks screwed upon its face, set exactly to the length and width of the box, would be preferable; and if these blocks are made about half the height of the box only, they will hold it steady while the string is being applied. The box being then removed, the blocks are ready to receive another.

This need of clamps or other appliances is one drawback of joints that do not tend to hold together independently. Yet we cannot very easily do without them, for, of all joints of small boxes, that known as "a mitre" holds perhaps the chief place, and being very neat—almost invisible, in fact—and easily made, and concealing entirely the cut edges of the wood, it is hardly surprising that it still occupies a prominent position. The keys, moreover, when inserted, act as holdfasts to some extent while the glue is drying. A better joint (so far as self-holding power is concerned) than that first described, is made by rebating the smaller or end pieces, and grooving the sides to receive it, as in Fig. 6; but the groove must not exceed in depth half the thickness of the wood. Nicely fitted, it makes a neat joint; but there is a danger of spitting off the little piece left beyond the groove, so that it is more suitable for a box of sycamore, or other wood less prone to split thin deal.

In drawings Figs. 2 and 3 I have added outside lines ⅛in. beyond the terminals of the end pieces. This ⅛in. extra width will be needed if the rebated joint is used. The inside dimensions are suited for the plain nailed-up box.

The mitre-joint, as is well known, is formed by cutting each piece to an angle of 45°, so that they form a right angle when put together. These are mitring knives, mitring boxes, and machines of various kinds now obtainable; but there is no need of such for our present purpose. Scribe a line ¼in. from the edge of each piece, and saw or chisel them to this from their outer edge, and the result will be a mitre.

There are guides sold, of which a very ingenious one is seen in Fig. 7, made of mahogany and about 2ft. long from end to end. The board A is hinged to the base B, and when raised it is supported at the desired angle by a movable peg, *p*, for which there are two or three holes into either of which it can be placed. The work, W, laid and held upon this by hand is planed to a bevel by a small, single-iron plane with rectangular stock, like a jack-plane—the tool lying on its side during the operation. The peg is sized to give either a mitre of 45°, or such angle as would be needed for five, or six, or eight-sided boxes. But in all these the plane can run with the grain, and the bevels we now require run across it. For small boxes, therefore, it is easier to mark, as in Fig. 8, and to cut in the line *a b* with a fine saw and keen paring-chisel; at most, a few touches of a flat file will be needed to produce a perfectly true surface. Fig. 9 is added to explain what is a key in mitred joints. A saw-cut, made into the angle, is filled by a bit of glued veneer, *k*, which, when the glue is dry, is sawn off evenly with the sides of the box, as seen at *b*. The saw-cut *a a*, is seldom made parallel with the top or bottom of the box, but at a small angle thereto, and, when two or more are used, they are often made to slope in alternate directions. Dark keys, too, are inserted in light wood, and white in dark, if it is desired to let the keys be visible.

O. J. L.

(*To be continued.*)

PRACTICAL PHOTOGRAPHY FOR AMATEURS.[*]

By S. R. Bottone.

§ 40. THE picture resulting from the operations described in the last six sections, is, of course, a "negative"; that is, the lights and shades are the reverse to what they are in nature, and in order to obtain a "positive" copy, it must be *printed* by placing it in the printing frame, § 6, with the image side uppermost, upon which must be laid a sheet of sensitised paper, and the whole exposed to light, and treated precisely as described at § 8 for the production of other prints.

Before proceeding, however, to print from this negative, it will be well to examine it carefully, so as to learn what are the qualifications of a good printing negative, what defects there may be, and what means must be adopted to remedy these defects in any future attempts to produce a picture by these means. In the first place, those portions of a negative which represents the high lights in the picture, should be very dark—almost black (the exact tone depends somewhat on the nature of the paper employed, and may vary from a ruddy brown to nearly black). The half-tones should show every detail, clearly and distinctly, without being clogged up with any veiling deposit; and the deeper shadows should be represented by lighter portions, while the deepest shadows, show almost bare white paper. Of course, a perfect negative such as described can only result from a proper exposure, followed by a proper development. If the picture presents the general characteristics as above described, but if the details (such as lines in masonry, branches of trees, sash-bars of windows, or any delicate tracery) are *unsharp*, or look *fuzzy* or *indistinct*, then the picture has been properly exposed and developed, but it has not been properly focussed on the ground glass previous to inserting the frame carrying the sensitised calotype paper; or, if this has been done, the camera or lens has been moved (so as to alter the focus) after focussing, and before inserting the dark slide.

If the picture appears *dark grey all over*, with little or no distinction between the highest lights and the deepest shadows, then either the picture has been exposed too long to the action of light in the camera, or else stray light has gained admission and acted on the paper, either before or after exposure in the camera. If, on the contrary, the highest lights only show themselves faintly marked in black, while the half-tones are hardly visible, and the shadows show white paper without any detail, the picture has been *under-exposed.*

§ 41. The tone which the negative takes while exposed to the action of the gallic acid will enable the operator to judge whether the time of exposure in the camera has been correct. Writing on this subject, Gustave de Gray says: "If it becomes immediately dark grey all over, the exposure has been too long; if the strong lights, which should be very dark in the negative, are not darker than the half-tones, the exposure has also been too long; if, on the contrary, the time of exposure has been too short, the lights alone will appear, faintly marked in black, the picture will not have any gradation of tone, but will be equal all over. If it has had an exposure of the proper length of time, a superb negative is obtained, which will present the contrasts of light and shade very distinctly."

§ 42. When the reader has made himself familiar with the *modus operandi* of the process as above described, he may attempt the manipulation of one of the best modifications of the Calotype process, as described by Thomas Sutton. This entails a little more trouble and care, which are, however, well repaid by the charming results, and by the certainty in action.

A solution called "double iodide" is first prepared by dissolving in one measure 20 grains of nitrate of silver in an ounce of distilled water, and in another 20 grains of iodide of potassium in about the same quantity of distilled water. The solutions are then mixed. The mixture immediately becomes yellow and turbid, and a yellow precipitate (iodide of silver) soon sinks to the bottom. As much as possible of the clear supernatant fluid is to be poured off, as it contains nitrate of potash, and then an ounce of water added to the precipitate, with as much iodide of potassium in crystals as will completely redissolve the precipitate, *but no more.* The quantities required will be about 200 grains. The mixture should be well agitated after each addition of iodide of potassium, which should be allowed to dissolve before more is added, proceeding cautiously towards the last. The paper to be iodised is then laid upon a board with a piece of blotting paper under it, and brushed over with the above solution of double iodide (applying the solution copiously) both longitudinally and transversely, inclining the board, and keeping up a flowing edge. The best brush to use is a large, round camel-hair, bound with string or silver wire (no other metal is admissible, as it would decompose the double iodide). The paper is then hung up to dry, and when nearly or quite dry is immersed in a pan of clean water, so as to remove completely all the excess of iodide of potassium, and leave only iodide of silver (of a primrose colour) on the paper. Two or more papers should not be soaked in the same water;

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[*] All rights reserved.

but each sheet should have a separate pan. When sufficiently washed—an operation that takes several hours—the papers must be hung up to dry, and put away for use.

To *excite*, or render sensitive, this iodised paper, two solutions are required—one a saturated solution of gallic acid in cold distilled water, which may be designated solution A; the other a solution of 50 grains of nitrate of silver in 1oz. of water, to which is added 1 drachm of glacial acetic acid, and which may be called solution B. Immediately before use 1oz. of distilled water should be placed in a chemically clean measure and mixed with 15 drops of solution A and 15 drops of solution B. Having placed the iodised paper, with blotting-paper beneath, on a clean, level board, the above mixture is applied copiously to its surface (in the dark room, of course) by means of a Buckle's brush—made by inserting a tuft of cotton-wool tightly into a glass tube as a handle; the paper is then held upright for a minute to drain, the surface then blotted off with clean white blotting-paper, and the sensitive paper put immediately into the dark slide for exposure in the camera. The average time of exposure in a good light, with a good view lens, is about seven minutes.

To develop the picture, the dark slide is taken into the dark room, the paper removed, placed on a flat board as before, and its surface rapidly and even brushed over as before, using a new Buckle's brush, with a mixture composed of three parts solution A to two parts solution B. The picture, the darker parts of which are at first faintly visible, soon comes out of a fiery red tint. At this stage of the development it is necessary to check it, in order to obtain dense blacks, instead of feeble reds, in the darker portions of the negative. To accomplish this, it will be necessary to brush over the picture and complete the development with solution A alone. Under this treatment the reds soon darken and intensify, and eventually became opaque blacks. The entire process of development occupies about 20 minutes. It is an excellent plan, after the paper has been brushed over with solution A, to lay it face downwards on a horizontal glass slab on which a quantity of solution A has previously been spread.

After being satisfactorily developed, the picture must be well washed and then fixed in the usual manner with hyposulphite of soda, again thoroughly washed, and hung up to dry. The negative is now finished; but before printing from it it is advisable to render it semitransparent, either by dipping in clean melted wax, and after ironing between sheets of blotting-paper with a moderately hot iron, to remove excess of wax, or else by oiling with almond oil, and drying in the same manner. It is of the utmost importance in following the last described process to use paper which is not alkaline. The English papers of Turner and Hollingsworth are the best, and of these the thinnest should be selected. The foreign papers, being sized with resin dissolved in potash, are alkaline, and pictures attempted on them by the above process blacken all over.

THE OPTICAL LANTERN: ITS CONSTRUCTION AND USE.—III.

By Chas. A. Parker.

The Inner Metal Lining.—The Hood.—The Jet Shelves.—The False Bottom.—Fitting the Lining to Body of Lantern.—Lining Doors.

We now come to the metal-worker's branch of the work in hand, of which most amateurs will possess sufficient ability to execute all that is herein described; but should any part of it prove to be beyond the skill of the reader, it can be readily supplied by a professional.

The material of which the inner body or lining of the lantern is constructed may be either tinware, iron, or brass, according to the taste of the maker. If tin or brass is employed, it will be requisite to varnish the interior a dull black; but in the case of iron it is rendered unnecessary, as this material is sufficiently dark in colour without any after treatment. Personally, the writer prefers to employ stout sheet-iron of the best quality, usually called Russian iron, as this material, which neither rusts nor tarnishes, is very rigid and durable. In any case, however, it will be necessary to use sheet-brass for the jet trays, as they have to be soldered together. By referring to

Fig 12

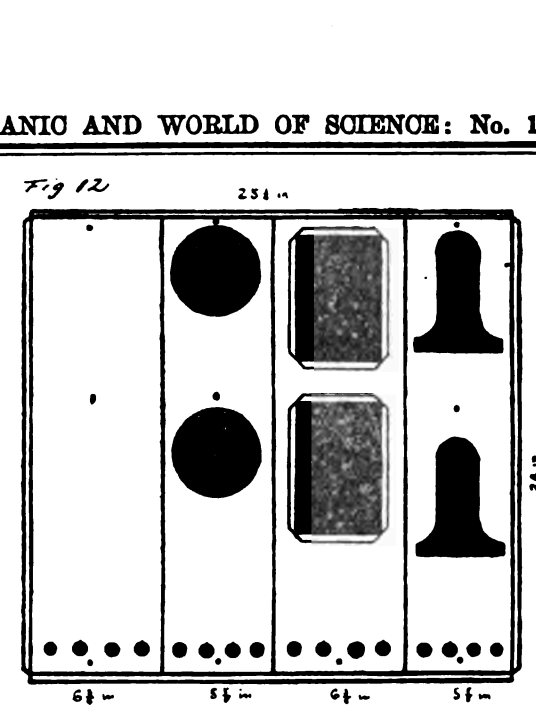


Fig 13

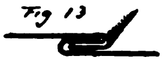


Fig 14

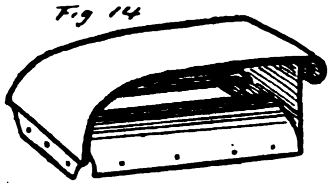


Fig 15

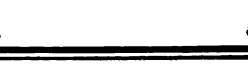


Fig 16

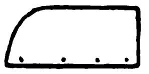


Fig 17

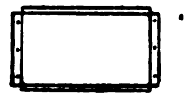
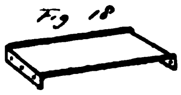


Fig 18



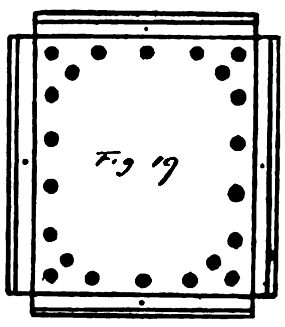


Fig 19

Fig. 12, which is a plan of the inner lining, it will be seen that it may be cut out of a single sheet of metal measuring 25¼in. by 24in., three of the sides being furnished with two openings a-piece, which correspond with the similar openings in the wooden body previously described. Two of them, it will be seen, are situated at the back of the lining to receive the jets, and next come the openings for the doors, and after these the circular apertures for the condensers, the remaining side being left plain metal. Having procured a sheet of metal of sufficient size, proceed to mark it out in lines by means of a sharp steel point to form the four sides, as shown in the above cut, first marking off ¼in. at each end for the folded seam, and then the remaining divisions, the front and back measuring 5⅝in., and the two sides 6¾in. each. When this has been done, mark out the jet apertures at the back, each of these being 6in. in height and 4½in. in width, narrowing to 2¼in. at the upper portion, the lower one being situated at 6in. from the bottom, with a space of 4½in. between the top of this and the lower portion of the upper opening. Having marked and cut these apertures, pass on to the next side of the lining and scribe out the rectangular openings for the doors, each of which measures 6½in. by 4¼in., with a space of 2¼in. between each, and a clear 7¼in. from the lower opening to the bottom of the lining. When marking these openings it will be necessary to draw another rectangle inside and parallel with the first, but just ½in. smaller on all sides, the metal being afterwards cut to the size of this inner opening. An incision is then made from the corners of this to the corners of the larger square, after which each of these ½in. sides are bent up to right angles, and then hammered down and turned flat on the metal, using a mallet first and then finishing with the hammer, the opening when completed presenting the appearance indicated in Fig. 12. It only remains now to furnish the front portions with a couple of circular openings for the condensers, commencing with the lower aperture. Make a centre-punch mark at 11¼in. from the bottom, and then strike out a 4¾in. circle by means of a pair of compasses, and 5in. above the outside of this, strike out another circle of the same diameter, the metal being afterwards cut to the exact outline.

An inexperienced amateur will, in all probability, have some difficulty in cutting sheet iron to the form of the larger apertures; it may, therefore, be stated that pieces may be readily cut out of a sheet of metal in this manner by means of a cold chisel, the metal being placed on a flat stone surface, or better still, a sheet of lead, as this will not injure the chisel. It will be found a very good plan to make a series of small punch-marks all round the front of the outline, leaving little less than ⅛in. between each one, and when this has been done, the intervening spaces can be readily severed by the means of a small cold chisel, which should be held horizontally in the left hand, while vigorous blows with a hammer held in the right hand are directed on the top of the chisel. By this means any possibility of the plate buckling out of shape will be effectually avoided, and the rough edges can be afterwards filed quite smooth. In sharpening the chisel again, care should be taken to keep the surface flat and not rounding.

Before proceeding further it will be necessary to punch sixteen ventilation holes ⅜in. in diameter along the entire length of the lower pivot of the lining, by means of a hollow punch, placing them at equal distances apart. If a hollow punch is not available, an ordinary one must be used, and the holes afterwards enlarged to the required size by means of a tool called a reamer, which is a five-sided tapering piece of steel fixed in a handle. In use the point of this tool is inserted in the hole, and then worked to and fro with a rotary motion until the hole has been enlarged to a sufficient size, any burrs being afterwards removed by means of a half round file. Three small rivet-holes should now be punched in the right side, the front, and the back, in the position indicated by the black dots in Fig. 12, these holes being provided for the screws which secure the metal lining to the woodwork.

The next proceeding will be to wire the top and bottom edges of the lining for the entire length. To do this a hatchet stake is screwed firmly in the vice, or it may be fixed in a square hole in the bench, and the sheet of metal is held in the left hand, with the edge projecting about a quarter of an inch beyond the edge of the hatchet; the edge is then turned up to right angles by careful hammering with a mallet, after which it is turned down inwards, but not closed, until a sufficient length of iron wire of about No. 10 B.W.G. has been run along the entire length of the fold of the metal, which can then be turned down close over the wire, using a tool something like a punch in form, having a semicircular concavity at its lower extremity. It will require some care and patience on the part of the operator to effect this neatly; but by the aid of a hammer and this tool it will not be found a very difficult matter to form a nicely-rolled edge, such as will be seen on any piece of household tinware. A substitute for the creasing tool above described suitable for the purpose can be readily made by filing a semicircular groove by means of a rat-tailed file in the end of a 3in. length of rod-iron about ¼in. in diameter The reader should note that, with these wired edges, the metal turned over will be about three times the diameter of the wire.

The lining is now ready for putting together; but before doing this it will be advisable to see that the metal is perfectly flat, and not buckled in the least, also filing off any inequalities or roughness of the edges. It will not be wise to put the lining together with solder, as the heat generated would be liable to melt the solder, and thus render the whole thing useless. The usual way of surmounting the difficulty is to employ a folded seam, which is shown in section in Fig. 13. To form this seam it will be necessary to turn about ½in. of the edge at each end up to right angles, and then hammer it down on a flat piece of iron about the sixteenth of an inch thick, turning the metal down in alternate directions, in order that the two edges may be afterwards sprung together and hammered down flat, thus forming a neat seam without the aid of rivets or solder. If the reader is unable to quite understand the formation of this seam, it will be advisable to examine the seam of a Colman's mustard tin, which will soon clear up any doubtful point.

When the body has been put together it will be time to make and fit the hood, which is shown complete in Fig. 14. The shaped top is formed of a sheet of metal carefully cut to the form of Fig. 15, the dimensions being 11¼in. by 6½in.; a ¼in. each of the long sides of this will require to be turned up to right angles, and then hammered down over a suitable length of iron wire in the manner before described, after which a projecting ledge for the purpose of securing the hood to the lining should be cut at the front and back, the former being 2¾in. in width, and the latter ⅜in. wide, each being provided with three small rivet-holes. After the hood has been curved by bending it nearly double and then up to right angles again, it may be placed on the top of the lining in order to see if it fits; but it should not be fixed in position permanently until the two side wings about to be described have been riveted to the lining, after which the hood may be secured to the metal by means of three copper rivets to each end. For these side-wings above-mentioned, two strips of metal measuring 6⅝in. long and 3in. wide are cut to the form of Fig. 16, and furnished with four rivet-holes each, enabling them to be riveted to each of the sides of the metal lining by means of small copper rivets. A few ordinary copper tacks will answer admirably for rivets, the heads, with a short portion of the stem, being nipped off and used as ordinary rivets. The tacks should be inserted in the holes, with the head underneath, supported on the hatchet stake or similar metal surface, the portion of the stem which projects above the holes being smartly hammered until a second head is formed, thus securing the two portions of the metal together.

When the hood is finished, it will require japanning before it is permanently fixed to the lining, and as this is the only portion of the apparatus requiring to be treated in this manner, it will be found advisable to place it in the hands of a professional to be done, as it would occupy too much space to describe the process at length, and, moreover, it is a kind of work that an amateur can scarcely hope to succeed in at once. The following imitation of japanning will be found to answer very well if the reader is unable to find a professional japanner:—Grind up sufficient ivory black with japanner's gold size to form a thick cream; then warm the metal, and lay on an even coat of this, afterwards placing it in a moderately hot kitchen oven, in which it is allowed to remain until the surface has set.

The jet shelves, of which we shall require two, will now claim our attention. For each of these a sheet of metal, measuring 7¾in. by 5in., should be cut in the form of Fig. 17, ⅝in. of each of the long sides being turned up to right angles for 6¾in. of the length, and then hammered down flat on to a strip of iron about ⅛in. thick, in a similar manner to that previously described for the folded seam. The metal should not, however, be closed down, as it is intended to form a groove along which the jet trays may slide, and when this has been done, ¼in. at each end must be bent down to right angles, a couple of rivet-holes having been previously punched in each portion, the shelf, when ready, presenting the appearance of Fig. 18. When another shelf has been made in precisely the same manner, the two may be riveted in position inside the lantern lining by means of six small copper rivets to each shelf, the upper one being fixed first at a height of 16½in. from the bottom of the lining, and the lower one at 6in. from the bottom. The exact position can, however, be ascertained without any measurements by simply fixing them on the same level as the jet apertures in the back of the lining. It is almost needless to say that the grooves of the shelves should be uppermost.

Before fixing the lining in the wooden body of the lantern, it will be necessary to make the false bottom, which is shown in Fig. 19. For this, cut out a sheet of metal measuring 7¾in. by 7in., and run a line all round the rim at 1in. distance from the outer edge, afterwards providing the central portions with about a couple of dozen air-holes ¼in. in diam., which are punched round the inner square at equal distances apart by means of a hollow punch. The four corners are then cut as shown in the above figure, after which the sides are turned up to right angles, and the inner edges wired round by turning them down over a suitable length of iron wire, which is manipulated in the manner previously described.

Nothing more remains to be done but to put the lining in the wooden body, securing it to the woodwork by means of ten ¾in. screws, each of which should be put through the rivet holes in the metal lining, and then through a ½in. length of brass tube of $\frac{3}{16}$in. bore, which will thus serve to keep the lining in its position. The screws are entered into the woodwork and screwed up tight by means of a long screwdriver inserted through the apertures in the lantern body. The bottom of the lining may be screwed up last, in order that the same screw which secures the lining may also serve to fix the false bottom in its place.

When the lining has been fitted in the body of lantern, the doors may be lined with metal and screwed in position. For the lining of each door take a sheet of metal measuring 6⅝in. by 5½in., then make a centre-punch mark in the middle of this to correspond with the circular aperture in the wood, and by means of a pair of compasses strike out a 1¼in. circle, which is afterwards cut according to the outline, and any roughness of the edges removed by a half-round file. A straight line is now scribed by means of a steel point parallel with the 6⅝in. side and ¼in. distance from them, and ½in. from this another line is scribed parallel with the first, after which a double bend is made up to right angles along the lines just scribed in order to form a step with a slight projecting ledge thus [whereby the metal may be affixed in the woodwork. Thus prepared, the lining may be screwed to the door by means of six ⅜in. screws driven through holes punched in the projecting ledges, and, when lined, the doors may be hinged to the right-hand side of the openings prepared for their reception in the lantern body, using a pair of 1in. brass butt hinges to each door. A small flush-ring catch should also be screwed on to each door as a means of fastening, a bed sufficient to take the catch having been previously cut in the wood by a sharp chisel. Flush-ring catches suitable for this purpose, which may be the smallest size made, can be obtained from any furnishing ironmonger, the price being about 8d. or 9d. each.

Errata.—The back of the wooden body of the lantern (Fig. 4) should measure 23½in. in length, instead of 25in. as stated in Chapter II. p. 561.

HOW TO MAKE A VIOLIN.—II.*

By W. Pickering.

Number of Pieces in a Violin.—No two authors seem to agree as to the number of separate pieces there are in a violin. These are given variously from 58 to 72; but it is possible to make an instrument with only 26 pieces, viz.:—Back, 1; belly, 1; sides, 6; blocks, 2; neck and scroll, 1; finger-board, 1; nut, 1; pegs, 4; tailpiece, 1; string for ditto, 1; nut for ditto, 1; tailpin, 1; bridge, 1; soundpost, 1; strings, 4, equal 26. This means, however, an unpurfled fiddle, and without corner blocks and side-linings; but I would recommend an amateur not to build an instrument of this kind. It is far more satisfactory to erect the edifice with the four corner blocks, and the twelve linings and twelve pieces of purfling. This will bring up the total number of parts to 58. Strictly each piece of purfling is composed (generally) of three pieces of wood—two blacks and a white, and if these were so reckoned, it would swell the total up to 77; but as the amateur is not likely to make his own purfling, seeing that it can be purchased ready made far better than he could hope to do it himself, it is fair to reckon the separate parts of the instrument at 53, "be the same more or less," as the lawyers say.

The Wood.—Although a violin is only a wooden box, the kind of wood used makes all the difference. The belly is made preferably of Swiss pine, and the back, ribs, and scroll of maple or sycamore (sometimes called harewood), though there are instances in which good Italian makers used beech, poplar, or pear-tree. Sycamore, however, is to be preferred on account of its beautiful "figure," though the amateur violin-maker will soon become aware that the richer the wood is in figure the more difficult it is to work. If he can get a slab of pear-tree or poplar, let him by all means expend his maiden exertions on it, and get his hand in, and accustom himself to his tools. Having hacked at this to his heart's content, he may then take a piece of nicely-figured wood, which can be bought at the wholesale warehouses at from half-a-crown upwards, according to its degree of beauty. He will find that "slab" backs, as they are commonly called, are cut from the tree in this manner:—

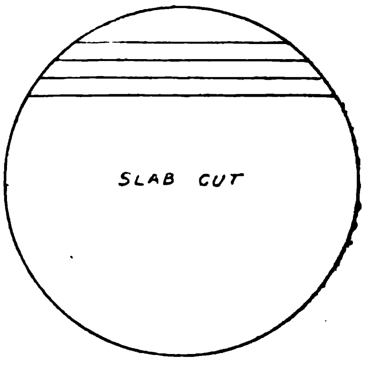


Fig. 12.

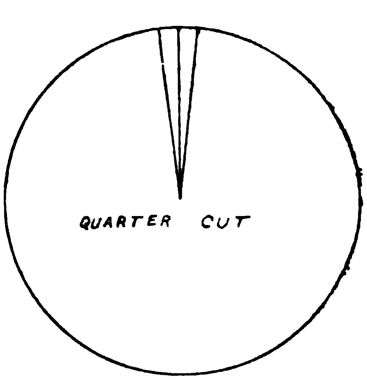


Fig. 13.

Some writers tell us that the wood from the south side of the tree only should be used, and that even that should be cut only in certain months of the year, and then should be kept five years to "season." It is hardly to be supposed that such directions, which savour rather of the faddy, can be attended to by the amateur, who, even if he lived in the country where the wood grew, would scarcely care to wait, watching his wood, five years before he began to make his violin. In selecting his wood at the warehouse, he may give the preference—if there is any such choice—to the oldest and driest looking pieces. It may be here remarked that many persons regard a *slab* back and a *whole* back as one and the same thing; but this is not the case. A slab back is one which is cut right across the tree, as in diagram, and whether it is in one or more pieces. A "quarter" back (Fig. 13), in which the cut is made from the outside to the centre, may be a whole back if the tree is large enough. The different modes of cutting the same tree produce quite distinct effects of figure, which is easily perceived when you have the two side by side. In the case of the whole back there is, of course, no joint or middle seam; but when the wood is cut on the quarter the two thick edges have to be very carefully planed and glued together, thus (Fig. 14):—

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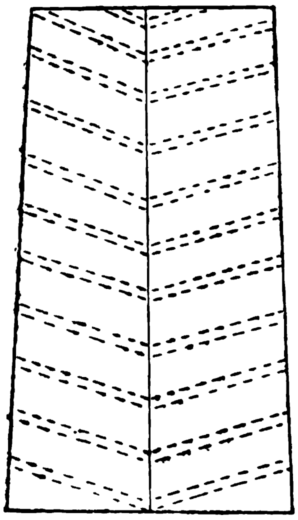

FIG. 14.

If the figure runs evenly, a pattern of considerable beauty will result. One or two strong bits of beech after this shape (Fig. 15) may be

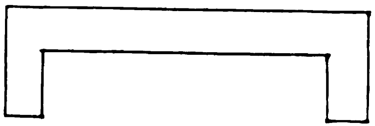

FIG. 15.

cut to form cramps for holding the two jointed pieces until the glue sets.

Too much care cannot be exercised in making the joint. It should be almost imperceptible; and the glue used should be as clear as possible, and hot and thin. Slide the glued pieces up and down on each other once or twice, so as to exclude the air; and then, having applied your cramps, put them aside. On no account should they be examined or handled until the glue is thoroughly set. You may now proceed in a similar manner to repeat this process on the wood for the belly.

When the joints of both tables have become thoroughly firm and hard set, it will be necessary to level the inner surfaces accurately. In doing this you should try them frequently with your steel rule or straight-edge, and plane, scrape, or glass-paper to the minutest degree, for if these inner surfaces are not perfectly level to begin with, you cannot expect to produce good work, and your instrument when glued up will be all "askew."

Having levelled the inner surface of, say, the back, the time has arrived when you must draw your design or outline upon it. Look attentively at a few well-made instruments, and endeavour to "get your eye in." Notice how the slightest difference in the corners, or the waist curves, affects the whole design, and, having studied this point closely, set to work on your drawing. You may at first sketch a few outlines on paper, in order to see how easy it is *not* to draw a violin. One simple way is to take the *shadow* of a good instrument thrown upon a sheet of paper or cardboard on a wall, and, in trying this, you should put the light as far away as possible, and the violin as near the wall as you can get it, or your shadow will be larger than you require. The ordinary violin is 14in. long by (about) 6⅝in. across the shoulders, 4⅝in. in the narrowest part of the waist, and 8¼in. in the widest part of the lower bouts. It is generally believed that size, other things being equal, indicates power; but in the case of a violin, you will find that if you get beyond these dimensions, there will be a tendency to run into a tenor quality of tone. After a few attempts at drawing, you may take a piece of stout cardboard, and, always working from a straight line for the centre, and which in the case of a jointed back should be exactly on such joint; draw one half of the pattern, then cut the cardboard round the edges and down the straight line, and your pattern will be something like this:—

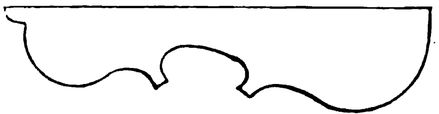

FIG. 16.

Place this pattern on the levelled or inner side of the wood, and trace with a blacklead pencil round the outline, keeping the straight line over the joint, if a jointed back. If you are working on a whole back, you must draw a central line on the wood to work from. Having traced the pattern on the wood, turn it over to the opposite side, and still keeping to the central line, draw the other half. Next place the wood in the vice, and with your bow-saw cut carefully all round the tracing. Then scribe a line on the *edge* of the wood, all round, about $\frac{3}{16}$in. from the levelled surface. Now take one of your spokeshaves, and begin to cut away along the edges the superfluous wood down to this scribed line, but not below it, and you can then much more easily finish off your outline with knife and file.

In selecting the wood for the belly, get the best piece of Swiss pine you can find, with the bate or grain running straight, and of an equal width. Do not, on any account, be persuaded to buy a piece of *larch*. It may be very fine, and nice to look at, but larch has never been found good for tone. Take care that the bate runs exactly at a right angle to the surface, and reject any which is slanting. The outline of your back being now so far complete, it is to be used as a pattern for drawing the belly, by placing it thereon and tracing the pencil round it, bearing in mind to let the two central lines agree. Again cut round the tracing with your bow-saw, and scribe the thickness on the outer edge, as you did in the case of the back. Cut away the wood down to it round the edges, and you may then cramp the two tables together, and finish off the outline of the belly accurately to that of the back. Now separate them, and put the belly aside for a time.

Having got your outline, the next thing to be determined upon is the model or contour. In your first attempt I should recommend you to select one which is moderately flat, sloping gradually from the middle right off to the edges, without essaying the delicate operation of the gutter or channel, which is generally to be found in high-class work, until you have acquired more control of your tools. It will now be necessary to clamp the back to the bench, level side downwards, and with your spokeshave slightly try in various directions to find the "run" of the wood. It will be found almost impossible to cut it in certain directions, and very easy to work it in others. *Verb. sap.* Work away carefully by the easier route, watching the result closely, so as not to go too deep. Until you have "got your eye in," which is only to be done by practice and attention, it will be well to cut three pieces of thin wood for use as templates, somewhat in this form—

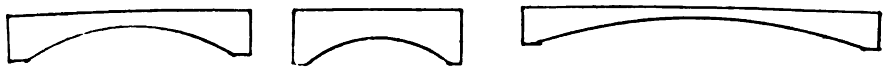

FIG. 17.

the first to cross the middle of the shoulders, the second for the waist, and the third for the middle of the lower "bouts," as they are called. These will guide you in making both sides of the model alike. Another may be made on the same plan for the lengthway of the instrument, as in Fig. 18.

After having trimmed away the wood with the spokeshave until you have got the model to assume a reasonable shape, and bearing in mind that keenness of edge on the blades will enable you to reach much nearer to the desired model than you would at first have supposed, you can take up work with the scrapers. Make use of your templates frequently to attain accuracy; you may then finish off roughly with glass-paper.

You can now turn the back over for inside

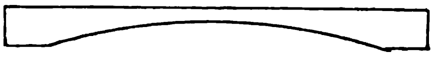

FIG. 18.

manipulation, and you will here find a use for the piece of wood you sawed off the top or bottom of the belly slab. Pare off the sharp edge of the inside curve, and glue a bit of felt or cloth upon it. This is for insertion between the model and the bench, in clamping, thus:—

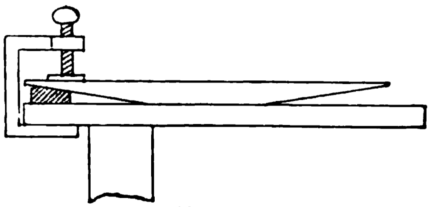

FIG. 19.

Before clamping, scribe a line ¼in. from the edge all round the levelled surface of your work, and draw lines across the corners, and make half-circles at either end. The wood outside the line and circles is not to be cut, but left level, being for gluing the blocks upon. That inside the lines may now be scooped out until it is only $\frac{3}{16}$in. thick at the edges, but gradually thickening to the centre, where, for the present, it may be left quite ⅜in. thick.

In the case of the belly, you can tell to a nicety whether you have attained regularity by frequently holding it up *close to a strong light*. It can thus easily be seen whether there is a thick patch here and there, and if so, a few touches of the scraper will reduce it until there is a perfectly even appearance through the wood. With the back of a violin, however, the light test is not available, owing to the greater opacity of the wood, and the extra thickness it is necessary to leave there.

It must not be imagined that because the inside work of your instrument will be out of sight it can be carelessly done. It must be scraped and sandpapered with the same amount of pains that you bestowed on the outside surface.

The Blocks, which are of deal, may now be prepared. They should be 1¼in. in height, the grain running at right angles to the plane of the instrument. The top block in which the neck is to be inserted should be 1¾in. by ¾in.; that at the lower end, which receives the tail-pin, may be somewhat smaller, say 1½in. by ½in. The corner blocks are not so easily manipulated. Prepare four bits of deal the same height as the end blocks, and from 1in. to 1¼in. square. Cut two of the sides so as to exactly correspond to the scribed line at the corners. The hollows, which should be carefully made, may be finished off with a piece of glass-paper wrapped on a round rule, or other piece of wood having the desired curve. Pains must be taken to make them stand *exactly* at a right angle to the back, because you are going to build your instrument without a mould, which was the practice with several good Italian makers. Leave the inner portion of the corner blocks in the square form as in Fig. 20, as they will be useful in clamping on the sides. The two end blocks should be left rectangular with the same view. The dotted portion can afterwards be cut away, and the end blocks rounded with the chisel after the sides have been attached. Having glued on the blocks, put the work aside and let the glue set. You can in the mean time take in hand—

The Ribs or Sides.—In purchasing the wood for a violin, you will receive a "set" of ribs.

These are three strips of maple which should match the figure of the back as well as possible, about 15in. long, 1½in. wide, and about $\frac{1}{16}$in. thick. One of the strips will, when cut in half, make the ribs for the two upper or shoulder curves; the others will make a waist curve and a lower curve each. As they are generally rough from the saw, both sides will have to be well scraped, and glass-papered to a smooth surface. This will, of course, reduce them in thickness, which is all the better, as they will be much easier to bend to the shapes required. The edges of the ribs may be made perfectly smooth by sliding them to and fro on a sheet of glass-paper which is lying on a flat surface. The bending them to the proper curves is a matter which will test the patience of the amateur violin-maker to the utmost degree. It is an operation which must not be hurried, or the ribs will break in the most provoking manner. The bending iron must be got to a degree of heat so that water dropped upon it will fly off with a hiss. The ribs for the waist curves should be built up first, and having got them quite smooth and clean, thin down still a little more at each end, where the sharpest curves will be, and the work will be all the easier. It will further assist if you moisten the surface you are going to place inside the violin with cold water. Then place the dry side on the hot iron, and press *very slightly* on the rib with a piece of wood, moving or sliding the rib to and fro continuously to prevent it scorching. In due time you will find the rib will begin to yield.

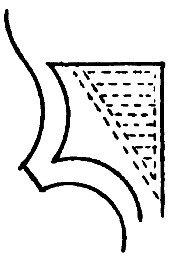

FIG. 20.

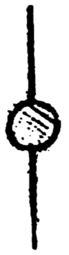

FIG. 21.

Try it frequently between the corner blocks until it assumes the curve of the scribed line, and fits the hollowed part of the blocks, and when it has reached that stage, apply the glue, and clamp in position, leaving the projecting ends to be dealt with afterwards. Proceed in the same manner with the rib of the opposite waist-curve. When both have set hard and firm, take your sharpest knife and carefully pare off the projecting ends *in such a manner* that the other ribs, when in position, will fit up to them so as to leave the joints scarcely visible. At the lower block an accurately-made joint should occur just where the tail-pin hole has to be bored (Fig 21). In the case of the upper block there is no necessity to trouble about a joint, as that portion will have to be cut away for the insertion of the neck. After the sides have firmly set, they will have to be levelled to the height of the blocks. Many of the good makers reduced the depth of the sides towards the upper block by about $\frac{3}{32}$in.; but the amateur need not attend to this point in his first attempt unless he pleases.

The ribs having now been got into position on the back, the superfluous wood of the corner blocks may be cleared away with a chisel, and the two end blocks cut smoothly into a semicircular form. Our amateur can then turn his attention to

The Side Linings.—These are strips of deal ¼in. wide and $\frac{1}{16}$in. thick. At many of the tobacconists long spills are to be bought, at about 3d. per bundle, which, being of regular shape, will answer admirably. Put a handful of these into cold water, and let them soak. When pliable, wipe them as dry as you can, and you may get them to the required shape without the intervention of the bending iron. Put them into position all round the lower side of the ribs, and close up to the back; hold them there by means of the little wooden clips before described, and stand aside till dry. They will then be found to have acquired the desired curvature, and may be glued in, using the clips again till set. Repeat this operation with the linings for the upper edges, and when all have set firmly pare off a bevel on the *inside* edge of each lining, and finish with glass-paper.

(*To be continued.*)

CHEMISTRY FOR STUDENTS.

By JOHN MILLS.

Author of "Alternative Elementary Chemistry," &c.

CHEMISTRY is a branch of science which, above all others, demands that extensive experiment and close observation should be accompanied by careful reading and deep thinking in order to clearly comprehend the mysteries which have been revealed by workers in this department of knowledge. The votaries of chemistry meet with a never-ending series of sudden and striking transitions in the condition of matter such as are well calculated to incite the mind to action and inspire the marvellous. For example, different gases may be brought together, resulting in the formation of solid bodies; colourless liquids may be mixed with each other so as to produce solids of almost every hue. The most refractory bodies can be dissolved in suitable liquids, and again recovered in the metallic form by processes known to the chemist, and cold bodies, after acting on each other chemically, sometimes develop a surprising amount of heat. These changes and transformations are so complete and magical, that formerly the so-called *alchemists* fostered the idea that it might be possible to find out a means of transmuting the common metals into gold, and so discover what was termed the *Philosopher's Stone.* At the present time chemistry is a powerful and indispensable factor in the manufacture of a great many of the conveniences of life we now enjoy, which were not accessible to our forefathers on account of their inferior knowledge of this branch of science.

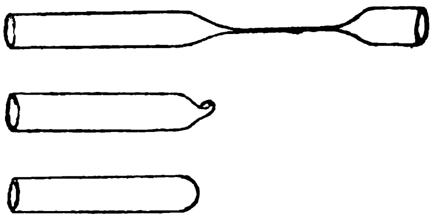

FIG. 1.

Object of Chemistry for Students.

In writing a series of articles on this subject, no previous knowledge of the science is assumed, and our aim throughout will be to teach the subject by a constant appeal to a number of carefully studied experiments arranged in such a way that every reader of the ENGLISH MECHANIC, who desires some knowledge of chemistry, either as a means of education or for practical utility, may, by reading the numbers as they appear, and following our instructions in the working details, act as his own instructor. No amount of reading or oral teaching can be so impressive as, or compensate for, actual experiment and observation, in the course of which all the five senses are taken advantage of to assist the memory. The articles will be illustrated by a large number of neat outline drawings of the actual apparatus employed in performing the experiments, and these illustrations will embody the fruits of a distinct effort recently made by the Science and Art Department to render the teaching of practical chemistry possible with a minimum outlay in apparatus and materials. The syllabus of inorganic chemistry—*first stage*—is to be the basis of our remarks, in the course of which every care will be taken to advance matter of a thoroughly scientific and trustworthy character, so that readers who follow us may, during the coming winter, lay a safe foundation for further studies in this very interesting science. Here is our syllabus:—

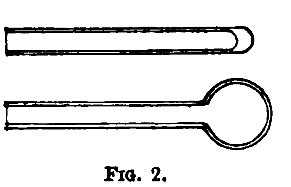

FIG. 2.

Subject X.—Inorganic Chemistry.
Theoretical.

Students are at liberty to use any recognised system of nomenclature or notation in the examinations.

FIRST STAGE OR ELEMENTARY COURSE.

Illustrations and examples of chemical action. Indestructibility of matter. Simple and compound substances. Laws of chemical combination in definite and multiple proportions. Dalton's atomic theory. Principles of chemical nomenclature. Symbolic notation. Formulæ and equations. Calculation of the quantities by weight taking part in reactions. Division of elements into metals and non-metals. Graphic notation so far as is necessary to explain the constitution of the following compounds:—Hydrochloric acid, water, sulphuretted hydrogen, ammonia, and carbon dioxide (carbonic anhydride).

French and English weights and measures. Calculation of the weight and volume of gases at the standard temperature and pressure.

Hydrogen.—Its preparation and properties.

Chlorine.—Its preparation and properties. Hydrochloric acid: its preparation and properties, also its analysis and synthesis.

Oxygen.—Its preparation and properties.

Ozone or Allotropic Oxygen.—Its preparation, properties, and constitution.

Water.—Its formation, properties, and composition. Determination of composition by analysis and synthesis.

Sulphur.—Its properties, occurrence in nature, and allotropic modifications. Sulphuretted hydrogen: mode of preparation, properties, and composition of. Oxides of sulphur: modes of preparation, properties, and composition of. Sulphurous acid and the sulphites. Sulphuric acid and the sulphates: properties, and composition of, tests. Properties common to acids in general.

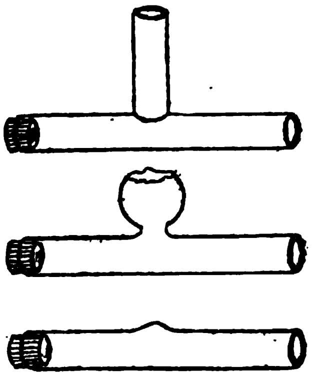

FIG. 3.

Nitrogen.—Preparation and properties. Nitrous and nitric oxides: composition, properties, and mode of preparation. Nitric acid and the nitrates: composition, properties, and tests. Ammonia: composition, preparation, and properties. The atmosphere: its constitution; effects of animal and vegetable life upon it. Its composition as regards oxygen and nitrogen, and how determined.

Carbon.—Occurrence in nature, allotropic forms of; properties of. The two compounds of carbon and oxygen. Carbonates, composition and properties of.

Students who attend science classes, and work under the supervision of a good teacher, will have but little difficulty in learning how to fit up chemical apparatus; but there are thousands of intelligent readers of the ENGLISH MECHANIC who, from one cause or another, are unable to avail themselves of such advantages, and it is mainly for the benefit of this section of readers that we are new writing. Many of the very best practical chemists, past and present, have learnt chemistry without a teacher, and we would recommend those of our readers who may desire to adopt a similar course, to paste out the sheets of instruction on foolscap as they appear, follow our directions to the letter in the execution of the working details, and ponder patiently and persistently over what is pointed out as the lesson to be taught by each experiment performed. An hour or two spent in this way each evening for a couple of months will be sufficient to insure to any artisan a safe passage through the examinations of the Science and Art Department in elementary chemistry. The greater number of the experiments may be performed with glass apparatus costing only a few shillings, and this may be obtained at Beckers, 33, Hatton-wall, London, E.C.; Woolley and Sons, 69, Market-street, Manchester; and at Baird and Tatlock's, 100, Sauchiehall-street, Glasgow. It is essential at the outset that the student should be able to work glass to a certain extent, and we therefore now offer a few preliminary remarks on this subject.

To Cut a Glass Tube.—The glass tube should be held in the left hand and laid firmly upon the edge of a table or bench; then, taking a three-cornered file in the right hand, and giving one long and steady cut with it, guiding the file with the thumb-nail of the left hand, it is only necessary to hold the tube horizontally between the fingers of both hands, giving at the same time a slight pull inwards and outwards in order to break the tube in case it is not very thick. For very thick tubes it is necessary to repeat the cut with the file several times in the same place; it should then be held across the chest and pulled as much outwards and as little inwards as possible. The sharp edges of the glass tubes so cut, before being connected with indiarubber tubing or put through corks, should have their ends smoothed. To do this, the tube should be held obliquely in the flame of the spirit-lamp, and turned round and round until the edges of the glass tube are fused. The edges may also be smoothed by filing with a hard file.

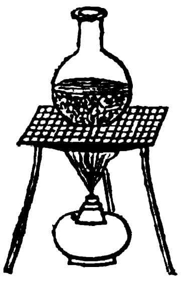
Fig. 4.

To Bend a Glass Tube.—Hold the tube lightly between the fingers, and warm gradually that part of the tube to be bent, in a broad gas-flame, turning it round constantly at the same time. When two or three inches of the tube have become softened it should be allowed to fall gradually by its own weight, the hand holding the tube being raised or lowered, just as occasion requires. A little practice will soon give the pupil sufficient judgment to see exactly what to do in each particular case. Tubes which have been bent so quickly become flattened in the bend, and are frequently creased, so that they are pretty sure to break there. (Fig. 1.)

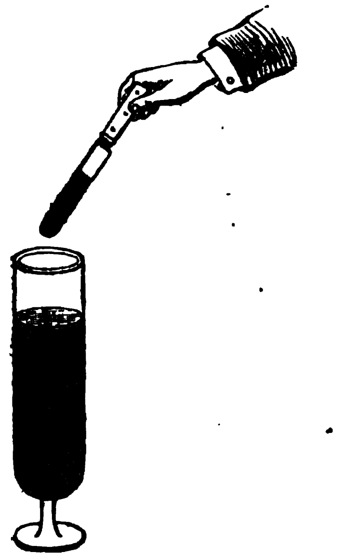
Fig. 5.

To Close the End of a Glass Tube.—The tube should be first softened near the end in the flame of a spirit-lamp or a candle, then drawn out with the hand and broken; the tail so formed should be heated again in the flame and drawn off time after time, till, when on melting, it runs up, making the end of almost the same thickness as the rest of the tube. When the end is red-hot it may be smoothly rounded off by moving it from the flame and gently blowing into the open end. In order to obtain the necessary temperature to do this the mouth-blowpipe should be employed. To blow a bulb on the end of the tube so closed, a good thickness of glass should be fused at the end before blowing in at the open end. A bulb may be blown in the middle of a tube by corking one end, heating the tube in the middle while the ends are lightly pushed together, and then blowing into the open end.

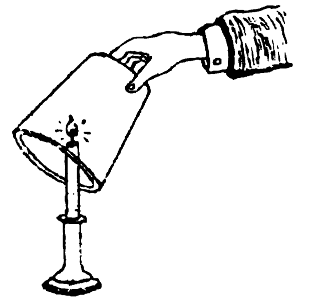
Fig. 6.

To Join Tubes Together.—To join the tubes end to end they should be cleanly cut, the flat ends softened in a flame, and then gently pressed together. While the glass is still soft, a slight pull outwards may be given to render the joint more uniform in thickness, and the cylindrical shape may be further restored by stopping one end of the tube with a cork and blowing down the open end. To make a T-joint, one end of one of the tubes is closed with a cork, and the point of the blowpipe flame directed to one side, so that by blowing a slight elevation is obtained. This operation of heating and blowing being repeated a few times, enables the operator to blow a hole in the tube. The thin glass is then removed, and the edge of the hole smoothed and softened in the flame, one end of the other tube being simultaneously softened, then applied to the hole, and fused on as before.

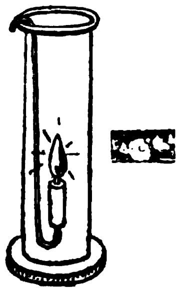
Fig. 7.

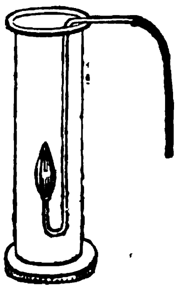
Fig. 8.

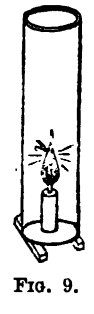
Fig. 9.

To Use the Blowpipe.—The breath should be sent from the cheeks and not from the lungs. To do this the lungs should first be filled with air and the cheeks blown out, then, keeping up the supply of fresh air by breathing through the nose, the blast is kept up by forcing air from the mouth by the contraction of the muscles of the cheeks. The middle part of the blowpipe-flame is called the reducing flame, and the outer part is called the oxidising flame. By the use of the blowpipe and a candle-flame a temperature may be obtained high enough to cause thin iron wire to burn with scintillations or sparks.

Experimenting.—To perform any experiment well, it is necessary to pay attention to every detail, no point, however insignificant, should be disregarded. A badly-fitting cork may be the cause of a failure in testing the properties of some gases, while in others such a fault might lead to serious explosion; as, for example, in the preparation of hydrogen, a gas which is explosive when mixed with air. Corks should be rolled under a board upon a table to soften them previous to fitting to the neck of a flask or a bottle; by this means they become more pliable, and render the vessels air-tight. Cleanliness is of prime importance. Besides the offence that dirt gives to the senses, it obscures the effect of many experiments, and thus gives a false impression to the student. A teacher who has to perform the experiments before a class should either have a thorough acquaintance with the subject or try his experiments over before he meets his class; otherwise he will find himself often disappointed. He should be sure that the stoppers of all bottles to be used during a lesson are not fixed, because such a circumstance is often the cause of much delay, and in many cases of absolute failure. In those experiments where a balance has to be employed, it is absolutely necessary that the most scrupulous care be taken in weighing. It is plain also that in showing the difference in weight between air and certain gases the balance must be most carefully equipoised, because the difference is so small that it might not be rendered apparent, whereas, if the necessary care be taken, failure is impossible.

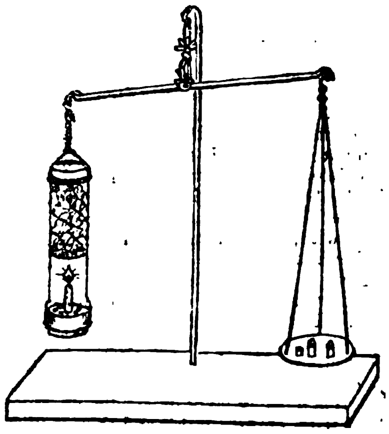
Fig. 10.

Province of Chemistry.—Chemistry is that branch of science which treats of the changes which take place between different bodies, so as to produce other bodies entirely different in properties from the originals. For example, if some flowers of sulphur and copper filings be well mixed the mass will acquire a greenish tint. However, no permanent change takes place in either the copper or sulphur. By the aid of the microscope the particles of each substance may be seen lying side by side, and they may be effectually separated by throwing on water, which will wash away the lighter sulphur and leave the heavier copper behind. Now put some of the mixture in a small flask, place on a tripod stand, and apply heat with a spirit-lamp (Fig. 4.) In this way the red copper and yellow sulphur are made to undergo a permanent change, which results in the formation of a black compound called *copper sulphide*, possessing properties entirely unlike its constituents. Before heating, the copper and sulphur existed as a *mechanical mixture*; but on the application of heat, a deep-seated change ensued due to the *chemical combination* of the two materials.

On the other hand, we may resolve or split up certain substances into two or more less complex substances. Thus, by heating chalk or limestone strongly in a fire, a gas called *carbon dioxide* is expelled, and calcium oxide (*quicklime*) remains behind. These bodies possess properties totally unlike the original chalk or limestone, inasmuch as the latter effervesces or fizzes when weak acid is poured on it, while quicklime, under similar treatment, does not fizz; further, the lime turns a moistened red litmus paper blue when pressed against it surface, whereas limestone has no such action: in this case the substance under treatment is said to have suffered *chemical decomposition*.

Again, dissolve some blue vitriol (*copper sulphate*) in water, dip a bright knife into the solution, and allow it to remain therein for a few minutes. A coating of red copper will thus be deposited upon the knife-blade (Fig. 5), the latter having expelled or displaced the copper from the liquid, its place being taken by a portion of the iron, which dissolves, and forms a solution of green vitriol (*ferrous sulphate*).

It is the province of the chemist to study such permanent changes in the conditions of matter, observe the properties of the new bodies formed, and find out the exact conditions under which chemical action is brought about in each particular case under consideration. The reader will readily perceive a fundamental difference in the merely temporary effects obtained by placing a hot body in contact with a cold one; the latter, of course, on removal, soon returns to its original temperature without having undergone any alteration in properties or composition. We may make iron expand by raising its temperature, thus: Take two blocks of wood, cut a notch in one, and let one end of a thin rod of iron rest in the notch, the other end resting on a stem of straw placed on the plain surface of the second block of wood. Stick a needle vertically in the straw, and then heat the iron rod by means of a spirit-flame. The rod will expand, and the free end, moving outwards, will roll the straw on the wooden block, as may be plainly indicated by the motion of the needle, which serves as an index. On removing the source of heat, the rod returns to its original length. This, and similar temporary effects, are classified as *physical changes*.

Combustion and Chemical Combination.—When a candle burns in air, it slowly diminishes in size until at last not a particle remains. In popular language, it is then said to have been consumed or annihilated. What has become of the candle? Is it possible to destroy or reduce its substance to nothing? It is our business to point out how suitable replies may be given to these queries. To begin with, if the materials of the candle still exist, they must be in the gaseous form, and we shall have to contrive some arrangement for examining the products of combustion, if such there be. Take a dry and bright glass tumbler, hold it over a burning candle (Fig. 6), and note the deposition of moisture, which quickly condenses on, and dims the surface of the cool glass. Again, stick a short piece of candle on the end of a bent wire, apply a light, and then lower into a gas-jar (Fig. 7). The candle continues to burn for a time, but soon begins to languish, and finally the flame dies out. Now remove the candle from the jar, pour in a little lime-water, cover the jar with the band, and shake well. A milky turbidity forms in the lime-water, thus showing that there is something else than air in the jar, for the same volume of air will not render lime-water turbid. This new product is carbon dioxide, commonly called carbonic acid, and is a body which will not burn or permit other bodies to burn in it. We thus see that water vapour and carbon dioxide are produced when a candle burns in air, and that both these products of combustion are ordinarily invisible, but that their existence may be verified by a couple of simple experiments. By soaking cotton wool with paraffin oil or methylated spirits, fastening it on the end of a bent wire, and burning as before, we may show that the same products are formed as when a candle burns; similarly, by attaching one end of an indiarubber tube to an ordinary gas-burner, and the other to a bent glass tube, drawn out at one end to a fine jet (Fig. 8), we may burn coal-gas in a jar, and show that carbon dioxide and water are the products, as before.

Combustion is really a chemical process consisting of the combination of the particles of the combustible body with a gas called *oxygen*, which is contained in the air. The tallow candle, paraffin oil, methylated spirit, and coal-gas all contain carbon and hydrogen, and these bodies, by union with the oxygen of the air, give rise to the chemical compounds carbon dioxide and vapour of water. Oxygen is the active body in causing substances to burn, and in order that the chemical action may continue between the burning body and the oxygen of the air, a constant supply of air must be kept up. Place a glass chimney over a burning candle, the flame soon dies out; whereas if supported on two pieces of wood, as indicated in Fig. 9, the candle will burn completely away. In the first case access of air is cut off, and in the second a continuous supply of air is admitted.

Matter is Indestructible.

Examining these new products still further, it may be demonstrated that their total weight is in excess of the body burnt—that is to say, the weight of the oxygen which has entered into combination has been added to that of the candle, for example. We may devise means for conclusively showing that an actual increase in weight does take place when combustion occurs. Thus, push a piece of wire gauze into an ordinary glass chimney, and fill the upper half of the latter with lumps of caustic soda and a few pieces of lime. Support a small piece of candle on a cork pierced with holes, and fit the cork into the lower end of the chimney. Now counterpoise the apparatus on the beam of an ordinary apothecary's balance (Fig. 10), and when this has been done, withdraw the cork, light the candle, and replace in the tube. As the candle burns, the water and carbon dioxide formed are absorbed by the caustic soda and lime, and a deflection of the scale beam indicates that the whole apparatus has increased in weight. From this, and numberless other experiments, the chemist has been enabled to enunciate the following grand truth, namely—

Matter is indestructible. We may, under suitable conditions, bring about changes in its form and properties; but we cannot increase or diminish its quantity.

(*To be continued.*)

IMPROVED MITRE-CUTTING MACHINE.

A HANDY tool has been patented by Mr. A. E. Mackett, of Bristol, for quickly and accurately cutting the mitre upon picture-frame mouldings, using an ordinary plane iron as cutter; by simply removing a pin and sliding out the cutter, the shoe forms a cramp for holding the frame in position whilst securing the corners. Fig. 1 is a side elevation, Fig. 2 a plan, and Fig. 3 a perspective view of the machine showing cutter—viz., an ordinary plane iron with back iron removed, in position for cutting mitres at an angle of 45°. The machine comprises a frame or shoe of the particular construction as shown in the annexed drawings, and indicated by A, having two vertical side cheeks in the front bevelled at an angle of 45° to the base or sole of the machine, to which are attached by means of set screws B, angle pieces C, and being set at such a distance above the bevel upon the front side cheeks as to allow an ordinary plane iron to slide accurately in the groove formed thereby. The back end of shoe is provided with two uprights upon which to pivot hand-lever D. The hand-lever to be of suitable length and provided with a plunger E, pivoted as indicated at F, being provided with a pin H, to engage in the circular hole usually provided in plane irons. The hand lever works in a vertical plane and directly over centre of machine. The front side cheeks are provided with set screws, I, for clamping material to be operated upon to prevent possibility of recoil whilst the cutting action is being proceeded with. The sole plate or bed of machine is provided with bearing strips, J, to facilitate the truing up of the front side cheeks to the angle of 45°. The machine is most conveniently used by being screwed down to the top of a bench, the moulding upon which it is desired to cut the mitre being placed upon the bearing strips J.

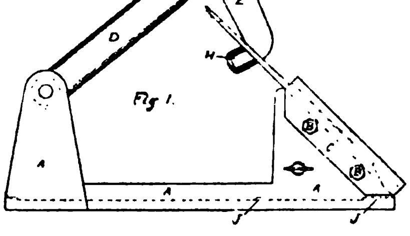
Fig 1.

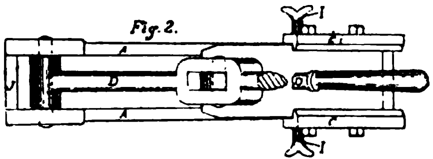
Fig. 2.

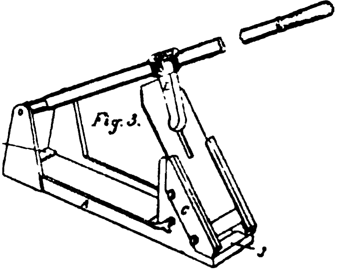
Fig. 3.

TALKING WITH THE STARS.

WHEN Prof. George Davidson, of the Davidson Observatory and the Coast and Geodetic Survey, was shown the Paris cablegram saying that an old lady had just died at Spa, leaving 100,000fr. as a prize to the astronomer, French or foreign, who within ten years shall be able to communicate with any planet or star, he read it through slowly once, then he read it twice more rapidly. Finally (says the *San Francisco Examiner*), he picked it up, held it at the proper distance from his eyes, and squinted at it just as he would squint at Mercury through his telescope if he wanted to find the big tortoise-shaped spot on its northern hemisphere. "An old lady! an old lady!" the astronomer finally exclaimed. "Now, isn't that a pretty way to treat such a piece of philanthropy as that? An old lady, indeed! Now, why under the sun do you suppose they keep back her name? I am inclined to believe that some good-looking young man—one of these smooth talkers—has been getting close to her and talking a lot of astronomy into her ear. From the very form her bequest takes I am aware that somebody—Flammarion or some other man—has been talking to her about the proposed triangle. The project is a very curious one, but can be explained quite easily."

Prof. Davidson picked up a blue pencil and drew on a white sheet of paper a right-angled triangle. "This that I have drawn," he said, "is the old triangle of Pythagoras." That triangle has a right angle, and the square, built upon the side opposite the right angle is equal to the sum of the squares built upon the other two sides. The proposition is said to be the fundamental one of geometry. It has been proposed to draw such a figure as that in the Desert of Sahara, or some other great plain, the lines, of course, to be hundreds of miles long, and made so that they would be distinct in the desert sand. One way would be to plant palm trees, so that the forests would take the shape of lines in the figure. Certainly the green of the palms would be so bright in the contrast with the white of the sand that the drawing, when completed, would be plain enough. These are the suppositions that go along with the idea. It is supposed that there are people on some of the planets, at least on Mars. It is supposed that the people on the planet are civilised and capable of looking through telescopes, and it is concluded that if this is so, they must know the Pythagorean proposition. So, if the people of Mars look through their telescopes at the earth, they will be sure to see that enormous figure on the desert, and seeing it they will realise that the earth is inhabited by men of knowledge, and that the drawing is a signal. Then of course they will set to work to answer it by building just such a figure on Mars. That will be talking from star to star.

"But all this is bosh and nonsense to me, and I daresay it was bosh and nonsense to the man who wheedled the Frenchwoman into setting aside her 100,000f. But whoever he was, he knew on which side his bread was buttered, and knew that such a trust, for whatever purpose, would bear interest. But even supposing that the Desert of Sahara is one great plain, and that it is large enough for the purpose, and even supposing that it was possible to make such an enormous figure, I am in doubt whether the people on Mars, with such telescopes as we use, would be able to see it. At certain times Mars is but 34,000,000 miles from the earth; but it gets further and further away, until the distance is 61,800,000 miles. That is a good way off to see triangles. But if Mars is inhabited I am inclined to believe that the inhabitants are not fools. If they saw a triangle-shaped object on the face of the earth they would not jump to the chimerical conclusion that there were idiots enough down here to build such an affair. The truth is, we do not know whether any of the planets besides the earth are inhabited. We think we know that it might be possible for men to live on Mercury. The situation and condition of things on the other planets are altogether different from those on the earth. So when we talk about the inhabitants of the planets we enter the realm of surmise, and M. Jules Verne has a better chance than the scientist. The four planets nearest the sun are Mercury, Venus, the Earth, and Mars. Mercury is only 35,392,000 miles from the sun, which is not very far when you take the heat into consideration. Consequently we believe it is a good many times hotter than Arizona on Mercury. There are other disadvantages, such as a lack of space, enormous mountains, and no certainty of atmosphere. Mercury is only 3,060 miles in diameter, yet there are mountains on its surface over 12 miles high.

"Venus is 66,134,000 miles from the sun, and is plenty hot enough, although nearly twice as far as Mercury from the great heater. Then there is some question about the atmosphere as yet, and the year is only 224 days long. The earth comes next, being 91,430,000 miles from the sun. After this planet is Mars, 139,311,000 miles from the luminary. All astronomers admit that if people like those on the earth live on any of the other planets, Mars is probably the one. The reason why is easy to tell. Although Mars is further from the sun than the Earth, his orbit is so eccentric that at certain times he is only 126,318,000 miles away, consequently the temperatures are likely merely a little more moderate than those on the earth. Then, too, the diurnal motion of the two planets is about the same, so that from one year's end to another the distance from the earth to Mars varies only from 33,800,000 miles to 61,800,000 miles. Mars has its seasons and its polar ice just like the earth. Through the telescope we can watch icefields at the poles get larger as winter approaches, and see them get smaller again in the summer. Mars has an atmosphere and clouds like those on earth. There are continents and oceans on Mars, so that altogether the analogy between that planet and the earth is very close, the striking difference being that Mars is much the smaller. Astronomers are more and more disposed to believe that Mars is inhabited. You ask me if we know, however, and I promptly tell you we do not. An astronomer named Schiaparelli claims he is able to see a double line of canals on Mars. These must be enormous works if he can see them, and must represent a stupendous amount of work on the part of an almost countless number of people. I cannot see them through my telescope, and many others fail. After all, these canals may be in Schiaparelli's eye. People get what is called astigmatism nowadays, and see two pencils where there is only one. Perhaps that is what Schiaparelli has. But even if there are people on Mars, and even if they have built canals, as for talking with them (and the professor repeated the statement to make it more positive)—as for talking with them, nonsense!"

MUSICAL INSTRUMENTS: THEIR CONSTRUCTION AND CAPABILITIES.—IV.*

VALVES were invented and first introduced in Prussia about A.D. 1815. At first there were two, but there are now generally three. In this country and France they are worked by pistons, which, when pressed down, give access for the air into channels or supplementary tubings on one side of the main bore, thus lengthening it by a tone for the first valve, a semitone for the second, and a tone and a semitone for the third. When released by the finger the piston returns by the action of a spring. In large bass and contralto instruments a fourth piston is added, which lowers the pitch two tones and a semitone. By combining the use of these valves lower notes are obtained. Thus, for a major third, the second is depressed with the third; for a fourth, the first and third; and for the tritone the first, second and third. But the intonation becomes imperfect when valves are used together, because the lengths of additional tubing being calculated for the single depressions, when added to each other, they are too short for the deeper notes required. By an ingenious invention of compensating pistons, Mr. Blaikley, of Messrs. Boosey's, has practically rectified this error without extra moving parts or altered fingering. In the valve section each altered note becomes a fundamental for another harmonic scale. In Germany a rotary valve—a kind of stop-cock—is preferred to the piston. It is said to give greater freedom of execution, the closeness of the shake being its best point, but is more expensive and liable to derangement. The invention of M. Adolphe Sax, of a single ascending piston in place of a group of descending ones, by which the tube is shortened instead of lengthened, met, for a time, with influential support. It is suitable for both conical and cylindrical instruments, and has six valves, which are always used independently. However, practical difficulties have interfered with its success. With any valve system, however, a difficulty with the French horn is its great variation in length by crooks, inimical to the principle of the valve system, which relies upon adjustment by aliquot parts. It will, however, be seen that the invention of valves has, by transforming and extending wind instruments so as to become chromatic, given many advantages to the composer. Yet it must, at the same time, be conceded—in spite of the increasing favour shown for valve instruments—that the tone must issue more freely and with more purity and beauty from a simple tube than from tubes with joinings and other complications that interfere with the regularity and smoothness of vibration, and, by mechanical facilities, tend to promote a dull uniformity of tone-quality.

Owing to the changes of pitch by crooks, it is not easy to define the compass of the French horn. Between C in the bass clef and G above the treble, will represent its serviceable notes. It is better that the first horn should not descend below middle C, or the second rise above the higher E of the treble clef. Four are generally used in modern scores. The place of the horn is with the wood-wind band. From Handel, every composer has written for it, and what is known as the small orchestra of string and wood-wind bands combined, is completed by this beautiful instrument.

The most prominent instruments that add to the splendour of the full orchestra are trumpets and trombones. They are really members of one family, as the name trombone—big trumpet—implies, and blend well together. The trumpet is an instrument of court and state functions, and, as the soprano instrument, comes first. It is what is known as an 8ft. instrument in pitch, and gives the different harmonics from the third to the twelfth and even to the sixteenth. It is made of brass, mixed metal, or silver, and is about 5ft. 7in. in real length, when intended for the key of F without a slide, but is twice turned back upon itself, the first and third lengths lying contiguous, and the second about two inches from them. The diameter is three-eighths of an inch along the cylindrical length; it then widens out for about fifteen inches to form the bell. When fitted with a slide for transposition—an invention for the trumpet in the last century—this double tubing, about 5in. in length on each side, is connected with the second length. It is worked from the centre with the second and third fingers of the right hand, and, when pulled back, returns to its original position by a spring. There are five crooks. The mouthpiece is hemispherical and convex, and the exact shape of it is of great importance. It has a rim with slightly rounded surface. The diameter of the mouthpiece varies according to the player and the pitch required. With the first crook, or rather shank, and mouthpiece, the length of the trumpet is increased to 6ft., and the instrument is then in the key of F. The second shank transposes it to E, the third to E flat, and the fourth to D. The fifth, and largest—2ft. 1¼in. long—extends the instrument to 8ft., and lowers the key to C. The slide is used for transposition by a semitone or a whole tone, thus making new fundamentals and correcting certain notes of the natural harmonic scale, as the seventh, eleventh, and thirteenth, which do not agree with our musical scale. Mr. W. Wyatt has recently taken out a patent for a double-slide trumpet, which possesses a complete chromatic scale. In the required length of slide the ear has always to assist. It is clear that the very short shifts of a double slide demand great nicety of manipulation. It is, of course, different with the valve trumpet. The natural trumpets are not limited to one or two keys, but those in F, E, E flat, D, B flat, and even A have been employed; but usually the valve trumpets are in F, and the higher B flat, with a growing inclination, but an unfortunate one, to be restricted to the latter, it being easier for cornet players. The tone of the high B flat trumpet cannot, however, compare with the F one, and with it the lower notes are lost. Of course, when there are two or three trumpets, the high B flat one finds a place. However, the valve system applied to the trumpet is not regarded with satisfaction, as it makes the tone dull. For grand heroic effect valve trumpets cannot replace the natural trumpets with slides, which are now only to be heard in this country.

The simple, or field trumpet, appears to exist now in one representative only, the E flat cavalry trumpet. Bach wrote for trumpets up to the twentieth harmonic—but for this the trumpet had to be divided into a principal, which ended at the tenth harmonic—and the clarino in two divisions, the first of which went from the eighth harmonic up to as high as the player could reach, and the second clarino from the sixth to the twelfth. The use of the clarinet by composers about the middle of the last century seems to have abolished these very high trumpets. So completely had they gone by the time of Mozart that he had to change Handel's trumpet parts to accommodate them to performers of his own time, and transfer the high notes to the oboes and clarinets.

Having alluded to the cornet à piston, it may be introduced here, particularly as from being between a trumpet and a bugle, and of four-foot tone, it is often made to do duty for the more noble trumpet. But the distinctive feature of this, as of nearly all brass instruments since the invention of valves, tends to a compromise instrument which owes its origin to the bugle. The cornet à piston is now not very different from the valve bugle in B flat on the one hand, and from the small valve trumpet in the same key, on the other. It is a hybrid between this high-pitch trumpet and the bugle; but compared with the latter it has a much smaller bell. By the use of valves and pistons with which it was the first to be endowed, the cornet can easily execute passages of consecutive notes that in the natural trumpet can only be got an octave higher. It is a facile instrument, and double-tongueing, which is also possible with the horn and trumpet, is one of its popular means for display. It has a harmonic compass from middle C to C above the treble clef, and can go higher, but with difficulty. A few lower notes, however, are easily taken with the valves.

We now come to the trombones—grand, soporous tubes—which, existing in three or four sizes since the 16th century, are among the most potent additions, on occasion, to the full orchestra. Their treble can be regarded as the English slide trumpet, but it is not exactly so. There appears to have been, as late as Bach, a soprano trombone, and it is figured by Virdung, A.D. 1511, as no larger than the field trumpet. The trumpet is not on so large a calibre, and in the 17th century had its own family of two clarinos and three tubas. The old English name of the trombone is sackbut. The old wooden cornet, or German zinke, an obsolete, cupped-mouthpiece instrument, the real bass of which, according to family, is the now obsolete serpent, was used in the 16th and 17th centuries as the treble intrument in combination with alto, tenor, and bass trombones. The leading features of the trumpet are also found, as already inferred, in the trombone; there is the cupped mouthpiece, the cylindrical tubing, and, finally, a gradual increase in diameter to the bell. The slide used for the trumpet appears for four centuries and probably longer, in the well-known construction of the trombone. In this instrument it consists of two cylindrical tubes parallel with each other, upon which two other tubes, communicating by a pipe at their lower ends curved in a half-circle, glide without loss of air. The mouthpiece is fitted to an upper end, and a bell to a lower end of the slide. When the slide is closed, the instrument is at its highest pitch, and as the column of air is lengthened by drawing the slide out, the pitch is lowered. By this contrivance a complete chromatic scale can be obtained; and as the determination of the notes it produces is by ear, we have in it the only wind instrument that can compare in accuracy with stringed instruments. The player holds a cross-bar between the two lengths of the instrument, which enables him to lengthen or shorten the slide at pleasure; and in the bass trombone, as the stretch would be too great for the length of a man's arm, a jointed handle is attached to the cross-bar. The player has seven positions, each a semitone apart for elongation, and each note has its own system of harmonics; but in practice he only occasionally goes beyond the fifth. The present trombones are the alto in E flat, descending to A in the seventh position; the tenor in B flat descending to E; the bass in F descending to B, and a higher bass in G descending to C sharp. Wagner, who has made several important innovations in writing for bass brass instruments, requires an octave bass trombone in B flat—an octave lower than the tenor one in the "Nibelungen." The fundamental notes of the trombone are called "pedal" notes. They are difficult to get, and less valuable than harmonics because, in all wind instruments, notes produced by overblowing are richer than the fundamental notes in tone-quality. Valve trombones do not, however, find favour, the defects of intonation being more prominent than in shorter instruments. But playing with wide-bore tubas and their kindred is not advantageous to this noble instrument.

(*To be continued.*)

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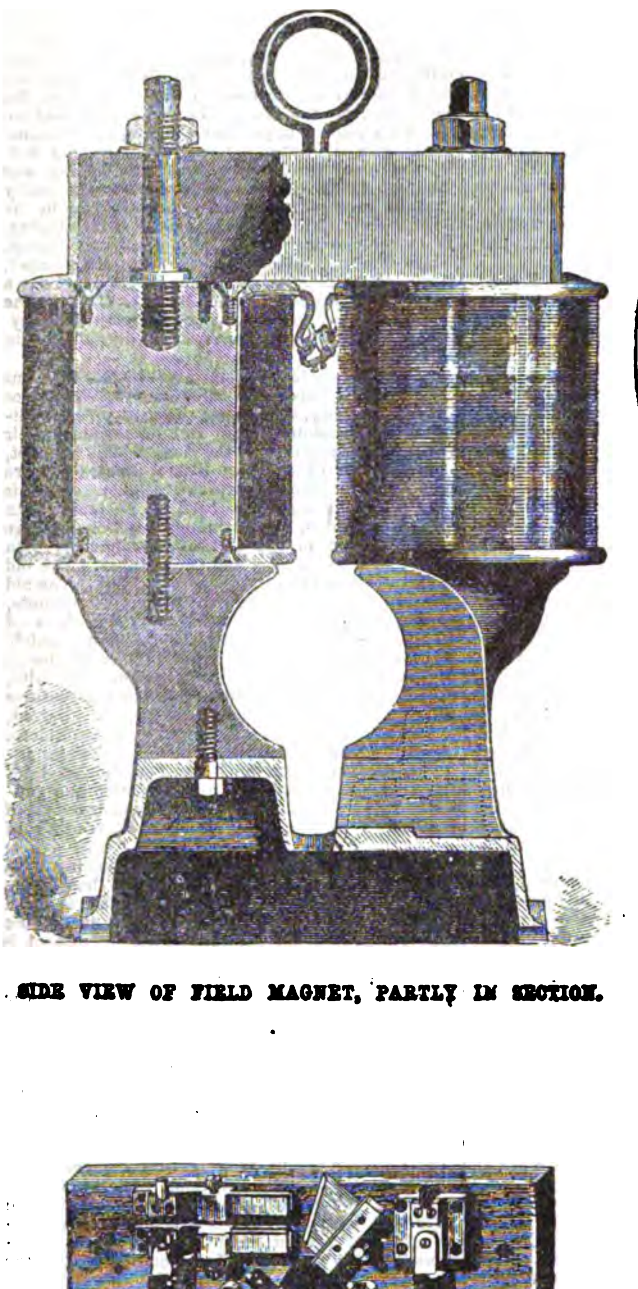
* By A. J. Hipkins, F.S.A. Extracted from a series of Cantor Lectures before the Society of Arts.

THE EDISON DYNAMO AND MOTOR.

THE following description of the Edison machine, which can be used either as a dynamo or motor, is extracted from the *Scientific American*:—

It is one thing to make a dynamo or motor from explicit instructions and quite another thing to design a machine adapted to generate or be operated by a particular current. The former is purely mechanical and within the range of most machinists and amateurs, while the latter is entirely within the province of the electrical engineer or electrician. When the work of machine building proceeds simultaneously with the study of fundamental principles, real progress is made.

The base, which is of brass, is made hollow, as shown. It is 14in. long, 7⅝in. wide, 1¼in. deep at the ends, with two 1⅛in. elevations at the middle



SIDE VIEW OF FIELD MAGNET, PARTLY IN SECTION.

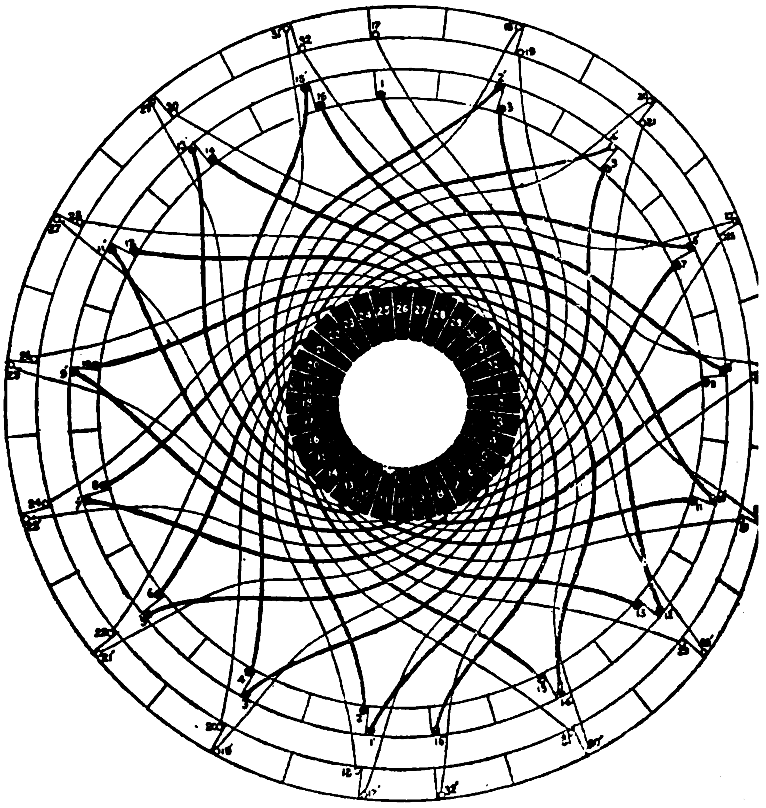


Fig. 1.—DIAGRAM OF WINDING OF EDISON ARMATURE.

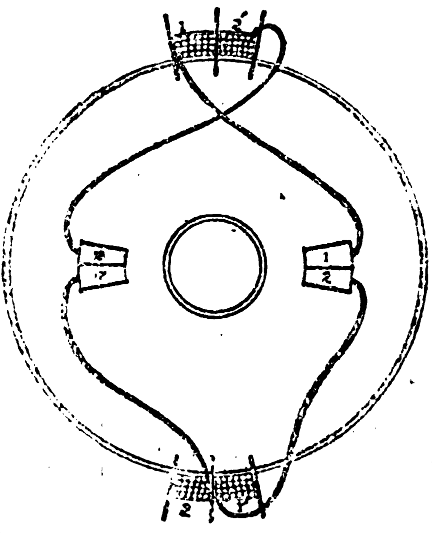
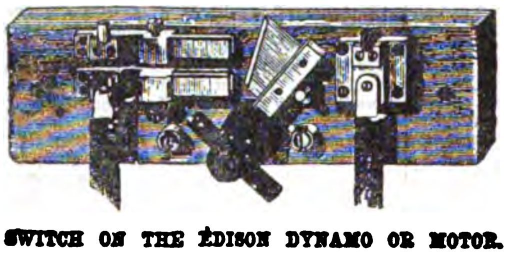


Fig. 2.—THE FIRST TWO COILS AND COMMUTATOR CONNECTIONS.



SWITCH ON THE EDISON DYNAMO OR MOTOR.

for receiving the cast-iron pole-pieces of the field-magnet, which are each secured to the base by two small tap bolts extending upwardly through the base and into the pole-pieces.

The upper surfaces of the pole pieces are truly faced for receiving the cylindrical field-magnet cores, which are made of Swedish iron, 2⅝in. in diameter, and 4½in. long. These magnet cores are each held in position by a threaded stud screwed into the pole piece and entering magnet core. Each core is provided with a vulcanised fibre collar at each end, which is ¼in. thick and ⅞in. wide. Upon each core, and between the fibre collars, is wound 5¼lb. of No. 24 silk-covered copper wire, with a wrapping of thin varnished paper between the layers. The cores, before winding, are thoroughly insulated with the same material. The fibre collars are each held in place by three conical-headed screws entering the end of the core, with their heads projecting beyond the body of the core. To the inner and outer ends of the winding of each arm of the magnet are attached pieces of larger wire to avoid breakage, and the inner ends are led out through grooves in the fibre collars. The yoke, of Swedish iron, is 2⅝in. wide, 2⅛in. thick, and 7½in. long. It is held in position on the cores by two ½in. bronze studs, each threaded at the upper and lower ends, and furnished with a collar which fits into the counter-bored part of the hole in the yoke. The studs are squared at the upper end to receive a wrench, and a nut is placed on each stud above the yoke for clamping it securely after adjustment. The machine is regulated or adapted to any work requiring less than its full power by raising the yoke more or less. The yoke is provided with an eye, by means of which the machine may be lifted. Front and rear boards of mahogany are arranged on opposite sides of the yoke, and held in place by brass plates at the ends. The outside ends of the field-magnet coils are connected with binding posts on the rear board.

A variable resistance of 10 or 15 ohms is inserted between these posts when the machine is used as a dynamo. In the front board, at the right hand side, is secured a bronze casting known as the right-hand motor head field magnet terminal. This is adapted to receive the line wire, also one of the leads, the upper end of which is screwed to the casting. The lower end of the lead is secured to a lead terminal attached to a block of wood secured to the right-hand pole piece. At the right-hand side of the machine a similar arrangement of the lead is found; but the upper lead terminal is made in two separate parts, one attached to the lead, the other being connected with the line, both being furnished with copper-switch tongues. The switch arm turns on a stud projecting from the front board, and carries a loose triangular switch plate of copper, having a knife edge, which readily enters between the switch tongues. The switch has a T-handle of hard rubber, by means of which it is turned. A stop-pin projecting from the front board limits the rearward movement of the switch arm.

The inside end of the right magnet coil is connected with the right-hand lead, and the inside end of the left-hand magnet coil is connected with the lower half of the left-hand lead terminal.

At opposite ends of the base there are plane surfaces to which are secured the self-oiling bearings of the armature shaft. Each bearing has a hollow standard furnished with a cap, which, together with a cross-piece in the hollow standard, forms a support for the spherical central portion of the bronze sleeve forming the journal box proper.

This sleeve is shorter than the outer portion of the bearing, and is slotted across the top to allow two brass rings to ride upon the armature shaft. These rings dip in the oil in the hollow standard, and as they revolve carry oil to the shaft in quantities more than sufficient for the purpose of lubrication. The oil is distributed throughout the gearing by means of spiral grooves formed in the inner surface of the journal box. The surplus oil drops back into the hollow standard. A screw plug in the lower portion of the standard allows of the renewal of the oil. The bearings at opposite ends of the machine are alike, except that the cast-iron

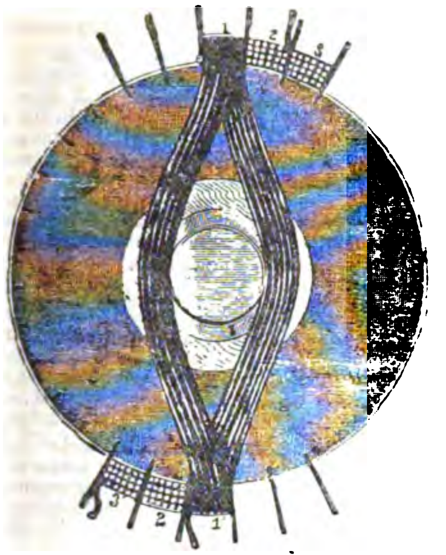


Fig. 3.—ARRANGEMENT OF THE LAYERS AT END OF ARMATURE CORE.

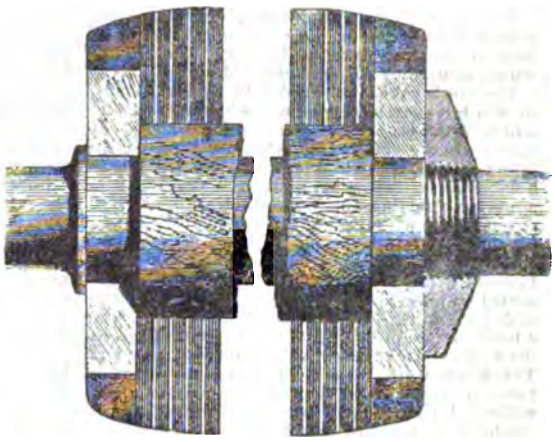


Fig. 4.—THE ENDS OF THE ARMATURE CORE.

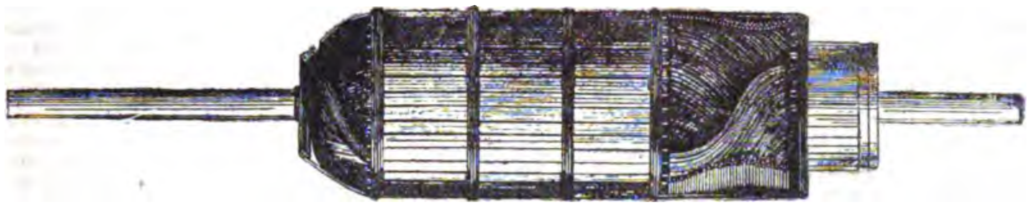


Fig. 5.—THE ARMATURE WITH PARTS BROKEN AWAY.

support of the bronze journal box, at the commutator end of the armature, is turned on its inner end to receive the brush yoke.

We give side view of the field-magnet and an illustration of the switch. The details are described and illustrated fully.

The steel armature shaft is 16¾in. long and ¾in. in diameter at the journals, and ⅞in. in diameter between the journals. The larger part of the shaft is 9¼in. long. Sufficient end chase is allowed in the armature journals to cause the surfaces to wear smoothly.

On the central portion of the armature shaft is placed a wooden sleeve, $1\frac{1}{16}$in. in diameter; on this are mounted the thin sheet-iron discs forming the armature core. These discs are 2⅛in. in diameter. They are arranged in series of five, with tissue paper between the discs, and between the series of five are placed several thicknesses of paper. Enough discs are clamped together on the shaft to make this portion of the core 3⅛in. long. The cast-iron discs between which the sheet-iron discs are placed are ⅜in. in thickness and 2⅛in. in diameter. One of them is fixed on the shaft, the other being held in place by a hexagonal nut screwed on the shaft. The cast-iron discs have their outer corners rounded, and in the edge of each are formed 32 equi-distant radial slits $\frac{1}{16}$in. wide. In these slits are inserted strips of vulcanised fibre for separating the different pairs of coils during the operation of winding.

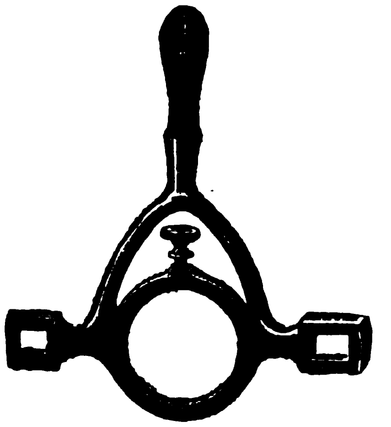


Fig. 6.—THE BRUSH YOKE.

It is impossible to describe the Edison winding without depending mainly on the diagrams, Figs. 1 and 2. There are two series of coils—that is to say, there are two coils in each division of the armature. There are 32 bars in the commutator, which are numbered consecutively from 1 to 32.

The armature core and shaft are thoroughly insulated by means of paper coated with an adhesive varnish. Jute string ribbon is wound on the face of the core as a further protection.

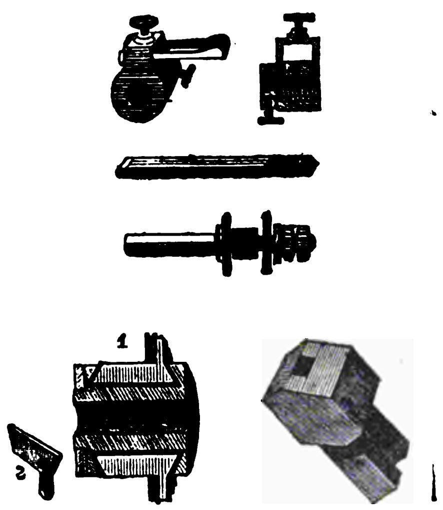


Fig. 7.—DETAILS OF THE BRUSH HOLDERS, THE COMMUTATOR CYLINDER, AND BRUSH HOLDING JIG.

The wire used on the armature is No. 21 copper wire, double covered; the inner covering being of silk, the outer of cotton.

Leaving an end out for connection with the commutator coil, No. 1 is begun at 1 and wound in four layers, with six convolutions in each layer, the outer terminal coming out at 1′. These ends are marked respectively 1 and 1′ in such a manner as to avoid any possibility of the detachment of the marks. If this caution is observed, much trouble may be avoided. A good way to mark them is to place a tag of parchment, or parchment paper, on each end of the wire, with the number marked on.

After winding coil No. 1 the armature is turned half way over and coil No. 2 is wound and marked in the same way, with 2 on the inner end of the coil and 2′ on the other end. The coil is then reversed and coil No. 3 is wound, and its ends are marked in the same way, and so on until the first series of coils is finished, the last coil of the series being marked 16 and 16′.

The first coil of the outer series is No. 17-17′. This is wound on the top of coil No. 1. The armature is turned over and No. 18 is wound on the top of No. 2, and so on until all of the outer coils are in place.

Before winding, the inner end of each wire is wrapped in jute string ribbon to a point within the end of the armature core, and it is further protected by a wrapping of thin adhesive tape. The outer end of the coil is covered in the same way.

About 3lb. of No. 21 wire are required for the armature. The length of wire in the first inner coil is 26ft. 6in. The length of wire in the last outer coil is 35ft.

The commutator cylinder is formed of 32 bronze bars, having bevelled ends and radial arms for receiving the wires. These bars are clamped in position on a sleeve having an undercut flange by a countersunk washer and a nut screwed on the sleeve. Mica is inserted between the commutator bars, between the bars and the sleeve, and between the ends of the bars and the flange and the washer. The radial arms extending from the commutator bars each have a slot in the end for receiving the terminals of the coils.

The coil terminals are arranged in groups of 16, the wires of each group being parallel. The terminals are carried around and attached to commutator bars, which are about 45° from the planes of the coils to which they belong, thus making the winding more symmetrical, and at the same time permitting of a better arrangement of the brushes. The coil terminals are inserted in the slots of the arms of the commutator bars and soldered with soft solder, the connections being made in accordance with the diagram, Fig. 1.

The wires, where they cross at the back and front end of the armature, are separated by sheets of mica. Where the winding crosses at the rear end of the armature, the wires are spread out so that they are only one layer deep. When the winding of a coil is finished, the terminal is fastened by stout threads inserted in the coil before winding the last three convolutions, and tied after the coil is complete.

A vulcanised fibre collar, a little larger in diameter than the commutator is slipped over the commutator bars, and placed against the radial arms of the bars, as shown. The edge of the collar is grooved, and a canvas cover is fastened to the collar by tying it in the groove. It is then drawn over the terminals, and fastened by the first ring of binding wire on the armature. At the opposite end of the armature a similar collar and cover is provided.

Before covering the terminals with the canvas, they are wound with twine, to give the end of the armature a symmetrical shape. The winding is varnished with shellac before its cover is applied, and the cover is varnished after it is secured in place.

The binding rings are formed of brass wire, wound tightly over a layer of mica interposed between the wire and the binding. The binding wire is secured by clips and soft soldering.

The brush yoke is provided with wooden handle, by which it may be moved, and a binding screw by which it is clamped in the position of use. In mortises in the ends of the yoke are placed insulating blocks, in which are inserted the brush-holding studs. These studs are each provided with a nut for clamping the brush-holder cables which communicate with the leads at the side of the pole pieces.

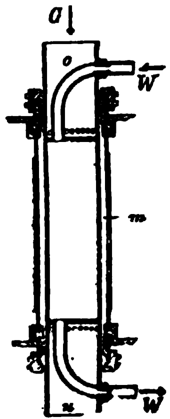
On each brush-holding stud is placed a sleeve fastened with a set screw, also a loose sleeve connected with the fast sleeve by a spiral spring concealed within it. The loose sleeve is furnished with a brush clamp for holding the brush, which bears on the commutator cylinder with a yielding pressure. The brushes are formed of spring copper wires fastened together at their outer ends with soft solder. A jig goes with each machine for clamping the brush and guiding the file while renewing the brush ends.

The speed of the motor on a 125-volt circuit is 2,400 revolutions per minute. The speed at which the armature is to be driven in order to generate a current having an E.M.F. of 125 volts is 2,730 revolutions per minute.

We have received a letter from the Edison General Electric Company, stating that the machine here described, according to the new rating, which went into effect June 15, is a 0·5 kilowatt machine, which, when used as a generator for supplying lights, will generate sufficient current to bring to full candle-power nine 16c.p. 112-volt lamps, and when use for power it is a ½H.P. motor at a rated volt. It is guaranteed to give 0·47H.P. at ⅞ of its rated volts. We are also reminded by this letter of the fact that this form of machine is a type which was brought out in 1885, and is known as the Standard Edison machine, which is made in several sizes. Each size is identical, in its general construction, with the machine described, and any of the machines can be used either as a dynamo or motor.

THE COMMERCIAL MANUFACTURE OF OZONE.[*]

THE generation of ozone by electricity, as well as a large number of its interesting reactions, are well known; but the introduction of ozone for commercial purposes has not yet been undertaken, on account of the lack of suitable apparatus for generating it in large quantities. The best method of generating ozone electrically, as is well known, is by means of the silent discharge, and as early as 1857 W. von Siemens designed his well-known ozone tube, which is still in use in laboratories.



The same idea has been embodied in the apparatus recently designed at the works of Siemens and Halske, of Berlin, for commercial purposes, and its construction is shown in the accompanying engraving. As will be seen, it consists of an inner metal tube which is surrounded by an outer one forming the dielectric tube. The top and the bottom of the metal tube are closed, and the space between these two covers is filled with cooling water kept in circulation by tubes, W and W, reading from the top and bottom. Above the top and below the lower covers there are rows of holes through which the gas to be treated, G, is drawn from the upper space, *o*, into the space *m* between the dielectric cylinder wall and the inner metal tube. From there it passes to the lower end *u*, and out. The dielectric cylinder is made of hard rubber or celluloid, and leather rings serve to connect the parts.

The apparatus is so arranged that the cooling water passes through all the tubes, and so that a tube in case of a rupture can be easily replaced.

The author has employed continuous currents, interrupted by a special rotating commutor at a rate of 600 per second. By this means, far more ozone is generated than with an alternating current machine and induction coil having only 50 to 100 reversals per second. However, when the number of ozone tubes is increased, this relationship is reversed, and the alternating current exceeds in efficiency the continuous interrupted current. Further investigation seems to show that the generation of ozone is largely dependent upon the nature of the alternating current, and that the steeper the curve the more efficient it is. The generation also depends upon the mean E.M.F. in the tube; thus, up to 4,000 volts, using a glass tube, no ozone is generated. With increase of potential, other things being equal, the generation increases rapidly, until finally the tube bursts, so that care must be taken not to exceed a certain limit. It was also determined that transformers with open magnetic cores, as in the ordinary Ruhmkorff coil, are more efficient than those with closed magnetic cores. Experiments have shown that with 2H.P. 2·4 milligrammes of ozone per second can be produced.

Among the many applications to which ozone lends itself, the author mentions particularly the disinfecting and sterilising of water, there being good reason for assuming that the worst natural water can be made potable by ozonizing. He also refers to its application in bleaching processes and the curing of wines, and, generally, for disinfecting purposes, its action on all bacteria and small insect life being very destructive.

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[*] By Dr. O. Frolich, an abstract of a paper read before the Elektrotechnische Verein of Berlin.

SCIENTIFIC NEWS.

THE position of Encke's comet on Sept. 17, Berlin midnight, is R.A. 8h. 4m. 49s., N. Dec. 29° 29′ 7″.

Wolf's comet on the same date (17th) will, at Berlin midnight, be in R.A. 4h. 6m. 21s., N. Dec. 19° 52·7′. Its brightness will then be nearly 10 as compared to unity at time of rediscovery.

The coming Harvest Moon, which occurs at 5h. 4m. a.m. on the 18th, will be a very remarkable one, as the moon attains her perigee less than an hour and a half after she is full, and her approach to the earth (221,720 miles) is one of the closest possible, the minimum distance at perigee being, according to Neison, 221,614 miles. Such a coincidence in the case of the Harvest Moon has not occurred during the last quarter of a century.

There is some doubt whether the asteroid announced as discovered by Dr. Palisa on August 14 is really new, as it may perhaps be Medusa (149), or Alice (291), the latter also discovered by Palisa, April, 1890.

Those who are interested in studying the ultra-violet spectrum of the Solar prominences, should procure a copy of the paper read at the British Association by Prof. G. E. Hale, B.Sc., F.R.A.S., director of the Kenwood Physical Observatory, Chicago. From an exhibit made to the Paris Academy of Sciences by M. Deslandres, it would appear that he has been engaged on the same sort of work as Prof. Hale.

Operations on the top of Mont Blanc have been suspended, for the season probably. It appears that a horizontal bore has been driven for about thirty mètres at a distance of twelve mètres from the plane of the summit, but solid rock has not been touched. M. Janssen has great faith in his scheme, and he hopes yet to be able to take photographs of the sun from the top of Mont Blanc.

Mr. W. F. Denning, writing about Jupiter, says that "students of this interesting planet will find abundance of materials to collate and discuss. There is ample evidence of the reappearance of certain features after periods of non-visibility. Some of the more durable markings apparently suffer temporary obscuration by vaporous masses suspended above them in the Jovian atmosphere. The disposition of the belts is also liable to change, though not so rapidly as is generally supposed, for many of the alleged variations have been due to differences in telescopic definition or to the rapid rotation of the planet—circumstances which have not always been adequately allowed for."

The death is announced of Mr. Louis John Crossley, of Halifax, in his forty-ninth year. As a manufacturer he was well known, but he might have acquired more fame in the scientific world if his avocations and his numerous public duties had left him more leisure to work at his favourite studies in his excellently appointed laboratory. He was a thorough electrician, and his telephone transmitter made his name known throughout the world. Mr. Crossley introduced the electric light and the telephone into Halifax.

Mr. Charles Jamrach, the well-known naturalist and dealer in animals, died on Sunday last in his 76th year. He was a native of Memel, and followed a business which his father had established some years ago in London and Antwerp. His knowledge of animals and their habits in confinement was almost unique.

Mr. Galton's Anthropometric Laboratory, which for a time was under notice to quit, the ground on which it stood being required for the Imperial Institute, has been accommodated in South Kensington Museum. According to a brief report by its founder, the results up to date have not been very remarkable, though useful. The difficulty there, as in the similar establishment in Dublin, is that the strong people are fond of testing their physical prowess, while the weak ones steer clear of this demonstration of their feeble powers. Hence a false standard is raised, and, if adopted as the average, may seriously mislead the boards who "pass" candidates for the public service.

The Coutts-Trotter Studentship at Trinity College, Cambridge, will be awarded next month. It is tenable for two years, and is for original research in physiology or physics. Candidates must apply to the secretary of the Coutts-Trotter Studentship committee at the College Office on or before Oct. 15.

The Geographical Society of Paris has received information of the melancholy fate which has overtaken an expedition led by Lieut. Paul Quiquerez and M. de Segonzac, for the purpose of penetrating into the interior along one of the rivers which discharge into the Gulf of Guinea. The stream in question, the San Pedro, flows along the eastern frontier of the State of Liberia, and is but little known. At a distance of 125 miles from the coast the party were attacked by the negroes and their boat capsized in the rapids, everything being lost. Lieut. Quiquerez succeeded in making his escape, only to succumb to a fatal attack of fever.

Some members of the "Kite" Arctic Expedition have arrived at Halifax, Nova Scotia, with large collections of botanical and entomological specimens—some previously unknown. They reached N. lat. 77° 43′, and report all the charts of Greenland to be incorrect—a statement which will scarcely be accepted.

An American paper thinks that the exchange of phonographic letters will have an effect on the art of elocution, which has lately fallen off. The phonograph may also be used in time as a spelling-book, and another suggestion is that it might be used in railway-carriages to announce the names of the stations in clearer tones than the "Slavic" languages in which the guards have indulged for so long a period.

It is stated that M. Raoul Pictet has made further discoveries in the production of extreme cold. He finds that a mixture of sulphurous and carbonic anhydrides liquefied by cold and pressure is more manageable than any other fluid, and is very useful, from its rapid volatilisation, in liquefying other gaseous bodies.

It is stated that a new method of demonstrating the presence of tubercle bacilli in sputum has been devised by Dr. Max Dahmen, of Crefeld, and as it has been tested and found correct, he has been advised to publish it.

A new steamer has been put on for the service between Weymouth and the Channel Islands. The *Ibex* is a schooner-rigged twin-screw steamer, 270ft. by 32ft. 6in. by 15ft. 6in.; gross tonnage, 1,160; net tonnage, 372. She is equipped with engines of 4,300H.P., and when tried for speed made 19½ knots as an average. She accomplished the passage from Guernsey to Weymouth, a distance of 72 nautical miles, in 3 hours 35 minutes, being an average hourly speed of 20·2 knots.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

THE AUGUST METEORS.

[32676.]—IN reply to Mr. Gobriel, I failed to see any of the August meteors this year, in consequence of the state of the weather at Portrush. I already called attention to the fact that in former years the main radiant often appeared to be situated in Cassiopeia, near the point observed by Mr. Gobriel, and also that there were several centres of radiation instead of a single one—both of which facts are unfavourable to the cometary theory.

Mr. Holmes's observation is interesting. I saw two streaks here (Portrush) on the 29th, somewhat in the same direction, though lower down. They were broader than that noticed by Mr. Holmes, and I took them for auroral streaks, which, perhaps, they were. There was a general glare over the sky in that direction in which the streaks appeared successively. Such streaks have been observed (especially about this time of the year) under circumstances when they could scarcely have been auroral or meteoric. Their connection, and that of the aurora, with meteors is worth investigating. Auroral or electrical streaks cannot, of course, produce meteors, and as it now seems clear that the auroral matter is not meteoric dust, I do not see how meteors can produce an aurora; but it is not unlikely that the luminosity of meteors does not depend simply on the resistance of the upper strata of the atmosphere; but on its electric condition and on the presence of auroral matter. I met some time ago with an observation (I forget by whom) that meteors distinctly brightened on crossing an auroral streak, and many observers seem to be convinced of some kind of connection between the phenomena. The heights assigned to the aurora agree fairly with those ascribed to meteors.

Portrush, Aug. 31. **W. H. S. Monck.**

[32677.]—I REGRET there is a mistake in the position of the third radiant mentioned in my letter, No. 32625, August 21. The position there given, 65° + 70°, is not sufficiently advanced in R.A., and the radiant would, I find, be better represented by, say, 85° or 90° + 70°. The region Camelopardus is barren of the brighter stars, and the mistake appears to have arisen from having too hastily read the atlas used—which was Proctor's smaller.

Did any of our other readers obtain a radiant in this region? If so, where?

W. H. Milligan.

METEORIC DUST-FALL ON THE MOON.

[32678.]—I HAVE been rather surprised and disappointed on reading "F.R.A.S.'s" answer to my query on p. 405, letter 32475, as to why the steep inner cliffs of lunar rings are invariably so much whiter than the more gentle slopes around the rim outside, if the whiteness is due to snow deposit on a rock basis.

Surely if the brilliancy of Aristarchus can be due to snow-fall (vide "F.R.A.S.'s" letter 29737, p. 70, March 22, 1889), it would show far more conspicuously on the *outer* margin of the rim (when gravitation could not so easily remove it) than on the steeper inner cliffs. As I pointed out in letter 32475, the maximum brightness in lunar rings is almost invariably seen precisely where the action of *gravitation* would be also at its maximum, and where on our earth snow does not lie—i.e., on the steepest slopes.

Cliff faces and the steeper inclines with us are generally the darkest features in our alpine views. On the moon this is reversed, and the steeper slopes and cliffs are the whitest. How is this? Is this because snow can lie on a cliff face better than on a gentle slope on the moon, or is it due to gravitation occasionally removing the layers of a vast snow ring, which, elsewhere, becomes gradually stained by accumulation of meteoric dust?

This is the question to which I invite an answer: With regard to meteoric dust-fall, it is a little disheartening, after all my efforts, to show that the relative darkness of lunar *maria*, and outer surface in many places, is "due to a steady (if slow) fall of meteoric debris," to find I am accused of "assuring" folk "that little or no dust at all can ever descend upon our satellite."

Formerly I had some difficulty in getting this dust-fall admitted at all, and now am accused of inconsistency if I demur to be smothered in it.

Our valued correspondent is not the only F.R.A.S. who has (if I may venture to say so) jumped to the conclusion that the dust-fall on the moon and on our earth must be the same.

I have before pointed out that while the total fall per square mile on each globe may be the same, a large percentage of the larger fragments which on the moon would penetrate the snow, are disintegrated by our atmosphere and fall as dust, the percentage of which to the total would be less on the moon.

With reference to this question of the unearthly brilliancy of lunar cliffs, where effects of gravitation are at a maximum, I feel pretty certain that "F.R.A.S." will admit that I have a good case, if he examines Photo. No. 4, *Knowledge*, Oct. 1, 1889, noting Theophilus and Pitiscus; also Atlas and Macrobius in Photo. 5; or Mr. Elger's lithograph of Aristarchus in *Journal* L.A.S., January, 1885, p. 66, which latter illustrates admirably the peculiarity I refer to as worthy of attention, and bearing out my views. I have lost touch with Mr. C. V. Boys, whom I knew a little in 1862-3, and shall look up his papers, which I believe endorse Prof. Langley's views as to a low surface temperature on the moon.

Sibsagar, Assam, India. **S. E. Peal.**

THE ORIGIN OF INFLUENZA AND DISEASE.—IV.

[32679.]—IN my preceding letter I described in outline the secondary and final factors in organic dissolution, and the means by which the second condition of disease is produced, with some account of inoculation and vaccination, to which I cannot refrain from adding, if men had deliberately worked with the avowed intention of finding, introducing, and practising a method by which disease might be readily and effectually implanted, perpetuated, and increased in virulence, they could not have succeeded better than by inoculating and vaccinating.

We have now to see what the microscope discloses with respect to the appearance of the yeast animalcule in this second condition of disease.

When the yeast corpuscles are forced out of the blood current into the tissues of the body, they are quite hemmed in, and have in consequence no opportunity to multiply as they would in the blood, from want of fluidity of the substance by which they are surrounded. Thus imprisoned, they commence to grow abnormally large in comparison to the original condition; to this increase in size there would appear to be hardly any limit. So long as their surroundings remain sufficiently fluid, their spherical form is retained, also their power of self-multiplication; but directly they become present in the tissues, the want of fluidity of such substance in which they are enveloped not only prevents their multiplication and allows them to increase in size in proportion to the time they are imprisoned, but, according to the structure of the tissue into which they are forced, their shape will be altered, their elasticity and increased dimensions permitting their original spherical form to be squeezed into all sorts of shapes. Also, as they are unable to multiply their kind, the young of the yeast animalcules continually increase inside them, and give a granular appearance, and, instead of containing two or three embryo yeast animalcules, as will be found in those of the first condition of disease, there may be as many as a hundred and fifty. The young cells may become exuded in amongst the surrounding large parent cells, but the want of the requisite fluid prevents their growing to any extent.

If we examine under the microscope some discharge from a tumour or cancer, we shall observe it to be composed of a number of irregularly-shaped cell-like bodies, in which are to be seen dozens of other very small cell-like bodies, and interspersed amongst the mass a number of similar little cells; these are by most microscopical observers called tumour or cancer-cells, as the case may be, and the smaller cells here and there amongst the large ones are called granular matter. But these cells are nothing else than yeast animalcules, variously altered in shape by the pressure on one another, and the surrounding structure of the tissue in which they have been imbedded, and in size by the time they have been in the body or remained in such position.

Again, when a piece of muscle is microscopically examined in which yeast animalcules are present, they may appear to be long, worm-like, granular bodies between the layers of muscular fibre; these are named by some, "worm-like granular matter;" or they may be more or less elongated in several directions, giving them an irregular star-shaped form, and have been called "connective tissue corpuscules;" these are simply the yeast animalcules ejected from the blood and variously flattened out in the spaces between the fibres of muscle.

So the original factor of alcoholic fermentation outside the body has quite a different appearance from that presented after it has been pent up in various parts of the tissues inside the body, and becomes almost unrecognisable—should anyone unacquainted with the foregoing attempt to arrive at what these bodies are which the microscope reveals, he will in all probability never be correct in his conclusions.

Also, if we take some pus matter from a tubercle or any form of ulcer, in fact any pus matter which nature is endeavouring to expel, we shall find by examining it with the microscope that it consists of yeast animalcules, variously modified in form, and increased in size, and the number of contained embryo yeast animalcules, according to the time they have been stored up in the body; to which must be added that, as this modification proceeds and the time increases during which they abide in the tissues, and the drugs that may be taken become associated with them, so their excreta become more degraded and corrosive, producing the phagedenic or eating pustules, as in virulent small-pox, leaving the skin pitmarked; or the like in a still more degraded form in cancerous, syphilitic, and scrofulous ulcers.

We have next to learn how the third condition is induced. When the whole physical apparatus is depressed by nature's efforts to reduce the first or second condition by the expulsion of the disease factor—our total ignorance of the cause and its effects almost always introduces some further burden to retard, and often to finally stop, these efforts—this is done by administering stimulants, which drive the moving matter away from the natural outlets, to the transient relief of the patient, though while life remains nature unceasingly returns to the work of expulsion, and at each expression of the curative effort further use of stimulants only suppresses and sends back the disease, till at last dissolution becames master of the situation. Stimulation merely increases the disease factor, and makes it more enlarged and degraded at the expense of the vitality or life-force. Stimulants are not necessarily confined to alcohol; the worst forms are such drugs as opium, morphia, chloral, &c., which are only expelled with an enormous expenditure of vitality. The third condition may be, and is, more often associated with the first, which latter is always more or less inherited by everyone, if not the second and third.

It will be clearly seen that our ignorant interference only adds one condition to another, and introduces a further disease factor, enabling the primary one to proportionately accumulate, so that when a collection of this has been formed in any organ of the body, the use of stimulants in any form will prevent such a result till eventually the inevitable one must follow.

The remaining condition of disease of much importance is that which is mostly inherited—viz., the gouty condition. This is originally brought about by the use of fermented drinks.

Before considering the active cause of this condition, it will be well to gain a little more intimate acquaintance with the immediate process of organic dissolution.

Alcoholic fermentation, as we have seen, decomposes all organised structures—i.e., reduces the complex molecular constitution of these structures to more simple molecular units. Now, in the process of dissolution, decomposition, or fermentation of grape or other fruit juice, the organised elements become unorganised, so that such substances are thus present in the fluid product of decomposition—called wine. It has been mentioned and partly explained that plant life and animal life are mutually dependent. This dissolution process will further show the reasons for this dependence. Plant life requires not only water and carbon, the latter obtained from the air (which may be exhaled by animals or by fermentation by the yeast), but also earthy elements which are present in the soil in which the plant grows, and although they can be appropriated by the plant for life purposes, the particular molecular composition of those earthy elements present in manure is most suitable for the requirements of plants and easily absorbed by them. Now manure is the product of organic dissolution; we know the organised earthy elements present in plants and animals are by this process reduced to unorganised earthy elements, so they become present in manure along with other metallic elements which are unorganised by the same means. This clearly gives a further reason why plant life and animal life are dependent upon one another for their existence. The plant grows and lives at the expense of the products of dissolution, and the animal lives and grows at the expense of the plant, and at last the animal succumbs to the dissolution process, and is then ready for the plant to recommence the same chain of events; so still more distinctly do we perceive the unceasing relation between the two. Even more than this, we can see that unless there were these processes with their active agents, yeast, P glaucum, and the microbes, the period of organic existence would be practically infinite, if there were no other means of keeping them within reasonable bounds.

Returning to the gouty condition, we see how the fruit juice when fermented contains unorganised material, and knowing that all such material is of no use to an animal for life purposes, we will explain how it is instrumental in the production of gout. The particular unorganised earthy element in the fermented fruit juice which induces gout is potash. When this is taken into the body it combines with the animal oil to form soap, which is matter quite foreign to the organism, and has to be expelled at the expense of the life force, the same as any other disease factor. When from excess of the element being taken or other cause the potash is unable to become converted into soap, it begins to permeate the osseous system about the joints and defrauds them of the natural oily lubricant; as it accumulates a so-called chalky deposit occurs, and thus gout is created.

We shall not attempt to describe in anything like detail the almost countless special and general complications which arise from violation of the physiological law that "no inorganic substance is of any use to an animal for life purposes." The internal or external application of irritants, vegetable or mineral poisons, unorganised compounds, mineral drugs, &c., which latter mostly invade the executive and directive nervous apparatus, causing excruciating pains, and in other instances preventing the volitionary movements, also paralysing the sensory, auditory, optical, and olfactory nerves, causing various degrees of numbness, deafness, blindness, and loss of smell; all this maltreatment tending to decrease the vitality and increase the animate factor in quantity, quality, and dimensions.

We have now completed our brief review of the principal diseased conditions, with their primary factor the yeast animalcule; how they become present and modified in the body; how drugs introduce another factor and increase the primary one, vaccination and inoculation doing the same; how the use of stimulants increases and degrades the first factor, and also introduces still another; also how by the use of fermented drinks the gouty factor is implanted, and finally we gain an idea of the limitless effects produced by all kinds of maltreatment. So that, with the exception of parasites, one or two minor complaints, and mechanical injuries, they include those processes of organic dissolution within the living body known as disease, from which it will easily be seen there is not much chance left for the other two factors in the process, to which, however, we will now direct our attention.

These two active agents, we have already stated, are the fungus Penicillium glaucum, and the bacteria or microbes. These two are quite minor factors in the body; the latter are *never* found in the blood in disease, except they are introduced as a a vivisectional practice by inoculation, or *after* death.

Commencing with the second factor, or P. glaucum. According to the condition of the body, or the amount of inherited or acquired disease, there will be a proportionate quantity of yeast animalcules expelled into the digestive track, and their excreta, alcohol and carbonic acid gas (the generation of this gas by fermentation in the digestive canal gives rise to flatulence), prepares the way for the P. glaucum fungus to vegetate amongst our food, and the absorption of the lactic acid excreted by the fungus creates the condition know as the rheumatic.

The fungus is found in those degraded states of disease in which the yeast corpuscles have completely blocked up a particular organ or part of the body chosen for their expulsion, but by maltreatment the expulsion has been prevented, and the P. glaucum gets in from the air and grows in a more or less degraded form, and thus gives rise to what are called fungoid growths. It is also found in some cases where the yeasty excretions are open to the air, and the spores of the fungus find a resting place, and so it makes its appearance.

If the sputa from a person in the last stage of consumption be examined with the microscope, the appearance presented is that of a forest of rod-like transparent branches, amongst which are to be seen the more or less enlarged yeast animalcules (a precisely similar appearance to the spent yeast from the brewer's vat), which we saw was the P. glaucum fungus intermixed with true yeast, and the same is the case in the sputa of the consumptive: when the patient gets sufficient drugs to prevent the expectoration of the yeasty phlegm, the spores of the P. glaucum get into the lungs from the air, and so produce the fungus.

Now we will lastly consider what the microbes have to do with disease. The majority have concluded they are the actual disease factors. It will be as well not to lose sight of the fact that these minute animalcules are the active agents in the final stage of organic dissolution known as putrefaction; they do not usually appear on the scene till the first agent—yeast—has done its work, the fungus P. glaucum has played its part, and then the microbes finally complete the process. Since they are the last agents in the process outside the body, they must, of necessity, be the last inside the body.

The microbes may be found on any surface where the yeast animalcules are being expelled, as where an ulcer has formed open to the air, where an ulcerated open cavity is formed in the lungs, which would be open to the air, and also in the body after death. They have been found after death in cholera, they have been found in the tubercules of consumption, in erysipelas, typhoid fever, diphtheria, in some forms of blood poisoning, all along the digestive track from the mouth to the anus; and, in short, wherever the air and its contained germs have access the microbes may be found, or whereever they are introduced by vivisectional practices or poisoning.

But though they may be found in these positions, they are, nevertheless, the last cause in the process, and not the primary cause of disease. Still, this was the origin of the idea that microbes were the cause of disease, although the fact that they were not present in the inflammatory stage was overlooked.

The origin of the idea that microbes were the active agents in all forms of disease was mainly the circumstance of their being found in these positions; also it was found that by injecting the putrefactive excretory fluid, carefully filtered of all microbes, or the microbes themselves, or both, into the blood of a healthy rabbit, or guinea pig, it rapidly caused inflammatory symptoms of a similar nature to a really tuberculosed joint in man; this was taken as conclusive evidence that microbes were the cause of tuberculosis; further, a particular form of microbe was supposed to be the cause of not only tuberculosis, but all forms of disease, entirely ignoring the fact that no microbes are to be found in the blood of anyone suffering from tuberculosis, &c., till after death; also that in inflammatory diseases, as scarlet fever, yellow fever, measles, small-pox, &c., they are again not to be found.

To illustrate the incorrectness of this conclusion, if we inoculate a joint with the poison from the sting of a wasp or honey-bee, a similar condition will make its appearance in about an hour, while the disease this is supposed to be identical with may take half a lifetime to develop. What would be thought of the sanity of a person who concluded from this that the poison thus introduced into the blood was the cause of tuberculosis. Such, however, is the peculiarity of the inferences mostly drawn by the orthodox medical fraternity.

Also, it was found that on injecting the fluid or microbes, or both, into the blood of a consumptive, a certain reaction occurred which was a sign of nature's efforts to throw out the poison; the patient after a few hours became feverish, vomiting followed, and in the event of a large dose being administered, unconsciousness, burning, swelling of the affected part, a discharge, and even sloughing and death. Now in those cases where death was not the result, on a reinjection of the poisonous fluid it was found there was less reaction, and at each successive injection the reaction, as they termed it, grew less and less. This was taken as an indication that the so-called remedy was effective; but the actual meaning of this was that the patient's vitality was sufficient to make every possible effort to resist and expel the first injection, which effort absorbed almost all the vital force at his disposal, and any further injections were beyond the patient's recuperative powers. The same thing in principle arises when a person tries to smoke or chew tobacco for the first time: the introduction of the poison induces such a vigorous effort of nature to expel the noxious intrusion on the nervous system that the force expended produces much exhaustion, and so with the first acquaintance of alcohol; the initial inception causes a more or less permanent reduction of vitality, and interferes with the healthy functions of the body for a considerable time afterwards, so subsequent fresh intrusions become less resented, consequent on the enfeebling action of each, and in time the body seems to tolerate the poison; but nevertheless it continues its poisonous effects, which are accumulated for future discomfort.

This apparent toleration of the patient to reinjections was considered sufficient to verify the conclusion that the injection of putrefying animal gelatine was the remedy for consumption.

Further than this, it was stated the treatment was specially valuable in determining between tubercular and cancerous affections. "If no reaction followed the injection of the fluid, in such cases the existence of cancer may be regarded as an absolute certainty." Now the previous assertion states that the patient may be considered to have recovered health when no reaction followed an injection; but in this case it shows the existence of cancer to an absolute certainty. Apart from the contradiction involved, it also means that the tuberculous condition is by this method converted into the cancerous; thus, instead of curing tuberculosis, the patient gets in exchange a cancerous condition of body, if not death.

Placing on one side all these conflicting ideas, assumptions, and statements, how can the addition of a cultivation of microbes from generation to generation in the fluid extract of a corpse result in anything but a putrescent mass of excreta and microbes? When this is introduced into our life current, what can be the effect but putrescence? Moreover, to start with the assumption that all diseases are caused by microbes, and then to add microbes and their excreta, or one without the other, for the overtly declared purpose of killing and reducing microbes in our bodies, is to convert addition into subtraction, which would reasonably indicate a pronounced species of insanity.

So we see how the mania of inoculation has dominated the orthodox medical school from the time of its first introduction down to the present day. They commenced with pumping the first agents in the dissolution process into our life current from small-pox pustules; then we got a distinction in name without a difference in form, under the title of vaccination, and now we have the final factors scientifically cultivated from generation to generation, and their ptomaines injected into us as a remedial agent. The latest preparation is, according to good authority, produced in a chamber hermetically sealed and sterilized; this chamber is divided into an upper and lower portion of an unglazed porcelain partition. In the upper part there is a salted meat broth, containing colonies of tubercle germ; by these the gelatinous mass is gradually liquefied. This slowly filters through the partition or diaphragm, which then contains all the secretary (excretary) products; this is the lymph used by Dr. Koch. By its injection into the blood the tubercle germ is to be killed, and at the same time the injected particles retain sufficient strength (mortifying or rotting power) to detach the dead germs together with the dead (rotten) tissues and expel them. This product of rotting dead flesh is to be injected into the blood of human beings, which mortifies our flesh and bones, requiring them to be scooped and cut away. Again, the continual reintroduction of this putrid liquid essence, so reducing the life force of the subject till there is no so-called reaction, and the statement that "if no reaction followed upon the injection of the lympth in such cases, the existence of cancer might be regarded as an absolute certainty," thus exchanging the tuberculous for the more degraded cancerous condition, by inducing mortification and necrosis of the bones, should be sufficient; but when these patients operated on, who seemingly recover, eventually show the signs of what this vivisectional business has done for them, it ought to be enough to bring the operators to a sense of their awful practice; still they will no doubt refer the effects of their horrible treatment of human beings to some other cause. Such is the newest and most scientific discovery of the remedial agent for tuberculous; the latest accounts may well observe "the Koch remedy remains under a cloud."

So it is very conclusively seen that, notwithstanding all that has been said and done with regard to these last two factors in decomposition, they have very little, if anything, to do with disease, much less the active cause, especially the latter, which are still at the present time considered to be the agents in disease, and that each particular species or each particular form is productive of a particular disease, and in face of this notion, the most astounding one of the addition of cultivated microbes as well as their putrefactive excreta directly to the blood is the remedial agent.

The obvious indication of all this is, that it tends to show how an erroneous conclusion continually enforced and carried to its limit of endurance finally brings on itself complete contradiction, and involves those who arrived at and maintained such ideas in a decided aberration of understanding, and the subjects of experiment in a most degraded state of body, if not death.

We will now turn to the all important subject—how is all this to be prevented and cured? We have learnt what is the primary cause of disease, and considered somewhat in detail the process involved during the gradual development of the various stages of disease from the initial and preparatory condition and want of knowledge and incessant interference with nature's purifying efforts; knowing the active cause, we have, in short, simply to remove it, and the effect *must* cease. That which induced the primary condition of disease is that which will, if removed, gradually insure the removal of not only this condition, but all the superadded conditions which have been produced in consequence of the absolute ignorance which has prevailed in all things relating to the cause and remedy since man first existed.

I have endeavoured to show what is actually *the* cause of disease, and should our Editor think the prevention and cure of sufficient importance to warrant my further intrusion on the space of "Ours," I shall be pleased to devote some further letters to the matter.

Dulwich, S·E. Vita.

THE MARINER'S COMPASS.

[32680.]—I AM obliged to those correspondents who have replied to my letter inquiring for information as to the invention of the mariner's compass; but, like Oliver Twist, I ask for "more." I send some notes from a Shanghai paper, which may be of use. A writer in the *North China Herald* says the Chinese did not learn the properties of the magnetised needle from any other country. They found it out for themselves, though it is impossible to point to the man by name who first observed that a magnetised needle points north and south. He suggests that it came about in this way. The Chinese have in their country boundless tracts of ironstone, and among these no small portion is magnetic. Every woman needs a needle, and iron early took the place of the old stone needles, and were commonly used before the time of Ch'in Shih-hwang—that is, more than twenty-one centuries ago. Whenever a needle happened to be made of magnetic iron, it might reveal its quality by falling into a cup of water, when it happened to be attached to a splinter of wood, for example. It came in some such way to be known commonly that certain needles had this quality. The great producing centre for magnetic-iron is T'szchou, in Southern Chihli. The city was very early called the City of Mercy, and the magnetic stone produced there came to be known as the stone of Tszchou, and so *t'szshih* became the ordinary name for a magnet. Later, the Chinese began to speak of the city as the "City of the Magnet," instead of calling it the "City of Mercy." The polarity of the magnetic needle would become known to the Chinese of that city and its neighbourhood first. The first who noticed the polarity would be some intelligent person who communicated the fact as an unaccountable peculiarity in an age when omens and portents were diligently sought for in every natural object and phenomenon.

The earliest author who mentions the "south-pointing needle" lived in the fourth century B.C. There can be no reasonable doubt that the polarity of the needle was known at that time. The discovery of the fact must have preceded the invention of any myth embracing it. As to the discovery, there is no reason to suppose it was in any way foreign, because the Chinese use an enormous number of needles, and have an inexhaustible supply of ironstone. But though the polarity was known, it was not turned to a practical use till the Tsin dynasty, when landscapes began to be studied by the professors of *fengshui*, or geomancy: There was at that time a general belief in the magical powers of natural objects. This was a Buddhist doctrine, and it took firm hold on the Chinese mind of that age. The Chinese philosophers of those times taught that indications of good and ill luck are to be seen all through Nature. The polarity of the needle would take its place in this category of thought. Though it is not distinctly mentioned by writers of the fourth century, yet to their disciples it became an essential part of the landscape compass which the professors of *fengshui* all use. Kwo Pu, the founder of this system, died A.D. 324, and it was not till four centuries later that the *fengshui* compass began to assume its present form. The compass used by the professors of geomancy for marking landscape indications was first made about the eighth century. It was of hard wood about a foot wide, and it had in the centre a small well in which a magnetised needle floated on water. On the compass were inscribed several concentric circles, as on the wooden horizon of our globes. They embrace the 12 double hours, the 10 denary symbols, 8 diagrams, and other marks. This compass was used in preparing a geomantic report of any spot where a house or tomb was to be constructed, so that the construction might not be upon an unlucky site or planned in an unlucky manner. At the same time there was living a Chinese who had studied Hindoo astronomy, and was the Imperial astronomer, and also a Buddhist priest. He noticed that the needle did not point exactly north, and that there was a variation of 2° 95′. This variation went on increasing till a century later—that is, till the ninth century. A professor of geomancy then added a new circle to the compass. On this improved compass the first of the 12 hours begins on the new circle at 7½° east of north.

The compass, it will be observed, grew out of the old astrological report or nativity paper, calculated from the position of the stars, and prepared in the Han dynasty by astrologers as a regular part of social life, especially when marriages were about to be solemnised. Some of the old astronomical circles are preserved in the new geomantic chart. This was the compass used when Shen-kwa wrote on the south-pointing needle in the 11th century. This author mentions that any iron needle acquires polarity by rubbing it on a piece of loadstone. He alludes to the variation as a fact which he himself had observed, and speaks of the south-pointing needle as an implement used by the professors of geomancy. By them it was employed in the form of a float upon water. After this, in 1122, an ambassador to Corea describes the use of the floating needle on board ship while he made the voyage. This is the first instance, the earliest by more than a century, of the use of the mariner's compass on board ship, found as yet in any book, native or foreign. The existence of the book in which this is recorded settles the question of the first use of the mariner's compass at sea in favour of the Chinese. At that time the needle floated on water supported on a piece of wood, but in the Ming dynasty some Japanese junks engaged in piracy were captured by the Chinese, and the compass in use on board was found to have the needle dry and raised on a pivot, while still pointing southward. The Japanese had learned from the Portuguese navigators to make a compass of this kind, and probably the needles they used were brought from Europe. From this time, the Chinese adopted the principle of a pivot, and made their compasses without a well of water in the middle to float the needle in. Charts were probably used of a very rough kind, but how far is not known. What is known is that the junk-master was aware of the direction in which the needle must point to reach the port to which he was going. In the Sung dynasty, embracing part of the tenth, as well as the eleventh, twelfth, and part of the thirteenth centuries, Chinese junks went to Persia and India. The Arabs trading to China directly would learn at that time the use of the compass, and would apply it on board their dhows. From them the Europeans learnt this useful invention.

The credit of the discovery, both of the polarity of a magnetised needle and its suitability for use by mariners at sea must, therefore, according to this writer, be given to the Chinese. It was China, also, that has the credit of having first noticed that any iron needle may be polarised by rubbing it with a magnet. In the thirteenth century the Arabs used a floating compass on their dhows. The needle was made to float on the water by attaching it crosswise to a cornstick or splinter of wood. A magnet applied to it drew it into a north and south direction. They would use western notation to mark the quarters and intermediate points on the horizon. When, therefore, the mariner's compass was adopted from them, the Chinese 24 points were not communicated. In the European compass the notation of 32 points is western, and rests on the winds and the sun. In the Chinese primitive mariner's compass the notation is that of the professors of geomancy, and rests on the old astrological division of the horizon into twelve double hours. From the Arab account we learn what the Chinese accounts do not tell us—that the Chinese floated the needle by inserting it in a splinter of wood.

Metes.

EMERGENCIES IN THE WORKSHOP

[32681.]—The following hints on the way to act when little accidents occur in the workshop may be useful to your readers:—There is no situation in life in which we are not subjected to certain perplexities and annoyances. The machine operator or foreman, whether a practical mechanic and expert at the business, or one of less mechanical ability, all meet with more or less annoyances from day to day. It is true the careful and experienced man may have less to contend with than one of less experience; but, in any case, there are always perplexities enough to satisfy either. Hot boxes, bad-running belts, cutter heads out of balance, and frequently carelessness on the part of some of the men under his charge, all go to make up the sum of the annoyances which the foreman of the shop or mill must contend with. Although these things are trying to the patience of the average man, yet there is nothing gained by losing his temper and fretting and swearing; on the contrary, it often renders matters worse. New machines, when first started, no matter how well and carefully they may be fitted up by the manufacturer, are often cranky, and need considerable care and patience upon the start. The boxes are all new, and liable to heat until the bearings become smooth and the oil worked thoroughly through them. This is more particularly the case with those journals with a slow motion, such as the roller shafts and gearing that run upon studs and pins. In fact, there is more danger with those bearings becoming injured on the start than those of a greater speed, for while the latter will soon manifest themselves by heating, the former will grind away in a silent manner, and unless they stick fast and refuse to move, the grinding process may go on silently, until both the box and journal may be seriously injured before it is discovered. The bearings of all modern machinery are much longer than formerly, consequently it requires more time and attention in order for the oil to work into the journal so as to cover the whole surface, and especially where the oil-holes are small and shallow, holding but a few drops at a time. I sometimes think that if the manufacturers of wood-working machinery were obliged to start up one of their machines—a heavy planer, for instance—and run it a few days in the winter season with the thermometer at zero, they would see the necessity for making better provisions for oiling than are found in many otherwise first-class machines.

The most common cause of the cylinder boxes heating when a new machine is first put up is in the manner in which it is placed. Take, for example, a planer with the cylinder boxes from 10in. to 12in. long, which is about the average length in a modern machine. Now when that machine is put up in the machine shop, and everything about it is level and in line, the cylinder boxes may be carefully scraped and fitted, so as to be perfectly free and have a perfect bearing upon every part, and if started up without being moved from its present position, would probably run without heating. But the machine must be shipped and again set up, and if not placed exactly in the same position as it was in the shop (which is almost impossible), a slight variation in this respect may cramp the boxes, so as to throw them out of line with each other and cause them to bind, provided the caps are screwed down upon the original packing. A bearing to run at high speed must not only be free to turn, but must also bear equally upon the whole surface of the box, otherwise it will heat, notwithstanding all the oil that may be poured upon it. When a machine is placed in its position in the mill and levelled by working from the bed-plate and the back-shaft, it is good practice to first place the cylinder in its bearings without the caps, and then, by turning it carefully by hand when removed from the bearings, it can be readily discovered whether the journals rest upon the whole surface, especially if a line be drawn lengthwise of the journal with a small quantity of red lead or any other substance that will leave an impression upon the box. If the box is cramped so that those impressions only show upon the end or upon opposite sides, raising one part of the machine and placing a thin strip under it may remedy this defect. Frequently a piece of thin paper will answer the purpose. But if, after correcting these defects as far as possible, it is still found that the bearing is imperfect upon the whole surface of the box, then those parts should be carefully scraped down until this is accomplished. If not, the chances are that the journals will heat until they wear down to a perfect bearing, and it is better to scrape them at once than to run the risk of damage to both box and journal by heating while they are being worn down. Sometimes, after the most careful scraping, the boxes may still be inclined to heat. In such cases, by running them a few hours in water instead of oil, that tendency has been corrected and the journal found to run afterwards in a satisfactory manner. It is frequently the case that a new machine which has run perfectly satisfactory for three or four months will, without any apparent cause, commence to heat, so that it can only be run a short time without stopping. Now, there never can be an effect without a cause, and although this is one of the annoyances that planing-mill life is subject to, the cause must be sought for and found. A good spirit level is the best instrument with which to commence the investigation, for in about nine cases out of ten it will be found that the building or foundation upon which the machine rests has settled, and the machine is winding and the boxes are cramped in consequence. Where a heavy machine rests upon the floor of a mill without any other foundations, no matter how strong the floor may be, or however heavily timbered, the shrinkage of their timbers or their warping is often sufficient to produce this effect. Heavy piles of lumber that are frequently stored in the mill to be dressed are often the cause of so changing the positions of a machine as to cause it to heat. Therefore, whenever it is practical to do so, a heavy planing machine should stand upon a foundation of its own, entirely detached from the building. Sometimes the use of poor, gummy oil will, after a time, cause a machine to run hard, and consequently heat. The remedy for this is a good cleaning and the use of a better quality of oil.

When the old style of sectional cutters were in general use, it was nothing uncommon to find one section from one-quarter to one-half inch longer than another, and they were never in balance, but since the Shimer head has come into general use there is much less trouble in that respect if proper care is manifested in filing, so as to keep them all alike; but if not, then those cutters are as liable to become unbalanced as any other.

Again, machines will break down in the midst of a hurried job (and who ever saw a machine break down at any other time?), and the foreman is frequently put to his wits' ends to get out the job in time to satisfy the customer. If there happen to be other machines of the same kind in the mill, so that the job may be transferred to another machine and finished, the annoyance is not so great; but if not, then some expedient for temporary repairs must be resorted to if possible, for that purpose, until permanent ones can be made. Here is where not only mechanical skill is needed, but good judgment also, for it will not answer to make those temporary in order to finish a job, no matter how urgent it may be, if at the same time they cannot be made safe, for it will not answer to attempt to run a machine in such a condition as to endanger the life of the operator. In all cases of this kind safety must be the first consideration, and while it is annoying to all parties to be obliged to wait, as is frequently the case, until repairs can be obtained from the factory, perhaps hundreds of miles distant, yet it is better to do so and let the customers wait, than to run the risk of killing one of his men, or of maiming him for life. A careful and conscientious foreman will not for the sake of a few dollars' profit, for the time being, assumes the responsibility of placing one of his men in a position that he would not be willing to fill himself.

Much of the perplexity and annoyance from breakdowns might be avoided if planing mill proprietors would allow their foremen to keep in stock a few duplicates of parts that are most liable to be broken, for it is a fact that the planing machine, with the small pinion that drives the feed works broken, is just as effectually laid up until it is replaced, as if it were the cylinder shaft, and by keeping a few of these small duplicates on hand, much trouble and annoyance would be avoided.

J. Tracey.

HINTS FOR EXPERIMENTALISTS.

[32682.]—I beg to submit the description of what would be, to the best of my belief, a new system for converting mechanical force into electricity.

What are known as gas batteries consist of either two gases or one gas and one liquid, such that gas combines with gas or gas with liquid under suitable conditions. My idea, referring to any of these batteries, depends on what I suppose the fact, that condensation of the gas or gases would increase the E.M.F. of the galvanic couple, and conversely, that rarefaction of the gases would reduce it. Let a series of two or more gas batteries be employed, and let the gas in one of them be compressed, while that in the other is permitted to expand to any desired extent. Let the electric current evolved by the battery under greater pressure be applied to electrolyses in the battery under less pressure, and let this current *also* be applied to useful work in an external circuit. Now, supposing these conditions of the two batteries to be reversed periodically, there should always be a current evolved from the cell under greater pressure of an intensity mere than sufficient to "recharge" the cell under less pressure. The system should be in equilibrium when the two batteries rest under equal physical conditions, but should, I think, be "self-exciting" when the said conditions are disturbed, whether by pumping gases into or out of one battery, or by heating or cooling the gases in one battery, or by the employment of all these processes simultaneously.

If gases were continuously pumped from the battery of low E.M.F. into the battery of high E.M.F., then the electric current evolved should be continuous. This current, which I venture to predict as in excess of that necessary to maintain the chemical conditions of the system would be derived from the effect of heat or pressure on the chemical affinities of the battery elements.

There are several directions in which I think the idea might be developed commercially; but, however, certain arrangements would have to be adopted so as to minimise loss by radiated heat. These I have not time to consider at the moment, but I will deal with them at a future time.

A. D.

BROWN'S ROTARY ENGINE.

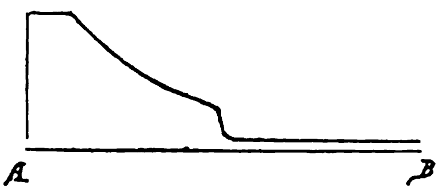
[32683.]—When I said that Mr. J. T. Towlson (letter 32637) cannot "get over" the consumption of water per brake horse-power per hour, I should have said that I myself cannot.

He says that it is possible that had he attacked the brake test this remark would have been reversed. I assure him it would not; but I should be anxious to know how Mr. Towlson would attack a brake test, made in the manner illustrated in the figure showing Brown's engine.

A rope is passed completely round a wheel, and attached at each end to a tested spring-balance. When the engine is running the two balances are read, and the difference of their readings is the net resistance to rotation at a certain radius. It is as if the engine were continually twisting a weight equal to the difference of readings up a well. The radius at which this resistance acts is the radius of the wheel + half the thickness of the rope; and the linear speed at which the resistance is overcome follows from this radius and the angular speed of the shaft. The product of the resistance in pounds into the speed in feet is so many foot-pounds per minute; that is, a certain brake horse power. Where does Mr. Towlson suggest that a mistake can be made?

The indicated horse-power is a very different thing. I will undertake to say that most indicator-cards from engines running at much less than 600 revs. are incorrect. The abscissæ are generally wrong, from the inertia of the indicator drum and the stretching and slacking of the string; and the ordinates wrong from the inertia of the piston, spring, and parallel motion. Prof. Jamieson's cards are 4in. long—this is far too long if the motion of the drum was reciprocating; 1½in. would be more correct—and the spring used, 48lb. per inch, is too weak—100lb. would be better. The little card thus produced, about 1in. high and 1½in. long, would fairly represent the behaviour of the steam inside the cylinder. The way an indicator behaves when an attempt is made to take a card of ordinary size —say 2in. high by 4in. long—at 500 revs. or more is simply frantic, and the card is meaningless.

I agree with Mr. Towlson that, though it is difficult to get a diagram at this speed, it is to be done; but not with any indicator gear one may happen to find on an engine. In my opinion, the way to indicate this, or any rotary engine, would be to give the indicator drum a continuous rotary motion equal to that of the engine. Then with a strong spring, cards far more trustworthy than those of any reciprocating engine would be obtained, as the inertia of the drum would be entirely illuminated. The cards would have this form, the points A and B coming together when the paper was wrapped round the drum. The card would be made of any length, say 6in.



I think I have now answered Mr. Towlson's question, Why should he or your readers place any more confidence in the brake report than in that of the indication test?

Now for the "absurdity" to which Mr. Towlson thinks my line of thought leads. What are our facts?

Prof. Jamieson finds the brake horse-power of an engine to be, say, 20·8. He, by indirect reasoning, gives the indicated horse-power as 29, and, of course, the mechanical efficiency as $\frac{20\cdot8}{29}$

I, with great respect for the professor, venture to think that the I.H.P. is over-estimated. I will make a conjecture, and say the I.H.P. is 25, and, therefore, the mechanical efficiency $\frac{20\cdot8}{25}$.

Next, Mr. Towlson says, if we go on like that we may find the I.H.P. only 10, and, therefore, the mechanical efficiency $\frac{20\cdot8}{10}$ or over 200, which is absurd.

The absurdity consists in supposing that the indicated horse-power could only be 10, when the brake horse-power was over 20.

"There is no evidence to show that it ever *indicated* more than this," says Mr. Towlson. There *is* the very strongest evidence to show that the engine indicated more than 10—viz., the fact that it gave out more than 20 on the brake. The indicated must be more than the brake horse-power.

Reading, Aug. 24. C. A. M.

THEORY AND PRACTICE.

[32684.]—In a letter which I find in the *Manufacturers' Gazette* (U.S.), Mr. W. H. Wakeman asks a pertinent question, "Is Practice all-sufficient?" which, as your readers will see at once, touches on the question of technical education, or on the difference between theory and practice. It seems to me that what he has to say will be of interest to your readers, and you may think it worth while to give the letter the benefit of your world-wide circulation, as it deals with a question which concerns all mechanics—and, in a certain sense, everybody is a mechanic. Mr. W. says:—In matters concerning steam engineering, it is a foregone conclusion that what we usually call theory and practice will always be at war with each other, and still, in our opiniou, there is no good reason why this should be so. The rugged, hearty, greasy, soot-begrimed, uneducated fireman stands as the representative of one, the graduate of the scientific school that of the other. We should not care to place either one of them in full charge of a modern steam plant, where some knowledge of figures is necessary in order to make calculations, and where a practical knowledge of firing, steam and gas fitting, making repairs and renewals, &c., is an essential qualification; but where a man combines the two he makes the successful engineer.

The running engineers who do not claim to be well posted concerning theory in the engine and boiler-rooms may be divided into two classes: those who recognise the value of a theoretical education and those who do not, and it is of the latter class that we wish to speak at this time.

It may be well at this point to ask what is meant by the word "theory." Turning to the dictionary, we find the definition given as "speculation, an exposition, a scheme, science as distinguished from practice." But we once heard a prominent consulting steam engineer define it as "telling how the thing was done." It seems strange that anyone should reject it when this is clearly understood to be the accepted meaning of the term among the craft; but there are some who regard any statement made in the mechanical press as visionary and so unreliable. How this is brought about is well illustrated in the following incident. A young man came into our engine-room one day and said that he wished to ask some questions. He pointed out a rule in a book for determining the weight necessary to put on a safety-valve lever to allow it to blow off at a stated pressure, the length and weight of lever and other data being given, and asked for an opinion as to its reliability. He was told that the rule was considered a good one, and generally accepted as correct. He then wished to have a certain problem worked out for him, that he might compare it with the results obtained in practice. We asked for the data, and received the following reply: "I think that the lever is about 30in. long, although I never measured it except as I did so with my eye. Its weights about 5lb, and I should judge that the valve was 4in. from the fulcrum. The valve is 5in. in diameter, and it must lift at 80lb." We saw at once that the data was incomplete, but worked out the example as given, and announced what the weight of the ball would be, which was unsatisfactory to him, as he knew that the ball did not weigh so much as that. We endeavoured to impress on his mind the necessity of being accurate when procuring data for any example, and to make it complete, or failing to do this, not blame the rule as published, but be selfish in such a case, and take it all to himself.

A short time ago a correspondent writing to the *Gazette*, and signing his name as "Johnny," expressed the idea that theory is a snare and a delusion, and practice alone the best teacher. I do not wish to appear to condemn all of the statements made by this writer; but, at the same time, should like to present a matter for his consideration. Suppose that "Johnny" should by experiment prove to his own satisfaction which is the most economical way to clean his fires (assuming that he is an engineer, doing his own firing).

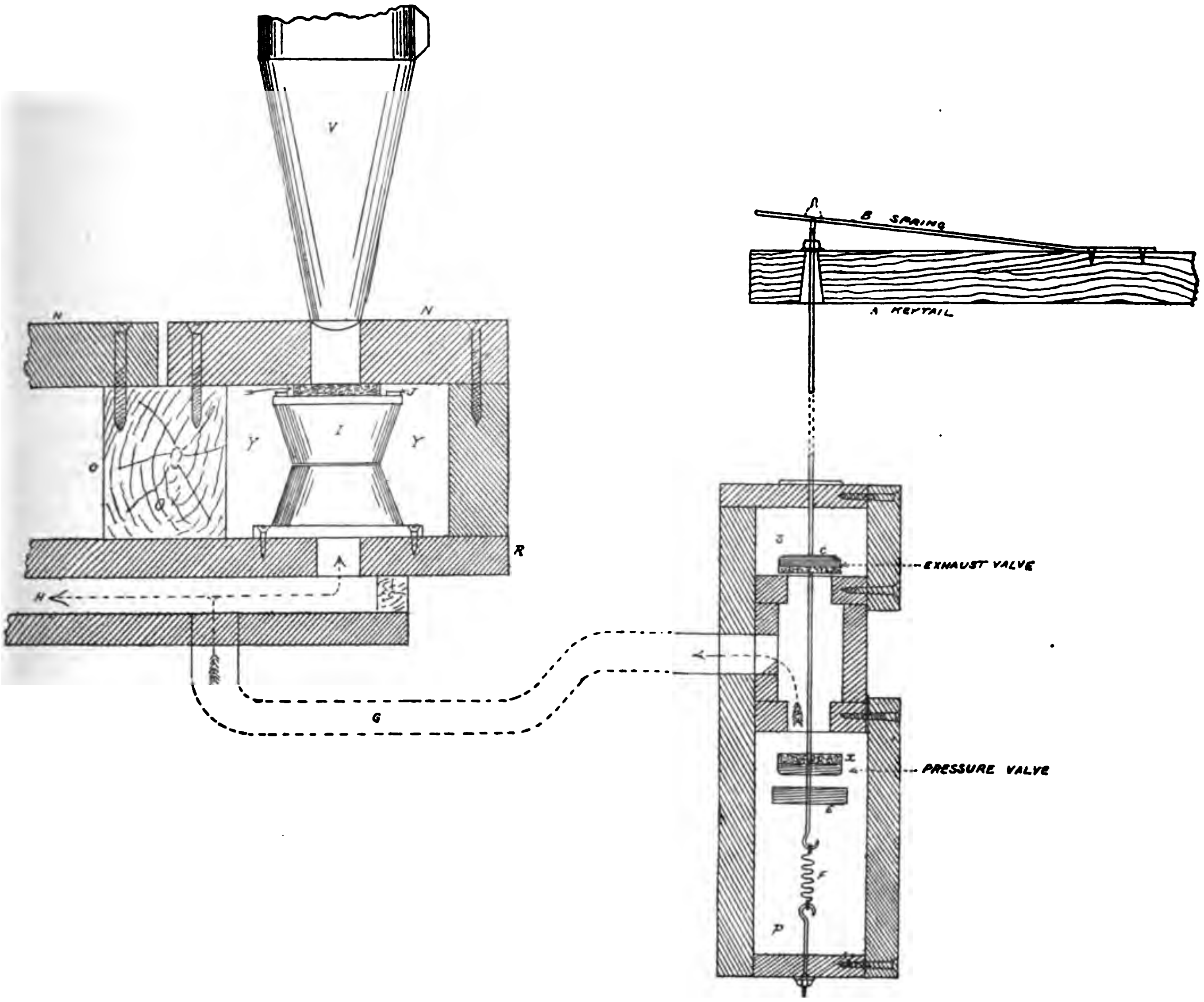
This is practice. Now suppose that he should sit down and write a letter to a friend describing the best way to clean fires under stated conditions. Suppose that this friend is the editor of a mechanical paper, and in due time it should appear in print. "Johnny" must remember that although this was a practical demonstration to himself, still when it appeared in print it was only theory to others.

The question that we wish to present is this: Under these conditions, would he advise the readers of that paper to place any confidence in theory, or to wholly disbelieve in it? We are of the opinion that the fact that it had appeared in print would not shake his confidence in it, and so it is with many things that appear in the mechanical press, for they are only articles describing what others have found to be true in practice. The writer does not affect to believe all of the vagaries that appear from time to time, claiming the right to discriminate between the true and the false, as set forth by different writers. "Johnny" goes on to say: "I would like to see 'Young Engineer' when he attempts to adjust his safety-valve. If he don't get blown up, it won't be the fault of those who tried to answer his questions."

This statement is something uncalled for, as the rules given for the purpose mentioned do not vary enough to warrant it. Probably there would be a slight difference in the results obtained; but if any boiler is being run so near to its bursting pressure as to be all right for one rule given, and if another one were to be used which would allow a little more steam to be carried, say 5lb., its destruction would be caused thereby, it is about time that boiler was condemned and thrown out of use. Take the case of a boiler 60in. in diameter, shell ⅜in. thick of iron, having a tensile strength of 5,000lb. to the square inch sectional area, and with double-riveted longitudinal seams. We would then have $\cdot375 \times \cdot70 \times 50{,}000 \div 30 = 437\cdot5$, which is the bursting pressure of such a boiler. If we use a factor of safety of five, we find that the safe working pressure is 87·5lb. If, in adopting a rule for the adjustment of our safety-valve, we get a pressure exceeding this by 5lb., we are not approaching the "dead line," as any of the boiler insurance companies will allow us to carry 100lb. on this boiler every day in the week.

Inasmuch as one of the rules which Johnnie condemns in such a wholesale way is endorsed by the writer, it may not be out of place to repeat here that we weighed all of the parts of the valve mentioned, tested the steam gauge, and then, after getting up steam, noted at what pressure the valve lifted from its seat. Having done this, the data so obtained was made use of to work out the problem, according to the rule referred to, and the difference between the actual weight of the ball and what the rule said that it ought to weigh, was found to be but 1·6 per cent., which would make but very little difference in the steam pressure carried on the boiler, it being less than 1lb. In a case like this it is very easy to prove the truth of the rule; but in some others it would be a more difficult matter.

Let us take, for instance, the following rule for



determining the strength of rivets in seams of steam boilers:

$$\frac{a \times r}{p \times t} =$$

strength of rivets, in which a = area of rivets, r = the number of rows of rivets, p = pitch of rivet, and t = thickness of plate, or to put it in another way, multiply the area of one rivet by the number of rows of rivets in the seam, and divide the product by the pitch of the rivets, multiplied by the thickness of the plate.

We have no doubt but that this rule is a correct one; but how are we going to prove it for our own satisfaction? If we had a testing machine at our disposal, and if we should rivet two pieces of iron together, estimate the strength of the rivets, and then prove it by pulling them apart, we should know whether it was correct or not; but as few of us can do this, we must take the word of those who have tried it, and so it is, not only with this, but in a score of other cases.

"Johnny's" idea of testing things for himself, and learning by experience, is a good one, and not to be condemned; but at the same time he will be severely criticised by those who know no other way than to follow in the track of others, and who have never learned to form an intelligent opinion of their own.

Mr. Wakeman's last paragraph is, to my mind, most important. No matter what sort of mind it is that employed—no matter how menial the work—it should be taught to think as well as it can; and when that is the aim of our teachers, and is carried out, we shall advance much more rapidly than we have under our School Board systems.

E. Dux.

ORGAN PNEUMATIC ACTION.

[32685.]—Construction of Soundboard and Valve-Box.—This is entirely different from the present form. The underside of soundboard consists of as many channels, H, as pipes, N, running across the width. These need not be larger in area than the connecting-pipe G, this being connected to the bottom or either end of channel. These channels are covered in with a board the length and width of the soundboard. Bars, O, are now put on this longitudinally, making as many channels as stops required. Holes, one for each pipe, are now bored through R into channels, H, beneath. Over these holes a small bellows, I (size according to pipe), is fixed, which, when extended to its full length, stands somewhat higher than the bars O. On these bellows a disc of leather makes a joint, when they come in contact with upper boards, M, which are screwed to bars, O, to cover one or more stops as required,

Explanation of Diagram.—A, keytail; B, spring; C, Exhaust-valve; D, pressure-valve; E, guard for valve; F, spring; C, connecting pipe; H, cross channels; I, small bellows; J, lead weight; K, leather disc; *n*, upper boards; N, pipe; O, bars dividing stops; P, pressure chamber; S, exhaust chamber; Y, pipe wind chamber.

Holes are bored through upper boards for pipe feet, central with the bellows beneath. The valve-box is formed by taking a balk of wood the length of the width of the keys, and boring holes from three of its sides to the centre, making three outlets. On this top and bottom chamber is built, open from end to end, a small valve being fixed over the holes in each chamber, so that when one is open the other is closed. These valves are connected to key-tails.

The connecting pipe G is attached to the remaining outlet. The spring F keeps valve C closed and D open, and also gives the required weight of touch.

Mode of Action.—Wind pressures P 2½in., Y 2in., and S open. Before a key is pressed down the valve D is open, the pressure, therefore, in the bellows I is the same as in P, which, being greater than the pressure in Y, causes them to expand and come in contact with the upper boards N; the leather disc making an air-tight joint prevents wind from Y passing through the pipe N. When the key is depressed, the valve D is closed, and valve C opened, the pressure in the bellows I being no longer sustained; then the pressure Y causes them to collapse, wind from Y then passes through the pipe N. When the key is loosed, valve D opens and C closes, and the pressure of P entering the small bellows I, overcomes the pressure of Y, causing them to expand and stop exit of wind from Y.

Another Mode.—Wind pressures = P 3in., Y 2in., and S 2in. By closing valve D, the pressures of Y, S, and the interior of I are equal. Then I, by their own weight, assisted by a weight J, will fall, allowing wind from Y to pass through the pipe N. When D opens, the pressures are unequal, that in the bellows I being greater than Y, causes them to rise, and stop wind passing from Y. In this arrangement no loss of wind occurs; when it is released from I, it expands to the pressure of S, and Y and S are connected together by means of a reservoir, which supplies Y with wind. This reservoir draws its supply from the main bellows, and would be self-acting.

Stop Action.—This would work on the same principle, having a "large" bellows similar to I, fixed at one end of soundboard, and over the hole in upper board a wind-trunk is connected. When the pressure is reduced (or exhausted) in the bellows, they are forced down from the pressure above (or it may be from pressure surrounding them), which enters the channel Y, until the pressure is again admitted to the interior of the bellows, causing them to expand and cut off supply of wind to Y.

Jas. Ferriday.

The Elms, Wellington, Salop.

"PHYSICAL" FORCE PHENOMENA.

[32686.]—In answer to letter 32572, I am prepared to demonstrate to Mr. Samuel Haigh or anyone else, that Miss Annie Abbott was simply a clever illusionist, and did not possess the least phenomenal power, as asserted in her exhibition on the stage.

I was one of a dozen who were selected by the people to attend her in her performance before an immense San Francisco audience. Every "trick" was trifling, and could be duplicated with a few minutes' training by any school girl or boy of 15 years.

As soon as the curtain went down eleven of the committee of experts rushed forward to shake hands, and compliment her with such remarks as "Grand—wonderful—mysterious," and the like. They would have staked anything on a wager, or signed a hundred affidavits; but in ten minutes I convinced more than half of the committee who were remaining of the shallowness of her performance, and of the foolishness of believing what they hear, and very little of what they see.

As Mr. Haigh and Mr. Black do not live far from me, some time when they come to San Francisco, and will call on me, they may send you an affidavit of a different nature from what they would at present.

San Francisco, Cal. **Ira G. Leek.**

WOLF'S PERIODIC COMET.

[32687.]—I have been able to find Wolf's periodic comet on the three occasions I have looked for it with a 6in. aperture refractor, power 33 or 80. It is a very faint and small object. On August 27th it was within a triangle of 8 or 8½ magnitude stars, and only just visible. On August 30th it was best seen, being then close to a pair of stars, magnitudes 12 and 13. On September 4th, being then in the Pleiades, it was not much more easily seen than on August 27th. Gn comparing its place among the nearest stars with the photograph of the Pleiades by Henry Bros, which forms the frontispiece of Miss Clerke's "System of the Stars," and taking the place of η Tauri—i.e., Alcyone, from the *Nautical Almanac*, I conclude that at 11h. 30m. p.m. the comet was in R.A. 3h. 40m. 33s. and 24° 4' N.D. The place by Herr A. Straen's ephemeris being 3h. 40m. 25·3s. and 24° 4' 36".

A. Freeman.

Murston Rectory, Kent, Sept. 8.

THE CANALS OF MARS.

[32688.]—As "F.R.A.S." (letter 32659, p. 38) appears to consider that Dr. Terby and the writer are in disagreement on the subject of what is required for seeing the "Areographical marvels discovered at Milan," it is plain that the statement in my previous letter was not sufficiently clear and complete. I therefore desire to further explain that it was always my practice (weather, of course, permitting) to continue observing Mars in the manner stated for at least an hour at a time. A somewhat extensive experience, not only with this planet, but also with the very delicate light streaks and markings visible on the full moon, has shown that, if the eye is preserved from undue fatigue in the manner indicated (i.e., by frequent short rests), the observations may be continued during this period without sensible loss of its sensitiveness, and this is what was meant by the term "perfectly fresh." It was seldom found, though, that any benefit resulted from continuing to observe the same region of Mars, or the moon, for a longer period than an hour. Some of the "Areographical marvels" were detected at the commencement of such a period of observation, others not until the end. On most nights last year, the seeing, or not, of any particular marking depended a good deal upon chance. The great obstacle to seeing the delicate details described by Prof. Schiaparelli arises from the disturbances of the earth's atmosphere. On a night on which most of the markings shown in Mr. Green's Map of Mars may readily enough be seen, one may well watch for an hour, or more, without being fortunate enough to secure a single interval of the exquisitely sharp and steady definition required for seeing the more delicate details of Schiaparelli. This is also evidently the experience of Dr. Terby. It may also be mentioned that in the case of the planet Jupiter the writer has frequently observed for five or six hours at a time, taking care, of course, to avoid over-fatigue in the manner above indicated, and the results obtained at the end of such a period are usually quite comparable in quality with those obtained at the commencement. With Jupiter, however, the rapid and varied succession of objects, due to the swift rotation of the planet, probably materially assists in preventing over-fatigue of the eye. But with Mars, in a case where the observations are continued for the period of an hour, little more than half that time would be spent in actually examining the planet; and with all deference to your correspondent's highly valued opinion, an observer must be possessed of a very poor sight if he is unable to look steadily at an object for such an interval, assisted, too, by frequent rests, without suffering from over-fatigue or experiencing a serious diminution in the sensitiveness of his sight.

As instances of the double belts on Jupiter, the first dark belt to the N. of the N. equatorial belt, the S. equatorial belt, the first dark belt to the S. of the last mentioned belt, and in particular the dark part of it referred to by Mr. Freeman in his interesting letter (32661) on p. 40, may be mentioned. But as "F.R.A.S." himself confesses that he is unable to account for the observed facts in connection with the duplication of the "canals" of Mars by the hypothesis emitted by Messrs. de Boë and Schleusner, which was a principal object in writing my letter, the question loses much of its importance.

With regard to the statement to the effect that these details have been observed only when Mars was very unfavourably situated for observation, I would point out that at the opposition of last year the planet was, on the contrary, very fairly situated as regards its nearness to the earth; its apparent diameter subtending an angle of over 19" (or, according to the *Nautical Almanac*, of over 22"); whilst, at Mount Hamilton, where not only the "canals" were observed, but their duplication, the meridian altitude of Mars amounted to just on 30°, quite sufficient to enable first-class results to be obtained in the superb atmosphere enjoyed on the top of that mountain.

In conclusion, permit me to ask very respectfully how your correspondent *knows* that the dark spots on Mars called, chiefly for convenience, by the name of "lakes," are "sheets of water covering hundreds of thousands of square miles"? Perhaps, too, as he is evidently so intimately informed on the subject, he would not object to stating what is their average depth, say, in fathoms.

Sept. 7. **A. Stanley Williams.**

STAR MAGNITUDES—THE ICE AGE.

[32689.]—Those who are interested in the subject of star magnitudes may perhaps desire to see the result of a count of the newly-published Harvard volume which I recently made. I had some trouble in obtaining figures strictly comparable with each other; but I think the following will be found substantially correct. I may remark that for half magnitudes the theoretical ratio is nearly as follows. The stars comprised in any half-magnitude are double those in the preceding half-magnitude, and equal to the entire number of brighter stars.

Magnitudes.	No. of Stars.
Brighter than 5·0	57
5·0 to 5·5	49
5·5 „ 6·0	98
6·0 „ 6·5	200
6·5 „ 7·0	334
7·0 „ 7·5	565
7·5 „ 8·0	973
8·0 „ 8·5	1654
8·5 „ 9·0	2871

These figures, of course, represent the number of stars in the zones selected by Prof. Pickering, not in the entire sky. The number of stars from 8·5 to 9·0, however, is probably incomplete.

May I remark that in his recent paper my friend, Sir Robert Ball, does not appear to have entered at any length into the real question at issue in the discussion as to the causes of the Ice age. This question is: Whether, if the quantity of heat received at a given place in the year is constant, an equal or an unequal distribution of that heat is most favourable to the formation of a *permanent* snow-cap or ice-cap? I rather think the answer will depend on special circumstances. Suppose, for instance, that in a place on the sea-shore, where moisture is always sufficient, the annual heat would suffice to maintain a constant temperature of 30° F. Here, if the distribution were uniform, there would be a permanent ice-cap; but I think it can hardly be doubted that a sufficiently unequal distribution would result in melting the ice-cap, and leaving the ground clear during a portion of the year. But suppose the annual heat to be sufficient to maintain a constant temperature of 34° F. In this case a uniform temperature would exclude snow and ice altogether, while an unequal distribution would certainly enable us to cover the ground with a snow-cap for some months in succession. I doubt, however, the possibility of forming a *permanent* snow-cap with this mean amount of heat. I should be glad to know if there is any evidence on this subject.

As regards the Ice age, however, there seems to me to be strong geological reasons for referring the great Ice age, which has left its traces all over the northern portions of both Europe and America, to a much more recent date than that which Dr. Croll's theory supposes. If man existed in the Ice age (as there seems reason to believe), this question possesses a wide interest.

I find it difficult to believe that man existed for 200,000 years in a savage state, and then shot up to the present civilisation in 10,000 years.

Portrush, Sept. 7. **W. H. S. Monck.**

SIR R. BALL ON THE ICE AGES.

[32690.]—Will some competent calculator give us a little further explanation of Sir R. Ball's correction of the extraordinary mistake which he says Dr. Croll adopted from Herschel, that the quantity or "units" of heat received by each hemisphere are the same in summer and winter? I must say it appeared to me so paradoxical in reading Croll's book years ago, that I only believed it on his authority, and not on his reasoning. Now that it is emphatically pronounced "wholly erroneous" by an at least equal authority, one is tempted to ask whether the two former ones can have forgotten that they were dealing with two fixed hemispheres, called North and South—i.e., of the equator. We have known great astronomers make equally surprising slips.

Sir R. Ball's proportion of 63 to 37 for summer and winter heat is (either by accident or necessity) practically that of the areas of the hemispheres facing the sun at the solstices, as they are simply the quarter hemisphere + or − the time contained between the Equator and Ecliptic—i.e., 90° ± 23°28', which is very nearly 7 to 4. But that cannot be the explanation wanted, for two reasons: First, the quantity of heat, even at the solstices, received on each hemisphere is not measured by their area, but by their projection on a plane perpendicular to the sun, which is about as 7 to 3 for midsummer to midwinter. Secondly, we want, not the solstitial proportion only, but the sum of the series of every day's proportion (or, more strictly, every moment) from one solstice to the next. I do not feel equal now to undertaking that calculation, nor certainly are the great majority of the readers of Sir R. Ball's valuable paper. It will be a charity to us if some one will either give it, if it is not too elaborate for these columns, or tell us where it is to be found. It is satisfactory to know that the correction only intensifies Croll's results, and in no degree reverses them as to the glacial periods or theory. **G.**

THE ELECTRIC FLUID.

[32691.]—In the reports which appear from time to time in the press of accidents caused by lightning, frequent reference is made to the "deadly fluid" or the "electric fluid." For my own part, I consider such terms when applied to lightning absolutely incorrect, and I wish to ask Mr. Bottone and your numerous eminent students of electricity whether electricity and lightning can be correctly termed a fluid or not? I have endeavoured to hunt up information on this point, and in one book I find it stated that "electricity is not a fluid in the general acceptance of the term"; while in an old English dictionary, compiled by the Rev. James Barclay and published in 1812, I find under the word "Lightning" the following statement:—"The identity of lightning with the 'electric fluid' was proved by Dr. Franklin in June, 1752, when he contrived to bring down lightning from the heavens by means of an electrical kite, which he raised on the approach of a storm of thunder, and with the electricity thus obtained charged phials, kindled spirits, and performed several other experiments." It would be instructive and interesting to know the nature of the "electric fluid" which Dr. Franklin identified with lightning, and also to have further information respecting the "charged phials, kindled spirits, and other experiments" which Dr. Franklin manipulated with the electricity (a fluid, no doubt) which he obtained by flying his electrical kite. Some of our numerous contributors must surely possess information as to Dr. Franklin's experiments, &c., and also be able to give unimpeachable data as to whether lightning is or is not a fluid.

Princes Risborough. **Septimus C. Gurney.**

ELECTRICAL.

[32692.]—Mr. Benjamin speaks of capacity a depending upon the size of the conductor only; but it also varies with the shape. The nature the conductor does not affect the present question, as we are only considering one substance—viz., the zinc plate. Mr. Benjamin's statement that "lessening the resistance does not cause more electricity to accumulate" is only correct when the resistance is lessened by using a conductor of a different material, for if one of larger size or shape be used, th capacity will be increased, and the quantity electricity which it can acquire greater.

It is a peculiar conclusion to arrive at, that b cause there must be some resistance before th current can pass, therefore it cannot be less th one ohm.

I do not know that there is any particular obje tion in regarding an increase of chemical action the cause of an increase in the strength of th current, although each explaining himself in different way makes it rather confusing. My reas for preferring to regard it as the effect is given my last letter. **F. E. Goodchild.**

FOR AMATEUR PHOTOGRAPHERS.

[32693.]—The following note from the pen Mr. A. S. Green, of Frankford, Pennsylvania, m be of interest to some of your amateur phot graphers, and possibly they may be able to off suggestions.

Most amateur photographers have at some time their career ushered the family or their friends in the dark room, with its mysterious light, to witn that wonderful and interesting process — developing of a negative. They should rememb however, that the ladies are averse to this se darkness, especially when the colour of the lig does not suit complexion. When I wish to ent tain my friends now with photography, I produc dozen or so perfectly white sheets of paper, and open daylight, or lamp-light, immerse them one one in a solution, and slowly a beautiful posit picture appears and remains permanent. T process is as follows:—Take an ordinary silv print, wash and fix in a solution (ordinary strength) of hypo. soda, with an addition of teaspoonful of bicarbonate of soda to the pint. No gold must be used. Wash the prints well, and immerse in a saturated solution of chloride of mercury. A part of the chlorine passes over to the silver of the picture, and changes the brown silver particles into white chloride of silver, which is invisible on the white paper. At the same time subchleride of mercury (mercurous chloride), which contains less chlorine than the chloride of mercury, is precipitated. This body is also white, and therefore invisible on the white paper. When the paper is perfectly white, wash in clean water and dry. These prints will keep any length of time, and light cannot affect them. To develop, place the print in a solution of ammonia or hyposulphite of soda, and the picture will slowly appear. **S. A.**

PHOTO. OPTICS, &c.

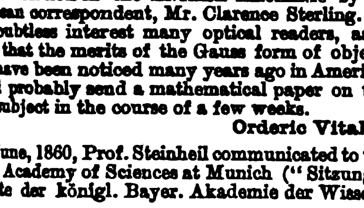
[32694.] — Lest "Orderic Vital" (letter 32674) and others should infer from my letter on the above book that its author would be likely to contribute to "Ours" a series of articles on telescopes and other optical instruments, I wish to say that it is quite useless to hope for such a thing, because, however willing and however well qualified he would be for the task, I know that his engagements would not permit it. Besides designing for and superintending one of the principal London optical works, he contributes largely to the German technical Press, and so scarcely has a minute to spare. And then a series of papers such as "Orderic Vital" invites is too large a task for almost any single man. Firstly, the strictly optical or glassing part should be separated from the mounting or mechanical part, and both these great divisions would again have to be sub-divided, because good lens hands are seldom also good prism hands, and micro-objectives are usually also made by specialists, and so are telescope and microscope mounts. Amateurs are better instructed in electrical than optical subjects. Comparatively few persons have a thorough insight into optical constructions, or even a partial insight, and so these papers, to be really instructive ought, I think, to be elementary.

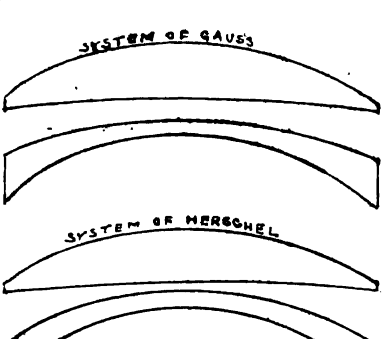
A. Caplatzi.

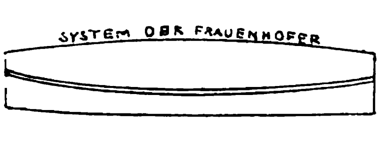
ON THE NEW FORM OF THE ACHROMATIC OBJECT-GLASS.

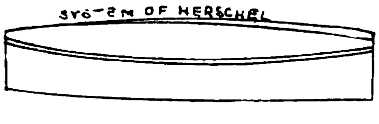
[32695.]—This communication has been sent to me for insertion in the English Mechanic by an American correspondent, Mr. Clarence Sterling. It will doubtless interest many optical readers, as it shows that the merits of the Gauss form of object-glass have been noticed many years ago in America. I shall probably send a mathematical paper on the same subject in the course of a few weeks.

Orderic Vital.









In June, 1860, Prof. Steinheil communicated to the Royal Academy of Sciences at Munich ("Sitzungsberichte der königl. Bayer. Akademie der Wissenschaften zu München," 1860, 11, 160) a notice of an object-glass of 36 lines aperture, executed at his optical establishment according to the system of curves proposed by Gauss in an article published in the *Zeitschrift für Astronomie* of Lindenau and Bohnenberger" in 1817. This telescope, and subsequently another ("Sitzungsberichte," 1860 V. 662) of similar form but larger, have been carefully tested, and in the opinion of competent judges they have exhibited a more complete achromatism, and in other respects more perfect definition, than was to be found with object-glasses of the ordinary form of equal dimensions.

It deserves notice that the resulting curves bear a considerable resemblance to one of the systems has been designed with express reference to the correction of the spherical aberration. Allusion is here made to the forms deduced by Herschel (*Phil. Trans.* 1821, page 258) for the elimination of the spherical aberration of diverging as well as parallel rays.

From the comparison subjoined it will be seen that one of the solutions satisfying his equation approximates nearly to Gauss's system, while the other approaches to a form employed by Frauenhofer. So far, therefore, as this holds good, each fulfils the condition proposed in Herschel's theory. As Gauss has published neither the mathematical investigation of the subject, nor even the final equations from which his curves were computed, we have not the means of deciding with entire certainty whether the resemblance referred to is merely accidental, or whether it expresses an affinity involved in the nature of the problem. But the latter seems the more probable explanation. The numerical values of the radii in his system, computed for a special case, are here transcribed from his original memoir (*Zeitschrift für Astron.* IV. 350), after reducing them to a focal length for the two lenses combined of 21 French feet, for the sake of comparison with the large Munich refractors:—

I.—Gauss's Curves.

First surface of the crown lens, convex radius = + 2·535ft.

Second surface of the crown lens, concave radius = − 7·521ft.

First surface of the flint lens, convex radius = + 3·123ft.

Second surface of the flint lens, concave radius = − 2·084ft.*

Compound focus = 21·000ft.

(* This number has been corrected to accord with the *erratum* noticed at the end of the volume cited).

In No. 1289 of the *Astronomische Nachrichten* Oudemanz has given the following measurements of one object-glass made by Frauenhofer for the equatoreal of the observatory at Utrecht. The numbers have been reduced to the same unit as before, assuming the focal length from *Astr. Nach.* 1281.

II.—Frauenhofer's Curves.

First surface of the crown lens, convex radius = + 14·157ft.

Second surface of the crown lens, convex radius = + 5·635ft.

First surface of the flint lens, concave radius = − 5·775ft.

Second surface of the flint lens, convex radius = + 2·5945ft.

Compound focus = 21·000ft.

Another of his object-glasses, probably computed from a similar formula, but for glass of slightly different refractive and dispersive powers, has values of the radii as follows (*Zeitschrift für Astron.* IV. 352).

III.—Frauenhofer's Curves.

First surface of the crown lens, convex radius = + 15·430ft.

Second surface of the crown lens, convex radius = + 6·144ft.

First surface of the flint lens, concave radius = − 6·262ft.

Second surface of the flint lens, convex radius = + 22·461ft.

Compound focus = 21·000ft.

These numbers we will now compare with the two solutions of Herschel's equations, using the notation $l\,r$ and r' to denote the reciprocals of the compound focal length, and of the radii of the front surfaces of the two lenses. The substitution of the values of the indices of refraction and of the dispersive powers which have been used by Gauss for computing the system I., gives the relations.

(In the equation z, *Phil. Trans.* 1821, p. 258, the coefficient of w^2 has been corrected from $\frac{2\mu' + 1}{\mu' - 1}$ to $\frac{3\mu' + 1}{\mu' - 1}$, vide article on "Light," *Encyc. Met.*, p. 426).

$$0 = 2{\cdot}3200\,r^2 - 21{\cdot}31\,l\,r + 59{\cdot}57\,l^2 + 3{\cdot}5792\,l\,r' - 1{\cdot}4233\,r'^2$$

$$0 = 6{\cdot}6400\,r - 24{\cdot}95\,l - 4{\cdot}1119\,r'.$$

From which we have—

$$0 = -\,1{\cdot}3917\,r^2 + 1237\,l\,r - 14{\cdot}56\,l^2.$$

With the roots—

$$\frac{r}{l} = 7{\cdot}4922, \text{ and } \frac{r'}{l} = 1{\cdot}3964,$$

which afford the subjoining two sets of values.

IV.—Herschel's Curves.

$$\frac{l}{r} = 7{\cdot}4922.$$

First surface of the crown lens, convex radius = + 2·803ft.

Second surface of the crown lens, concave radius = − 9·525ft.

First surface of the flint lens, convex radius = + 3·482ft.

Second surface of the flint lens, concave radius = − 2·361ft.

Compound focus, 21·00ft.

$$\text{V}\ \frac{r}{l} = 1{\cdot}3964$$

First surface of the crown lens, convex radius = + 15·038ft.

Second surface of the crown lens, convex radius = + 5·397ft.

First surface of the flint lens, concave radius = − 5·507ft.

Second surface of the flint lens, convex radius = + 22·135ft.

Compound focus = 21·00ft.

With radii proportional to these numbers the figures in the accompanying plate have been constructed representing sections of the different object-glasses, each having a focal length of 2ft. and an aperture of nearly 4in. The ratio of the aperture to the focal length has been taken larger than can be adopted in practice in order exaggerate the amount of curvature. It will be seen that the curves in the systems of Gauss and Frauenhofer may be nearly represented by the two solutions of Herschel's equations.

Note.—The refractive and dispersive powers in III., and probably in II., differ by small amounts from those used in computing IV. and V.; moreover, in the latter the effect of the thickness of the lenses and of their distance from each other has not been included, so that the numbers, to be strictly comparable, would require a small correction. The values V. computed with the elements of refraction and dispersion used in III. neglecting only the correction for thickness become—

+	14·212ft.
+	6·349 ,,
−	6·488 ,,
+	25·375 ,,
	21·000 ,,

)

It follows that Gauss's form, originally designed to secure a more complete elimination of the chromatic dispersion, must be also rather favourable than otherwise as regards the correction of the aberration of figure. It may be remarked, further, that his investigation, neglecting the thickness and distance of the lenses, leads to an equation of the fourth degree, which has no solution corresponding to V., nor to the above values of the radii used by Frauenhofer. On the other hand, if the curves in III. and V. have been derived from substantially the same theory, which seems a probable inference, it is scarcely possible that Frauenhofer should not have had at some time under consideration the system represented by the other solution of the equation which would have conducted to forms approximating very nearly to the system of Gauss.

G. P. Bond,
Director of Harvard College Observatory.

(From the *Proceedings* of the American Academy of Arts and Sciences, Vol. VI. 1863.)

DIALLING.

[32696.]—I am an amateur sun-dialist, and, judging from the questions occasionally asked in your unrivalled scientific paper, the interest taken in this pleasing mathematical recreation is reviving. Could not some contributor give us an article periodically on the subject—say one or two columns once a month? The best work ever written on the subject is, according to Keith, Emerson's. Could not you let us know what Emerson has to say by reproducing an abridgment of his work, if it is still in existence?—also Leybourn? (Mr. Archbutt, of Westminster Bridge-road, has, or had, what he believed was the only copy of Leybourn's work existing, some two or three years ago.) There is also "Hawney's" work (a friend of mine unearthed a copy of that work in Paris, at one of the old bookshops on the bank of the Seine last year). What has Fergusson to say on dialing in his astronomy? I hear there is also a work by Gatti on dialling. Are their systems all the same, or similar? or do they follow each other, like the proverbial flock of sheep? Keith says "the writers on dialling are very numerous." I have been searching for years, and advertising occasionally; I have only met with two. Could you give us a few names of these numerous writers? **C. H. T.**

WASTED FOOD.

[32697.]—I see that corn is rising sharply in price; I am afraid the harvest will not be good, and I am tolerably sure the potatoes will not keep. May I, then, call attention to the wasted food which is often allowed to rot in the pastures and woods? Unfortunately, our children are not taught things that would be specially useful to them in their surroundings—country children especially. They find out how to gather and eat blackberries and nuts; but they call many of the edible fungi Toadstools, and leave them alone. Let me ask for space for the following extract from Dr. Badham's "Esculent Funguses of Great Britain," which just now is very much *ad rem*. Writing some years ago, Dr. Badham says:—"I have this autumn myself witnessed whole hundredweights of rich, wholesome diet, rotting under trees; woods teeming with food, and not one hand to gather it—and this perhaps in the midst of potato-blights, poverty, and all manner of privations, and public prayers against imminent famine. I have, indeed, grieved when I have considered the straitened condition of the lower orders this year, to see pounds innumerable of extempore beefsteaks growing on our oaks in the shape of Fistulina hepatica; Agaricus fusipes to pickle in clusters under them; Puffballs [Lycoperdon giganteum, is no doubt meant], which some of our friends have, not inaptly, compared to sweetbread, for the rich delicacy of their unassisted flavour; Hydna, as good as oysters, which they somewhat resemble in taste; Agaricus deliciosus, reminding us of tender lamb kidney; the beautiful yellow Chantarelle, that Kalon Kagathon of diet, growing by the bushel, and no basket but our own to pick up a few specimens in our way; the sweet, nutty Boletus, in vain calling himself edulis, where there were none to believe him; the dainty Orcella, the Agaricus heterophyllus, which tastes like the crawfish when grilled; the red and green species of Agaricus to cook in any way, and equally good in all." So far Dr. Badham. Now, I would ask, Why are not country children especially taught to distinguish the common fungi—the edible from the poisonous? If they were, the poisonous would soon be stamped out—the "survival of the fittest" would come into full play. Our legislators, in their "wisdom," apparently think grammar and parsing of far more importance than an acquaintance with natural science. I am writing this, however, mainly to ask those of your readers who live in country districts to see what can be done (either by natural-history societies or by lectures, or, rather, discourses, and especially by descriptions on the "spot"), to teach country people what a large quantity of food is annually wasted simply from a want of knowledge. In my neighbourhood (a pasture district) there is not much chance of getting a mushroom unless you keep guard over it, but Blewits and Champignons are to be captured. I am, however, too near London to stand much chance, as the mushrooms that are known are soon taken, and those that are not known are smashed.

Saml. Ray.

VIOLIN-MAKING.

[32698.]—I HAVE made a discovery which may throw considerable light on the art of violin making. It is almost certain that the old Italian makers who first fixed the violin model did not do so scientifically, but from experiments which proved this to be the best shape acoustically. In measuring a violin, I was struck with its similarity of proportion to the musical scale. The longitudinal vibrating space inside representing an octave, you have the dominant in the widest part, the mediant in the narrowest—the two principal chords of the scale; in depth the ribs represent a semitone, which gradually extends to a full tone in the middle of the instrument—in fact, all the measurements correspond approximately to some interval of the scale mathematically divided. I am convinced there is an analogy between the form of the violin and musical scale, as there is said to exist between it and the primary colours, the human form, and other things in the harmony of nature.

I should like to know (1) has this analogy been noticed before? (2) If a violin made exactly to a mathematical division of the scale in every detail is likely to improve its tone—of course, assuming that the wood is of the best, and the workmanship of the most skilled description?

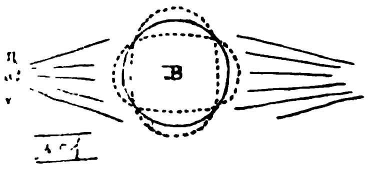
Student.

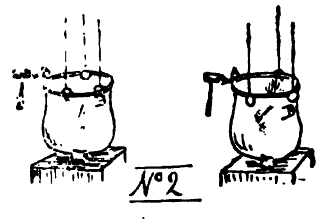
REFRACTION OF SOUND-WAVES.

[32699.]—WE are told by Tyndall (see his book on "Sound," page 19, § 6, an article on the refraction of sound started thus: "Another *important analogy* between Sound and Light," &c.) that sound waves can be refracted in a similar manner to the way in which rays of light are. To experimentally prove this he interposes a lens of some dense material in the course of the sound-waves, and from the result concludes the waves have been refracted. In the place of a magnifying glass he uses a balloon filled will a gas heavier than air—namely CO_2.

I think there is an error in the deductions from this experiment. Suppose now that the balloon filled with a heavy gas was replaced by a very thin bulb, say of blown glass, but with no heavy gas in it, the sound-waves would act upon it in the way I now describe with the aid of a sketch.

The waves coming direct from the watch W, alter the shape of the bulb B alternately into the shapes shown by the two dotted lines; this is evident from the experiments performed with balls suspended so as to rest against the edge of a glass bell (see illustration No. 2). When the bell is hit at A, the ball B flies inwards before the other two balls do. If we hang the balls so as to rest against the outside instead of the inside of the bell, and hit the bell again at A, the ball B would fly out after the other balls had.





To go back again to the first illustration. The motion caused on the side of the glass bulb farthest from the watch would be exactly similar to that caused by the waves of sound coming direct from the ticking of the watch to the other side, this being caused simply by the elasticity of the bulb, and not by any refraction whatever.

I think this is the correct interpretation of Tyndall's experiment. I certainly fail to see any reason for giving sound-waves a special property (viz., refraction) to explain what appears to me a phenomenon, or due simply to the waves causing an elastic body to vibrate. **A. T. Wheeley.**

PATENT FEES—TAXATION OF INVENTORS.

[32700.]—AT the recent meeting of the British Association Mr. Lewis Edmunds, D.Sc., read a paper on the "Taxation of Inventors," which is worth the attention of all interested in the progress of invention, and for this country that means everybody; but I am unable to agree with him in some of his views, just as I am unable to agree with Mr. Leng, M.P., who has recently published his speech in the House, with the comments of Sir W. Harcourt and Sir M. Hicks-Beach. What Dr. Lewis Edmunds has to say may be briefly summarised as follows, but his paper should be read in full by those interested. He compares the fees payable at the Patent Office with the insignificant demands made on an author of a book to secure his copyright. "There is," he says, "no species of property which is so heavily pressed upon or so burdened with taxes as the very limited one which the law allows an inventor to acquire. Although distinctions may be drawn, the monopoly granted by a patent is in many respects of the same character as the copyright acquired by an author, and the word 'copyright' might be almost equally well applied to the rights acquired by an author and by an inventor. But while the properties of an author and an inventor are very similar in their nature, the position of an author is immensely superior. He or his representatives hold the copyright for life and seven years after, or for 42 years from the date of publication, whichever may be the longer term; and no fees of any kind are payable to the Government, except when for the purpose of securing rights in foreign countries, or of taking legal proceedings for an infringement, it is necessary to register the copyright at Stationers' Hall, in which case a small fee is demanded. There is no special taxation of authors of any kind, unless, indeed, we count as such the five copies which have to be presented to the British Museum and the University libraries, and this is a small matter. But an inventor is not so fortunate. By the nature of the case, he can only secure himself after complying with numerous formalities and making a full disclosure of what his invention is. This, of course, cannot be complained of. But even then the inventor obtains the monopoly of his invention for 14 years only, and this is now subject, after the first four years of the term, to the payment of heavy annual fees, ranging from £10 to £20, and amounting to £150 in all."

There is no "necessity" to register at Stationers' Hall; but I hold that an author is entitled to his work in perpetuity, and there are those who, with some good argument, say that an inventor is entitled to hold his invention or patent (provided he can maintain his right) as an assignable property and something that can be handed down to his heirs for ever—just as land is, which certainly was not created by its present owners. But we have to deal with the law as it is, and it is difficult to see how an inventor of, say, a "machine" can hope to claim more than a monopoly of that machine. He surely ought not to be able to prevent anyone making something similar, and for the same purpose, so long as the special points of his invention are not copied. The comparison with the author of a book will not hold, because it is easy to give the views of the author in other words; but they are not his words, and it is not his book. It may be said that it is also easy to get round a patent in the same way; but it is not, for if you achieve the same object by different means you have invented another way of doing so-and-so, and your method is just as original as the prior patentee's. There is really no comparison—"A book's a book although there's nothing in it"; but it remains as so many words, and it must not be copied. An invention is a different thing. I may invent a machine which does certain work in a certain manner; but surely it would not be right to prevent anyone else doing the same work in another manner.

Dr. Lewis Edmunds deals with the fees payable at the Patent Office, and he says:—"Looking to the report of the Comptroller-General of Patents in this country for the year 1889, it appears that the total income from fees on patents was £151,794 4s. 4d., of which sum £93,205 was paid by way of renewal fees. The surplus profit of the office was a little more than this sum—namely, £93,534 8s. 9d.—and this went to the Treasury, and was used for the general purposes of government. It follows that if the annual taxes were abolished the Patent Office could still pay its way. This surplus profit is, therefore, a direct tax upon the inventors. The taxation of inventors through the medium of 'renewal fees' is a remnant of the old demands and perquisites incidental to the passing of letters patent under the Great Seal. It is entirely inequitable in principle, it works great injustice and hardship in practice, and, by damaging the value of property in inventions, acts as a drag upon the inventive genius of the nation, and thereby injuriously affects all the industries of the country."

I will, if you allow me, deal with this part of the subject in another letter; but I may as well point out that whatever "taxation" the patentee pays is in reality paid by the public if his patented invention is worth anything; if it is not, what does it matter to the public? The Patent Office must be supported somehow, and whether by fees from patentees or from grants out of the taxes, the thing is as "long as it is broad," though the actual manner of payment may be different. Dr. Lewis Edmunds says:—"In the United States of America inventors are not discouraged as they are here. There a patent may be obtained, which lasts for 17 years, for a payment of about £7 10s. in the first instance, and no further fees of any kind are payable. A British patent which runs for 14 years, therefore, costs more than 20 times as much as a United States patent which endures for 17 years. Consequently, although there is a search as to novelty which weeds out a large proportion, there are twice as many patents issued in the States as there are in England, with corresponding advantages to the industries of that country. The patenting of not only home, but also foreign, inventions is thereby encouraged, and an inventor, having obtained a patent, is induced to push his invention, and to make further improvements in it. The success of an invention means the improvement or creation of some new industry, and hence the country shares with the patentee in the profits." Exactly so, and the country pays for the benefit in one way or other.

Sir F. Bramwell made some remarks on Dr. Lewis Edmunds's which I epitomise as follows: He cannot agree with the author that the United States system of patents compares favourably with the English system. Those who took a leading part in framing the Act of 1883 well considered the mode by which the poor working man should be enabled to obtain a patent at a price which should not be beyond his means. It was thought that the best way of attaining this end would be to have a very small initial fee, giving provisional protection for a certain period. This system placed the comparatively poor man in a better position than in the case where a heavier charge was made in the first instance. A patent, however, might be so bad that it was not worth the while of anyone to take it up, and yet it might contain a discovery of such a character as to prevent anyone from using an improvement. In these cases it was contrary to the interests of the community that such patents should exist, because they were not good enough to be worked, and they might be an obstacle to improvement.

Sir F. Bramwell then made some remarks on the manner in which the specifications are printed and the drawings reproduced, saying that in "many cases one was compelled to refer to the original drawing." The type, too, it seems, has "become crowded and inconvenient."

It is not worth while criticising such remarks. The specifications and drawings are printed in a manner which is quite sufficient for all required purposes.

Saml. Ray.

SHOP NOTES.

[33701.]—The following "shop notes," by Mr. Colvin, in the *American Machinist*, may interest your readers, and I send them in case they may be overlooked.

In every well-regulated shop there is some method of driving mandrels or arbors in the work without bruising the ends of the arbor. Some use copper hammers, or hold copper plates to strike on, while some use lead im much the same way—and some, I regret to say, very often use the sledge without any protection whatever. In some instances the hide-faced hammers are used, and, after the hide faces are worn out, they are replaced by lead faces, which do very well indeed. For use with the sledge, however (and the hammers themselves are not heavy enough for some work), this is too expensive, and is unnecessary.

In this shop the hammers are cast as shown in Fig. 1, being a plain cylinder of lead with a groove around the centre. The handle is shown in the same cut, and is held in place by the ring or collar *r*, that slips over [the handles much the same as a blacksmith does his tongs. This handle is bent up of round iron or Bessemer steel, making a very cheap and effective tool that can be used to advantage in any shop not already equipped with this kind of tools.

In this same shop there is lots of pump work, and the pump barrel is in the form of a strainer, at least part of it is perforated for the admission of water, and this must be very smooth in order not to cut the packing of the piston. These perforations are drilled in a jig, and, of course, leave a burr on the inside, which must be removed. This presents quite a problem to remove them cheaply and speedily. When my friend Fred Schrader took the job, he devised a plan that was ingenious and effective, and though it might be altered to run by power, and so be more speedy, it does its work well. It consists of a bar of iron or steel with a forked end which receives a spool, this spool having two grooves to keep the belts separate. The countersink is formed on the end of the spindle for the spools, the whole turning in the end of the bar when actuated by the belts shown. Two sections of the spools are shown, which correspond to the spool in the bar; the end of the belt on *b* is fastened to a spring which brings the spool back to its original position after it has been revolved.

It will be readily seen that, by pulling the loop *l* (which, by the way, can be of any desired length to bring it in convenient position), the spool and countersink will be revolved at the same time, winding up the belt on the spool *b*; the spring reversing the motion and returning the countersink to its original position. This makes a very quick method, and is a great time saver. For small pipe this can be reduced in size quite materially by having the bar round, as shown in the lower part of the same cut (Fig. 2); the countersink can be of the required size, and that is all that need project from the round bar. The bar in the first case is planed out in the shaded portion, to allow the belt to slide freely; and in the round bar shown the side might be planed away, though for compactness the whole thing might be made of a piece of pipe, the belt sliding in the inside, and no planing would be necessary.

The belts, it may be mentioned, are really belt lacings, which answer very well. This, like many other tools, was made temporarily, but worked so well that a new one seems unnecessary. This is often the case with many of such improvements—they are made to try on this job, and work so well they are never built in the best manner.

There is another ingenious device due to my friend that may help some one else out of a bad job some of these days—it is shown in Fig. 3. There was a boss to be faced off in an out-of-the-way place on the machines, and the plan in use was to chip and file it "near enough." The boss was tapped for bolting some part of the machine to it, and this gave an opportunity for the device shown in the cut. It is very simple. A square piece of steel, filed, planed or ground to four cutting edges, and a hole through the centre for the bolt as shown. This bolt screwed in the hole forms a guide, a wrench on the square cutter serves to turn it, and the feed is regulated by turning the bolt. A few turns will face the boss all that is required, and a true face is the result, instead of the vagaries of a chipped and filed face. There are many places where this tool can be advantageously used, and it will pay for itself in a very short time.

I was speaking of trouble with belts "creeping on," and was shown a rig for preventing this nuisance and its attendant danger to both men and machinery. The rig is shown in Fig. 4, and will need little explanation to make it clear. A part of the shifting bar is shown with a notch cut in the top, at the right position for stop. A piece of wood nailed to the ceiling forms a guide for a sliding piece that drops into the notch and holds the bar from shifting from belt pressure alone, though it is easily moved, when desired, in the usual way. A weight on the drop holds it in its lowest position, and can be varied to suit the man at the machine.

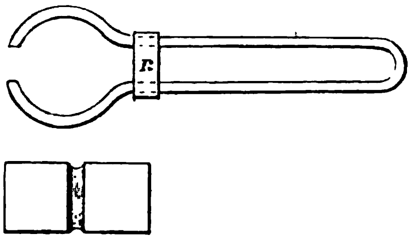


Fig. 1.

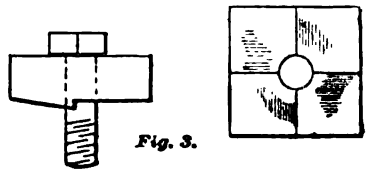


Fig. 3.

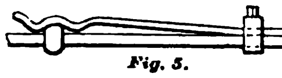


Fig. 5.

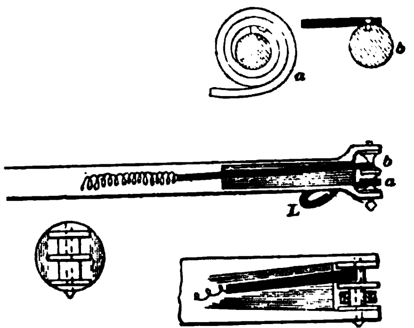


Fig. 2.

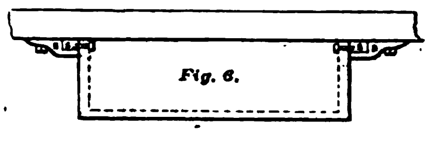


Fig. 6.

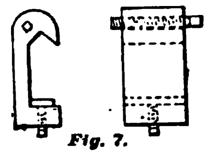


Fig. 7.

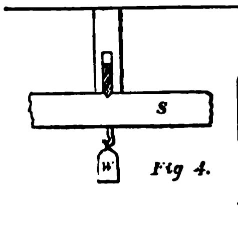


Fig 4.

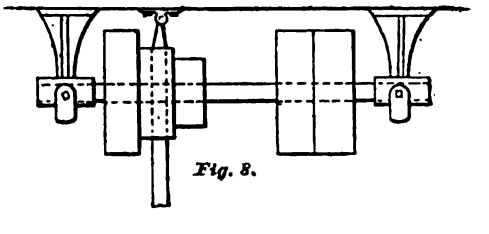


Fig. 8.

As many counters are now fitted with iron rods, this will not be applicable to them. Fig. 5 shows how this case is provided for very satisfactorily; five or six years' use has proved its utility. For single shift counters, *i.e.*, where no backing belt is used, only one bend will be necessary in the spring; the cut shown is for the double shift. A piece of steel, bent as required, and fastened to the bar by a collar or clamp, is all that is required; care should be taken not to have the spring too short, as there will be too much resistance to the shifter; for double shifts we use about two feet for the spring. No tempering is necessary.

We all know how drawer slides wear from constant use, and how they sometimes drop with their contents, to the disgust of the user of the same. This can be avoided by having the slides and brackets of cast-iron; they don't cost much, and not only outlast the wooden ones, but slide easier, as they they are planed on the sliding surfaces. The brackets *b* are fastened to the bench by lag screws as usual, and the slides bolted to the sides of the drawer by cap screws from the inside. This makes a very neat job, as well as being substantial, and the cost is not excessive.

It is sometimes necessary to face a lot of work in the lathe, and have the faces a certain distance from the other parts, such as facing nuts for some special job when all must be the same, and, in fact, there are numerous cases where it is convenient, if not absolutely necessary, to have some means of stopping the carriage in the same place every time. This can be easily accomplished by the use of the stop shown in Fig. 7, which fastens to the lathe bed over the shears, and can be set in any desired position.

The screw in the top of the stop is useful to graduate the distance without moving the whole clamp; it can be divided to read hundredths, and so be very useful for measuring distances in the lathe. In some cases it may be advantageous to use two, one at each end of the lathe bed, or rather carriage, but for most cases one will be all that is required, but that one will be found useful in many ways that are not thought of at present.

While speaking of stops, an ingenious arrangement comes to mind that I found on an old Pond lathe in an out-of-the-way corner. It was a long lathe, probably twenty feet at the least, and had a device for holding the screw from sagging that may be new to some; it was so arranged that there was always a support at the centre (or nearly so) of the screw without any attention on the part of the operator. Two supports, one each side of the carriage, a spring on each end of the carriage, and a pin in the middle of the lathe bed (on the front side) are all there is to it, but the combination is effective. In use, suppose one of the supports is at the middle of the lathe and the carriage at the head, the carriage moves towards the middle, and the support at the head end follows, being held by the spring on the carriage. When the carriage reaches the other support the spring on that end locks into the support and takes it along with it, but the support on the other end soon reaches the pin and is detached from the carriage, remaining in the middle until the carriage returns. It is a very ingenious device, and must be seen to be appreciated; I know of no better one in use at the present day, and this was an old lathe built in the year 1 B.C. by the looks, though the way a lathe is kept has much to do with its ancient appearance. It should be part of the trade to clean lathes and all machinery at least semi-occasionally, for a man is not apt to take much care of machinery that is so dirty you can't see the name-plate, or tell what colour it was originally painted.

It is often quite a job to throw belts from one cone to the other on the counter when the ceilings are very high, and several devices for this have been made. Some use a pole with a peg or roll on the top, and it seems to answer in some places, but the easiest rig I know of is that shown in Fig. 8, though perhaps it does not make it quite clear. As the cut shows, there is a ring fastened to the ceiling, and a shifter hangs free from it. By swinging the shifter against the belt from the desired side it forces the belt on or off the cone. A few minutes' acquaintance with one will do more to show the value of it than any description can; it will save time and patience, and remove the opportunity for a man straining himself, as is sometimes done.

A friend tackled me the other day in regard to the whistling clause in a recent letter of mine, and said if I had to work with men all around me whistling McGinty or Annie Rooney as loud as possible, I would not be so willing to allow the liberty. Any privilege can be abused, and usually is by some one man, to the detriment of all hands; at the same time the right to whistle should not be taken from the men in general: it is a great companion to many, and when carried on in a civilised manner need not disturb any one. A man should not be allowed to disturb any one else with whistling any more than in any other manner, but the quiet whistlers should not come under the same ban as the disturbers of peace and happiness.

Having a lot of brass plates to face, and not having any way to hold them besides chucking, and then reversing to turn the other side, my friend made another good rig for turning out work in a hurry. He turned up a plate of iron and bolted it to the face-plate, and got it true on the face. Putting a piece of smooth cardboard against the iron plate, he holds the plate against it with the back centre, and faces it while it is held by the friction of the plate on the cardboard and the iron plate. When one side is turned or faced off it is reversed, and the other side similarly treated; in this manner the plate is of uniform thickness, and can be quickly turned true on both sides. Cannot this principle be used in many cases where at present the work is carried on under difficulties? And why is not the principle of magnetic attraction used more extensively in this line of work (for iron, not brass)? An electro-magnetic chuck or face plate is easily constructed, and for much work would be of great value. A few cells of closed circuit battery or a line from an incandescent circuit would furnish current which could be applied to the running lathe by brushes similar to the dynamo, and would be of great use in many cases. It is not thought that this would revolutionise the machine business or any branch of it, but we might as well use the applications of electricity as anything else, when it is to our interest to do so. This has been tried, I am sure, though not acquainted with the results. If any reader has had any experience in this line I should like to hear of the results.

Detroit. **J. Miller.**

BALL-BEARINGS.

[32702.]—Re "Vulcan's" letter 32650, its writer is scarcely logical. He says, first, that I am an authority on ball-bearings; second, that he is not; and third, that consequently I am not an engineer—this three or four times, and underlined at that,—not open to reason, lacking in both mechanical knowledge and experience, and, in effect, that I "must not attempt to convince engineers" —i.e., "Vulcan"—that anything he has not already done is at all possible. Good old "Vulcan"; but a little calmer next time, I pray you. Also a word in your ear. The constant repetition of "you are not practical" as an argument (save the mark!) recalls Hamlet's "Methinks the lady doth protest too much," and raises visions of men who, though good draughtsmen and clever theorists, are still fallible, and would find themselves sadly out of place trying to clear a seized journal in the middle of a Biscayan gale—an experience I have had more than once, and do not again desire.

"Vulcan's" ideas as to cycle bearings are almost comically incorrect. A tricycle axle rarely runs on the bottom balls, and the load is far beyond his estimate. Further, he implies that I advised the use of cycle balls (say $\frac{3}{16}$, $\frac{1}{4}$, and $\frac{5}{16}$) for such work as a loco. axle has to do. I suggested no such idiotic foolishness. The crushing-point of a $\frac{3}{16}$ cast steel ball is about 3½ tons.

In a pair of ball-bearing pulleys for a skewed 9in. link-belt, transmitting an average of 40H.P., the balls used are ¾in. diameter, and have been running without the slightest repair or trouble for 3½ years. The plain bushed pulleys previously used were a constant source of annoyance and loss of time, but the engineers there, not following "Vulcan's" plan of "dealing with things as they are," took it into their heads to deal with them *as they ought to be*, and so actually surmounted the difficulty by fitting ball bearings. This was doubtless all wrong, and, of course they could not have been practical men, or they would not have done it; but if not practical according to "Vulcan," they were effective, which is possibly quite as good. Let us hope they will be forgiven.

Now, "Vulcan" admits "that hard metal, such as the balls and races, being of hardened steel, have less friction than of the softer wrought iron running on gun-metal," and again by implication, that rolling friction is much less than rubbing friction; yet he will not put two and two together and figure out to its logical conclusion.

I do not contend that ball bearings would never give trouble. That is chiefly a matter of workmanship. I do contend that the principle of spherical roller bearings, laughed at when first applied to cycles, and ridiculed by engineers of "Vulcan's" mind when suggested as suitable for lathes and lathe-shafting, has proved a conspicuous and practical success, reducing risks of seizing, &c., &c., to an almost invisible minimum, and that the same principle sensibly and *proportionately* applied to much heavier work still, would, in all probability, prove a still greater success by reason of the greater results involved.

"Vulcan" says it is not practical to carry heavy weights on ball bearings. I say it is already done, though not, perhaps, for such heavy weights as in a loco. His difficulty as to oil squeezing out is an imaginary one, seeing that his bearings may be their own oil-cups.

The pith of the whole matter is this: "Vulcan" has attempted to lay down the law on a matter in which he has only prejudice in place of experience. Let him throw his prejudice aside, and try one bearing, made under his own supervision and tested by himself. I am quite open to conviction, and then shall be glad to hear from him. The experiment would not be very expensive, and in any case would be worth all the writing, "for the sake of argument," in the world.

Ball.

MAGIC SQUARES: CURIOSITIES OF HIGH NUMBERS.

[32703.]—Astronomy is often mentioned as a study that gives us a perception of the infinite—or, at any rate, the vastness—of great numbers. But, Sir, I think the study of magic squares is even better than astronomy in this respect. The interesting letters of Mr. Cram and Dr. Willis expound methods for making these squares, which in the case of larger squares produce variations in numbers that are perfectly bewildering in magnitude—numbers so great that to save room in writing them we have to content ourselves with their logarithms. But I will first give examples of some of the smaller numbers.

In the first place, it must be mentioned that it is not always essential that skeleton squares, like Mr. Cram's Fig. 1 (letter 32618), be superimposed with magic squares identical in both arrangement and position. All that is necessary is that these compartments containing the same numbers shall be so superimposed. Thus the compartment in the top left-hand corner consisting of 25 cells each filled with the number 50, may be superimposed with any square of 5 whatever. The remaining three-quarters consisting of the numbers 0, 25, and 75, must be superimposed with an identical square; but it may also be any square of 5 whatever. Now as there are, in round numbers, at least 300,000 different squares of 5, each of which may be turned into eight different positions (or "aspects"), a little calculation soon tells us that from that one skeleton square alone $(300,000 \times 8)^2$ different magic squares may be produced—that is 5,760,000,000,000. When we consider the great variety of ways in which Mr. Cram's Fig. 1 may be made, the total number of squares of 10 made by this method is astonishing. The same remark applies to Dr. Willis's square of 10—the numbers to the right of the dot being variable similarly in more than five billions of ways.

In the second place, it is to be remarked that this method of "dispersion," or "drawing together" of the numbers (whichever it may be called), is applicable to all squares made in compartments,—not merely to those that are made in four compartments only. Thus, a 9-square, composed of 9 squares of 3, may be treated in the same way as Mr. Cram's Fig. 2 when it is turned into Fig. 1; or as the figure at the bottom of Dr. Willis's first column (letter 32673), when converted into that at the top of the following column. For example, here we have a skeleton square made in this manner from one consisting of 9 squares of 3.

8	2	8	1	9	1	6	4	6
2	8	2	9	1	9	4	6	4
8	2	8	1	9	1	6	4	6
3	7	3	5	5	5	7	3	7
7	3	7	5	5	5	3	7	3
3	7	3	5	5	5	7	3	7
4	6	4	9	1	9	2	8	2
6	4	6	1	9	1	8	2	8
4	6	4	9	1	9	2	8	2

This skeleton may now be superimposed with another skeleton, consisting of 9 squares of 3, each composed of the series 0, 9, 18, 27 . . . . . 72. Taking into consideration the variations of both skeletons, there are (if I have calculated it rightly) exactly 1,623,201,856 magic squares of 9 obtainable this way.

Until now, we have been dealing with small numbers. The square of 3 being capable of no variation, except of "aspect," we do not get very high numbers where that square alone is concerned. But suppose we take an 18-square, not made in 4 compartments like Dr. Willis's examples of oddly-even squares, but in 9 compartments, each of which is a square of 6. Now, taking the number of different squares of 6, in round numbers, as one billion (there are probably many more than that), we get, taking into account the 8 aspects, a choice of eight billion to select from, for each of the 9 compartments; and get, for the total number of squares of 18 producible this way, the enormous number the ninth power of eight billion, which takes, to write it down in figures, more than a hundred digits. Its logarithm is 116·1278. After that it will not surprise the reader to know that there are 10^{164} squares of 25 made in compartments; 10^{230} squares of 24 composed of 16 squares of six; 10^{341} squares of 30 composed of 36 squares of 5; or 10^{476} squares of 36 composed of 36 squares of 6. As these stupendously high numbers merely represent the number of the squares made by one particular method, the total number of such squares must be very much greater. The number of the "bordered" kind probably exceed the number of those we have been considering.

At first sight it might seem marvellous that magic squares are so difficult to make by the uninstructed. It would by many be thought that if a square can be made in quadrillions, quintillions, or decillions of ways, it would be wondrously easy to construct. To counteract such an idea we have only to compare the number of variations with the total number of permutations of numbers in the square, and it will be seen that vast as the number of a certain magic square may be, it becomes almost infinitesimal in comparison with the higher number. Thus the number of squares of 15 composed of 25 squares of 3 would take 29 figures to write down; but, on the other hand, it is to the number of permutations of 15^2 numbers in a square, merely as one is to a number of figures more than 400 figures in length.

In conclusion, I may add what is not generally known, I think, to even students of magic squares, and that is that, given any magic square whatsoever, it can be changed into a fixed number of other squares also magic, by merely transposing the rows and columns in a definite manner. If R be the root of the square (if even), and R + 1 the root if odd; then the number of variations of the square so obtainable are:—

$$4 . 6 . 8 . 10 . . . . . R.$$

Accordingly, any square of 20 may be transposed into (4 . 6 . 8 . 10 . . . . 20) varieties, or more than a thousand million; and a square of 50 into a number requiring 33 figures to write down—260 quintillions.

The rules of such transpositions are very simple. The *n*th column may change places with the $[(R + 1) - n]$th column, provided the *n*th row also changes place with the $[(R + 1) - n]$th row. And *n*th column may change places with the *m*th column, provided the $[(R + 1) - n]$th column changes places with the $[(R + 1) - m]$th, and provided the same transpositions are also made in the rows.

New Athenæum Club. **T. S. Barrett.**

PAST, FUTURE, AND SPACE.

[33704.]—In query 75254, "Har." inquires how "past and future time can be always existent?" and very naturally combines with that question one as to "What is the term space of 'four dimensions' intended to mean?" There is every likelihood that past and future are coexistent in space of four dimensions; the misfortune is that space of four dimensions has no existence, actual or conceivable. "The address lapsed into metaphysics and became unworthy of further notice." That is Dr. Oliver Lodge's own verdict in a summary of the proceedings of Section A, and no one need, or is likely to, dispute its justice.

But no better illustration can be found of the justice of my criticisms on the course adopted of late by so many scientific men. How often have I argued that by leaving the sure path of the Baconian inductive method, and entering on the easy, seductive method of inventing *a priori* hypotheses and make-believe explanations, they are simply returning to the old methods of "science falsely so called," and losing the power to appreciate truth, or even to understand what truth really is? Dr. Lodge is one of the most active of that growing clique (for that is the real name for the party who claim to be apostles of "orthodox" doctrine), who are pertinaciously dragging "ether" into every scientific problem. No one can admire the earnestness, the mental energy, and the real scientific work of Dr. Lodge more than I do, and therefore I feel strong regret to see such a mind given up to this etherial intoxication. That he should "lapse into metaphysics" is a direct natural result of the habit of looking to imaginary agents for the explanations which are to be found only in proved realities, and should be sought only in the way of experimental tests. He and his companions are leading their disciples into the quagmires of metaphysics. The boundary line between the most exact branch of science, mathematics, and the idlest dreams of the human mind, metaphysics, is in these days completely broken down, with the result that some of our noblest intellects are being washed over, resembles about what would happen in "space of four dimensions," or any number of dimensions. We are taught now that in such space straight lines are really closed circles, and parallel lines meet, and a lot more similar rubbish, serving only to make students fancy that truth has no real existence, and as a direct result we have such trashy speculations as that past and future are nothing but a constantly existing panorama. The next step, and a very narrow one, plunges us into the Berkleyan notion that nothing exists at all except in perception.

They give us a semblance of argument, and say that just as a being existing in space of one or two dimensions would be unable to conceive space of three dimensions, so our incapacity to conceive space of more dimensions does not disprove its existence. That is just the argument of the etherealists, that we cannot dispute its existence and properties on the ground of want of knowledge, because we do not know what matter is, or the cause of its properties. At all events, we know they exist, and we know the same of space, though from a more exact view we know that abstract space has no existence, merely because it is the negation of existence, and simply the "locus" in which its existence occurs. But if we use a little common sense we can knock all these arguments to pieces. *Space of one or two dimensions is a complete misnomer:* lines and surfaces are not space at all, *they are only limited extension.* The very idea of space implies non-limitation; it has not even three dimensions, except for the purpose of the mathematician. The only definition possible of space is extension without limit of direction, a sphere with its centre everywhere and its circumference nowhere—in other words, infinitude. But the idea of space of one, two, or four dimensions is—limitation, controlled direction; in such imaginary space motion is not direct and free, but also limited by a boundary.

The amusing thing is that these transcendentalists claim everything which is not inconsistent with their doctrines as positive proof. I have given many instances of this, and Mr. Shearmen (p. 40) provides another, in a quotation from Prof. Young. The coincident disturbance or visibility of a centre of disturbance of the sun, and a magnetic storm on the earth, "is entirely in harmony with the recent remarkable experiments of Hertz upon the transmission of electric induction." Yes, and so it is with half a dozen other explanations. The theory based on the Hertz experiments is, however, a pure assumption taken for granted, and then asserted to be undeniable and proved, while other explanations are ignored.

Sigma.

PYROMETERS.

[32705.]—Can any of your readers suggest a means of measuring high temperatures besides those mentioned in the following note on the ordinary pyrometers? Although much ingenuity has been employed in the construction of pyrometers, great doubt is felt with regard to their accuracy, more particularly at very high temperatures. Numerous pyrometers have been devised by utilising the expansion of air from heat. Where these instruments can be conveniently applied they are capable of yielding fairly accurate results. Another kind of pyrometers are founded on the property which clay possesses of contracting at high temperatures. The apparatus consists of a metallic groove, 24in. long, the sides of which converge, being half an inch wide above, and three-tenths of an inch below. The clay is made up into little cylinders or truncated cones, which fit the top opening of the groove when they have been heated to redness; and their subsequent contraction, when still further heated, is shown by their sliding gradually down the groove till they arrive at a part of it through which they cannot pass. This measure of heat is no longer employed by scientific men, as its indications cannot be relied upon, owing to the variations in the quality of clay; but there are times when the principle involved in its construction may be of use for rough approximations of high temperature. In another class of pyrometers the temperature is measured by the expansion of a metal rod, inclosed in a case composed of blacklead and clay—in fact, of the same composition as a plumbago crucible, in which is drilled a hole $\frac{3}{16}$in. in diameter and $7\frac{1}{2}$in. deep. Into this hole the cylindrical rod of soft iron or platinum of nearly the same diameter, and $6\frac{1}{4}$in. long, is introduced, so as to rest against the solid end of the hole; and upon the outer or free end of the metallic rod rests a cylindrical piece of porcelain, called the index. When the instrument is heated, the metal expanding more than the case presses the index forward, which, by means of a wedge, is kept in the position to which it has been forced, when the instrument is removed from the furnace and cooled. A scale is then attached to measure the precise extent to which the index has been pushed forward by the metallic rod; it thus indicates the difference between the elongation of the platinum rod and that of the black lead which contains it. For its indications to be absolutely correct, it is necessary that the case and rod should expand uniformly, or both vary at the same rate. There are still other pyrometers arranged on different principles. For instance, those using the known melting points of solids; those depending on the chemical decomposition of solids, as Lamy's; those measuring temperatures by heating a known weight of water, and allowing to cool in it a known weight of platinum or other metal, which has been heated to the temperature of the space or of the body to be tested, as Pouillet's; those which determine temperature from the measures of strength of thermo-electric currents produced by heating the junction of two different metals, as Becquerel's; those which determine temperatures by the measurement of changes produced by heat in the electrical resistance of a length of platinum wire, as Siemens'; those which use the expansion of the wave length of a sound, which traverse a tube placed in the furnace whose temperature is to be measured, as Mayer's.

B. M.

Errata.—In the letter on "Magic Squares" ("E. M." Sept. 4, 32673), line 16 from beginning, for "cubic" read "entire." And in the square of 14, the number in the 8th cell of the 7th row should be "28," not "23."—J. Willis.

USEFUL AND SCIENTIFIC NOTES.

Some German engineers have invented a new lining for bearings. It consists of a thin layer of compressed vegetable parchment, and may be made to stand a great deal of use by being occasionally impregnated with mineral oil. This (says the *Engineer*) sounds very like the description of the compressed paper bearings tried several years ago.

The driving engines at the Chicago Exhibition, as now designed, will aggregate about 25,000H.P., including steam and electric motors. The great Corliss engine at the Centennial developed 1,456H.P., and at Paris in 1889, 6,000H.P. was required to drive the machinery. The machinery hall of the coming Exhibition will have six lines of shafting, each 800ft. long. Each line is to be divided into four sections of 200ft. each, each section to be driven by an engine; or, in all, twenty-four engines with a capacity of 125 to 200H.P. each. The combined pumping plant is expected to have a capacity of 40,000,000 gallons daily. The electric plant is stated at 16,000H.P.

Combined Ammeter and Voltmeter.—Messrs. Morris Bros., Ltd., Electricians, Birmingham, are introducing this instrument, which we feel sure will command a large sale. It is mainly intended to measure the electromotive force and current of batteries; but it may be used for other purposes, such as measuring the E.M.F. and the amount of current passing through accumulators, while charging or discharging the amount of current taken or used by an incandescent lamp, or lamps, &c.; it also indicates the direction of the current. It consists of a strong and well-finished brass case, about 4in. diameter and 2in. deep, a thick bevelled edge plate glass, suitable terminals for connecting with the source of power or energy; it is also fitted with two contact keys—the one to the right hand for volts, the other for ampères—a silver-plated scale or dial, the top line being marked in ampères, the bottom in volts; each instrument is calibrated separately; they are well made, and will stand rough usage. To use the instrument, connect the black or left-hand terminal with the positive and the other to the negative (no current passes until one of the contact keys is pressed), press the key marked volts when the aluminium hand or pointer will give the electro-motive force in volts on the bottom scale; press the key marked amps and the pointer will give the current in ampères on top line of the dial; as the readings are direct, no calculations are necessary. The price, calibrated 10 volts and 10 ampères, is 50s.

Adjusting Signal Wires.—A steelyard compensator for automatically adjusting railway-signal wires has been patented by Messrs. McKenzie and Holland, of Worcester, and has now been in use for some months at Worcester railway station, giving complete satisfaction. The apparatus consists of a bell-crank lever, mounted in a suitable cast-iron frame, the signal-wire being attached to the shortest and vertical part of the lever, while a sliding weight fitted with friction rollers bears upon the horizontal part of the lever. The weight is so constructed that when the signal is in its normal or danger position, part of it overhangs the centre of the bell-crank lever; sufficient weight is, however, left pressing upon the lever to keep the wire taut. When it becomes necessary to lower the signal to "all right," the weight is pushed along the lever by means of the lever in the locking frame, and when the signal is at "all right" or at "danger," the weight is free to counteract either expansion or contraction of the signal-wire. The chief advantages claimed for the apparatus are:—The signal arm is so controlled by the apparatus that it must indicate either "danger" or "all right." It cannot show partly on and off. The apparatus will compensate the wire at any distance or temperature, either when the signal is showing "all right" or "danger." No back or tail weight is required to assist the signalman in pulling the signal off to "all right," the distant signals being worked with the same ease as the home and starting signals. When working the distant signal all jerking and snatching is avoided, a steady pull being all that is necessary to put the signal to "all right;" consequently there is little liability of the wire breaking. Should, however, the wire break, the signal would instantly go to "danger." The apparatus can be fixed either inside or outside the signalman's cabin. The present adjusting gear can be dispensed with.

REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[74820.]—**Model Locomotive Making.**—I am much obliged to "J. H." for answering my queries; there is one, however, that he has overlooked—viz., What determines the length of slot-link H? Will be pleased to have reply.—D.

[74971.]—**Spiral Springs.**—Several replies on this subject can be found in back volumes; but it is not clear what is the exact information the querist requires. The internal diameter of the coil of spiral springs should be about four times the thickness of the steel of which the spring is made. The formula given by the querist's "theorists" may be wrong; but who knows? A formula is itself a theory. What more does he want? Clement.

[74973.]—**Wind Vane and Dial.**—In the circumstances it would be advisable to use a slot-link chain passing over pulleys; but a rod might be used supported in sliding collars. T. J.

[74976.]—**Polishing Ebony Walking-Stick.**—Fill in the stick with tallow (washed) and plaster of Paris stained black, if necessary. When dry, body-in with French polish, and proceed in the usual way; or, if preferred, size, and coat with copal varnish. To get a good effect it will be necessary to rub down with pumice dust and repeat the coats.

A. W. S.

[74979.]—**Extermination of Rats without Poison.**—It has been an old custom of mine to bait or feed the rats or mice for several days with a pan of ordinary flour or meal in a convenient place for them. When they have come in great numbers regularly, stir in with the flour or meal one-third part of fine dry plaster of Paris, and placing always a basin of water near. As meal, flour, plaster, &c., produce thirst, when Mr. Rat takes a drink, he at once has a cakeing of plaster in his stomach, and lies down to die, too stiff to turn round and run away.

San Francisco, Cal. W. G. Leeke.

[74980.]—**Typewriter Ribbons.**—The majority of these are merely silk supplied by an aniline ink (violet as a rule) to which a glycerine has been added. W.

[74983.]—**Cement for Glass Troughs.**—As these troughs are kept for studying the development of low animal life, and are "the usual square form," may I ask why bother about cement? In these days they could be cast square in one piece, or the edges could be joined together by the blow-pipe if it is absolutely necessary to build the troughs up out of pieces of glass. R. H. B.

[74986.]—**Defective Sight.**—Better consult an oculist. The eyes must be examined before any useful advice can be given. The defects complained of may be optical, or arise merely from disordered digesting organs. M. A.

[75000.]—**American Organ.**—Only one spring is required for any pallet in an American organ of the usual construction; but if the tubes are built up, or there are many in one piece, it might be advisable to use two, especially if amateurs find it difficult to get suitable wire. The best hard-drawn spring wire is needed—say 14 drawn down to 16, which a wire-dealer will do if a pound is ordered. The bulk of the wire sold by ironmongers is soft stuff. It must be specially ordered for springs.

Organon.

[75007.]—**Electric Law.**—Is not this "law" explained in all the textbooks? It is almost universal law in everything that attraction is inversely as the square of the distance. I know nothing about repulsion. What does "Puzzled One" mean? The query is addressed to "Sigma"; but I have no doubt it is fully explained in his book. Nun. Dor.

[75008.]—**Electric Belt.**—Get some broad strips of red flannel—three say, and sew in some discs of copper and zinc in such a way that the two different metals are separated by a thickness of flannel. That is an electric belt which, if it is only "believed in," will do as much good as anything else.

Video.

[75021.]—**Brass Goods.**—Brass goods of any kind will corrode unless lacquered, and they will corrode more quickly where gas is burned.

Brown Paper.

[75022.]—**Malleable Metal.**—The malleable iron must be coated if it is wanted black or brown. There are alloys of iron and bronze; but what is it the querist really wants? Selim.

[75047.]—**Stand for Telescope.**—In answer to "Amateur Astronomer," T. Westlake considers Mr. Calver's the best altazimuth stand he has seen, with some good advice; and perhaps for a reflector it may be the best, but to me it does not appear very suitable for a refractor even of small aperture. Most of the portable tripod stands for refractors are too loose or easy at the joints,—so much so, that if the telescope body is not nicely balanced, it will not remain in any position unless a steadying rod or other support is attached. I, with many more old readers of the "E.M.," and workers with the somewhat larger-sized refractors, say 5in. to 6in., would be very glad if someone would describe (with sketch, if possible) a good firm, rigid altazimuth mounting, suitable for outdoor work, and occasionally for public use. A good, plain mounting, steady, and not clumsily heavy. I am much in want of such a one. I am using one with a 4½in. now, and, without the two steadying rods, could not work often with any comfort and ease; and even with them (the rods on), it is very shaky with a gentle wind; and so it is bad to change quickly and easily to another part of the heavens. If I tighten up a bit, it jumps and jerks. I have a good contrivance for raising the lath leg stand suitably high. I would like to see a good altazimuth mount for a 6in. refractor, for out-door work, trunnion, or otherwise, firm, but not unduly heavy, because portability is a great consideration. Will someone consider this, and answer early?

A Member from the First, L.A.S. and B.A.A.

[75130.]—**Piano.**—There is no need for a drawing. A description of how to construct a soundboard will be sufficient. First of all, a rabbet must be made round the frame. You can plane it on the bottom and bend side, but under the wrest-plank a strip of wood, ⅝in. thick and ½in. wide, must be glued flat on the uprights. On the standards of the treble and bass a piece of wood the same width, but must be flush with the rabbet on the bend side and that under the wrest-plank. The rabbet on the bass standard reaches only two-thirds of its length downwards, so as to allow the soundboard to be free. This rabbet must be a little deeper inwards, so that when the soundboard is glued in it will be forced upwards in the central part. See that the rabbets are ⅝in. high from the standards to allow space between them and the soundboard. Now fit the soundboard in, and mark the uprights on it behind to get the space for the bars; usually 10 or 11 bars are put on, two between two uprights. The exact place for the bars is calculated in accordance with the thickness of the soundboard; but as you have made the frame you cannot do that now, and must see to get them in at equal distances as well as you can. Make the bars ⅝in. thick—i.e., that part which is glued, and ¾in. high. See that the vertical rays of the wood are on that side of the bar to be glued. Now take a board, which must be ¼in. hollow; or, if you put ¼in. strips of wood under it on opposite ends so as to allow the board to be pressed down when the bars are glued on, that will do as well. Plane the bars ¼in. round lengthwise on the side where they will be glued. To glue them on you require at least six laths or wooden ribs 1in. diameter or less according to the length. Fit them between the ceiling of your room and the soundboard, so that when you put them on the bars they must be bent, the spring of which is the force to press the bar on. When the bars are glued, plane the sharp corners off and bevel the ends from about 4in. from the end to ⅛in. thick, like a wedge. Now glue ⅝in. thick and ½in. wide strips of hard wood all round on the front of the soundboard to correspond with the rabbet underneath. Now lay the soundboard in the rabbet and mark the bars where they must be let in to allow the soundboard to lie flat in the rabbet. The bridges are made of beech 1in. high 1¼in. wide. The vertical rays of the wood must be on the side which is to be glued. Now get ten blocks all the same thickness, fit them between the bars, just on the part where the bridge will be glued on on the front. Put the blocks under the soundboard and glue the bridges on the way as you did the bars. The board is now ready to be glued in the frame; but you glue only three sides and leave it loose on the bottom and bend side where you screw it down with 1¼in. screws through each bar. A strip of cloth must be laid on the rabbet to prevent jarring.

J. H. Schucht.

[75136.]—**Tape Machine.**—Will Messrs. Clark and Montigue kindly say how it is possible for a thing to be "secret" and "patent" at the same time?

Sm.

[75153.]—**Skin Eruption.**—I would advise a course of vapour baths, and strict attention to diet. No *animal* food, especially *salted* meats or fish, must be partaken of; but farinaceous food and fruit only. Preparations of wheat, oats, barley, peas, beans, and lentils, with milk and eggs, are allowable, and these contain all the elements of nutrition which are required for the sustenance of the human body, and are especially suitable for persons with a tendency to gout or gouty eruptions.

F.R.C.S.

[75154.]—**Magnet Construction.**—You are quite right in saying the coils are right- and left-handed alternately. Wind a bar from end to end, and the two ends are exactly alike; continue to wind the second coil in the same direction over the first to the starting end, and if the first coil is right-handed, like a corkscrew, the second will be left-handed, like a left-handed screw. If the bar is bent to horseshoe form, it is just the same: one current will not neutralise the other because they are passing in the same direction, and though in one coil it goes from the pole to the centre, and in the next from centre to pole, the polarity is the same, because one helix is right and the other left.

Trial.

[75163.]—**Varicose Veins.**—I have used the ferrum phosphoricum, and the improvement still continues. I have been from home, or should have replied sooner.

Quilp.

[75171.]—**Keeping Milk and Meat.**—Perhaps some brother Scot can say what they use "ayant the Tweed"; but all that I have ever had occasion to analyse contained boric acid as the principal ingredient.

P. W. Stanley.

[75174.]—**Terebene Driers.**—The term is not quite synonymous, as you appear to suppose, with "patent" driers, of which there is an extensive variety, both "dry" and "liquid," and some of these may be found in books and technical journals. Terebene driers (pale or deep), on the other hand, so far as I know, is a trade secret—that is, a recipe which has never been published. At any rate, though quite familiar with both formulæ, I have never seen either of them in print.

P. W. Stanley.

[75179.]—**Photographing Diagrams.**—Something wrong with my reply last week. I have never heard of the "Oxford" plate; and the reason I prefer oxalate developer is that it does not cause the picture to veil over, whereas pyro. does do so if development is too prolonged.

Sm.

[75189.]—**Dynamics.**—In calculating the work done on the rope, the weight of the head must be included. But, in calculating the work done on the neck, the weight of the head must be deducted. Consider the difference in effect of a heavy metal cap on the head, and of the same weight on the shoulders.

J. S. C.

[75189.]—**Dynamics.**—Allowing that the term "momentum" may serve to denote *weight* × velocity, in place of *mass* × velocity, which is its correct signification, the question asked is *not* what is the *final* momentum of the criminal, but what is his *effective* momentum—i.e., the portion of his momentum which acts in stretching his neck. To avoid confusion, let us call the man's body B, and his head H. Now, during his fall, his whole momentum is the sum of the independent momenta of B and H; but the stretching or tension of the neck does not commence until the velocity, and therefore the momentum, of H, is destroyed by the stoppage of the noose at the end of the fall; and in order that (in mercy to the man) this stoppage may be nearly instantaneous, the noose ought to be fairly taut round the neck before the fatal lever is pulled. The weight of H then ceases to act, and the strain on the neck is due solely to the momentum of B. In fact, after the rope—assuming it to be nearly inelastic—has brought the head to rest, B continues to descend through some fraction of an inch, or else there would be no stretching. Hence, the effective momentum is measured by the weight of B multiplied by the velocity due to the fall. "R. S. P." ought surely to know (if he has ever read any book on dynamics) that given d, the depth of the drop, if v be the velocity it generates, we have—

$$v = \sqrt{2gd} = 8\sqrt{d} \text{ nearly.}$$

We have nothing to do with the time occupied in the descent, although, knowing d, this can be obtained by another well-known formula. Probably the pull on the neck would be better expressed in foot-pounds than in momentum. I have long thought that it was high time to substitute the Spanish garotte for the gallows. This instrument consists of a vertical post, from which a horizontal ring projects. The post is fitted with a horizontal screw in line with the centre of the ring, and mounted with a fly-wheel to give it momentum. The criminal is placed with his neck in the ring, his back being against the post. A spin of the fly-wheel at the back of the post drives the screw into his spinal marrow, and death is, I believe, almost instantaneous. This is doubtless a much more certain and humane mode of execution than hanging; and it involves no calculation in drop, which now seems to be the hangman's difficulty on many occasions when his services are required. There ought to be, and probably there is, some rule, however rough a one, regarding the length of drop. Were hanging a matter of simple strangulation, the answers to this question already given would be correct. But I have here assumed that, in order to insure almost instantaneous death, the neck must be stretched sufficiently to dislocate the vertebræ.

C.

[75201.]—**Cancer in the Stomach.**—It would be interesting to hear from what authority or causes "Yan" believes himself to be "disposed to cancer in the stomach," for which diagnosis there is probably as much foundation as that I have cancer disposition in the thumb and finger now writing these lines; as, did such a condition or the usual symptoms thereof really exist, then the M.D. who pronounced such a fatal disease to be *in prospectu* existence, would of all others be the one to advise diet, &c. Cathedral towns are choice spots for M.D.'s purse-filling propensities. As an instance of the mischief they can do for a guinea, a poor man of a naturally nervous organisation, and whose frame, countenance, &c., gave clear evidence that the wear-and-tear of an anxious energetic temperament was greater than the reparative, recuperative powers of digestion and assimilation, asked my opinion therapeutic concerning certain spinal, &c., pains. I suggested a glass of honest John Barleycorn ten minutes before dinner and supper, and abstinence from purgatives and liver pills. "No, no," said he, "poor Dr. G., of G——, twenty years ago told me, 'Tom, 'tis the liver. Beer is so much poison to you; don't touch it.' I paid him a guinea for *that*, and I'll believe him rather than you." I soon made him satisfied that the liver was sound as a bell, got him to take his tonic—i.e., ale, and thus put blood in his veins and flesh on his bones. His nervous system was in fact starved, hence the attacks of neuralgia, which was constitutional and hereditary. "Yan" would find *his* own symptoms and their remedies described here and there in "The Uses of the Sixteen Principal Medicines in Homœopathy," 2s. 6d. See 75173, p. 44.

The Lydney Dispenser.

[75202.]—**Blue Copying Process for Plans.**—There are three processes for the production of copies of tracings: 1. White lines on a blue ground; 2. Black lines on a white ground; 3. Blue lines on a white ground. Full particulars are issued in a pamphlet published by Bemrose and Sons, Irongate, Derby, or 23, Old Bailey, London, E.C.

E. Cope.

[75214.]—**Ball Bearings.**—Examine the spokes and rim carefully. Is one loose, or a crack present?

F. J. G.

[75214.]—**Ball Bearings.**—Perhaps you have your chain too tight; if not chain, just count the balls, and see that you have not got a ball too many in one side, and one short in the other side. I had a bicycle brought to me that way only the other day.

Nan.

[75224.]—**Permanent Magnets.**—Stroke them several times with the poles of a powerful magnet from the centre towards the ends, remembering to draw north pole of the inducing magnet over that portion which you intend to remain south, and the south pole over that which you propose rendering north. See also replies under No. 75124 in the "E.M." for September 4 and August 28.

S. Bottone.

[75225.]—**Driving Motor by Leclanches.**—To Mr. Bottone.—It would be impossible to drive a motor for more than a few seconds at a time by means of Leclanché cells. A motor to give 1½ man-power should have an armature of the Siemens H type, 2¼in. diam., 5in. long, running in field-magnets 6in. long by 5in. wide, and ¾in. thick, wound with ½ wire of the armature, and 10lb. on the field-magnets, the gauge of wire depending entirely on the ampères of current you intend using. The watts required to cause such a motor to give 1½ man-power is nearly 400. Consult my book "Electro-Motors: How Made and How Used," for designs.

S. Bottone.

[75227.]—**Gas Fires.**—There is no doubt that gas fires are quite as healthy and effective as coal fires under the same conditions. "Gloster" may perhaps be able to hire one from his gas company at a low rate; but if he has not a reliable chimney, a gas fire will be as great a nuisance as a coal fire under the same conditions. The necessary gas consumption in ordinary cold weather for a room 9 × 9 × 13ft. = about 1,000c.ft. capacity, would be 10c.ft. of gas per hour if a combined gas fire and warm-air stove is used; if an incandescent fire, without warm-air arrangement, about 14ft. per hour will be required. The average consumption for the five winter months will probably be less than half this.

999.

[75239.]—**Astro. Telescopes.**—For a Gregorian telescope the magnifying power may be approximately arrived at by the following formula.

$$M = \frac{F + f'}{f'} \times \frac{F}{f}$$

where F, f', and f = focal lengths of the object speculum, small mirror, and e.p., or substituting the figures given—

$$M = \frac{17 + 1\frac{5}{8}}{1\frac{5}{8}} \times \frac{17}{1\frac{1}{2}} = 130 : 1 \text{ nearly.}$$

If the telescope referred to is a Gregorian, I think Mr. Wake will find the distance between the two specula to be a trifle over 18⅝in., instead of 18in. as stated.

A. Gadd.

[75230.]—**Electrical.**—The proper stiffness of spring is such that when the proper battery-power is used, the core of the coil can just pull the platinum speck away from the contact screw, and as this is variable even in the same coil, it is usual to furnish good coils with a screw in front of the spring, by means of which the tension of the spring can be increased or decreased at will. You will find an illustration and description of mode of attaching vacuum tubes to rotator in the lessons which I furnished to the "E. M." some time ago on Electro-Motors, or, if you have not access to these, in my book, "Electro-Motors: How Made and How Used," for which see my adverts. in Sale Column. S. Bottone.

[75240.]—**Transformer.** — The conditions demanded are so contradictory that it is impossible to fulfil them in one instrument. How can a transformer give a large current of ¼ to ½ an ampère? Why the five or six accumulators alone give 20 or 30 ampères. Do you mean 2,000 volts from the current of five or six accumulators? Please express yourself more exactly, and I will try to reply. S. Bottone.

[75241.]—**Dynamo.**—There must be something radically wrong with your dynamo, if with an armature wound with 12lb. of wire, and field-magnets with 76lb. of wire on them, you only get 5 ampères and 50 volts. Why, such a machine should give easily 30 ampères at 55 volts. Please describe fully type of machine, mode of winding (series, shunt, or compound), also gauges of wire and speed of driving. I will then attempt to find the cause of failure, and suggest a remedy. S. Bottone.

[75242.]—**Truffles.**—Are used in small quantities, sliced very fine, for flavouring stews, omelettes, and also for stuffing geese and turkeys. S. Bottone.

[75245.]—**Cat.**—Give it powdered areca nut—on an empty stomach. Sm.

[75245.]—**Cat.**—First, let "A. M." go to his druggist and buy a good areca nut, not one all cracked and worm-eaten; then let him grate off as much as he can pile on a sixpence, mix it up with either butter or lard, and smear it on cat's side. As the cat is a very cleanly animal, it will lick the lard off, and, of course, the areca nut, thus saving you all struggling and scratching. An hour after this is done give a half-teaspoonful of castor-oil. One thing I forgot, and the most important, too, the cat must not taste food for at least 12 hours before giving the areca nut, better still if 24 hours. Repeat medicine after lapse of a week. Stewart.

[75247.]—**Steam Boiling.**—I suppose you will be aware that water boils at 212° Fahr., varying a little with the varying pressure of the atmosphere. Every pound added to the pressure increases the heat of the water from boiling point. If your coil will bear the pressure, you would save considerably in steam by having the valve at the outlet in place of the inlet. Of course, you would require a steam-trap to let out the condensed water. The reason of the reduction of pressure to nothing when the steam is let into the cold pipes is the sudden condensation of the steam. The difference of pressure between the coil and the boiler will depend upon the size of the entrance and exit of the steam to and from the upper coil; if they are the same, there must be a certain amount of pressure in the pipe before it can leave the coil as fast as it enters. By adopting the above plan, you will save coal, and the water would boil in less time.

The Cedars, Sunderland. W. Grimshaw.

[75251.]—**Refrigeration.**—Liquid carbonic acid gas (not *carbolic*, as printed) produces intense cold in the following way: In the first place, the liquid is produced by great pressure and extreme cold. At the ordinary temperature and pressure of the air, the compound (carbon dioxide, or CO_2) exists as a gas. When, therefore, some liquid carbon dioxide is exposed to the air, its tendency is to at once become gaseous. Now, heat is necessary to complete this transformation, and as the liquid is in a great hurry, it begins to absorb heat from everything nearest to it—in other words, everything within its reach becomes cold. This action is so energetic under certain circumstances that the compound, or part of it, absorbs so much heat from itself that the other part becomes frozen into a fine, light powder. F. E. P.

[75252.]—**Electric Lighting.**—A 2H.P. gas-engine should enable you to drive a dynamo capable of feeding ten to twelve lamps of 45 volts, 16c.p. each. Telephone wire will not answer. You will need an insulated cable (go and return), of 7 strands No. 21 wire. S. Bottone.

[75252.]—**Electric Lighting.**—You do not say what available power you have to spare. You will require one indicated H.P. for every 10—12 100volt lamp, and if they are taken direct from dynamo, the engine must run very steadily without any variation of load, or the light will be very unsteady and trying to the eyes. If it is not feasible to work in this way, you might be able to charge secondary cells during the daytime; but as you give no particulars no one can answer. Telephone wire will not do. Sm.

[75253.]—**Electric Engine for Boat.**—You can buy these any size from the dealers in scientific toys. I should recommend for battery the B.T.F. dry cell. Sm.

[75253.]—**Electric Engine for Boat.**—A small electro-motor of the Siemens type, with armature about 1¼in. diameter, 3in. long, running in fields about 4in. square, would best fulfil the requirements. The best and most compact battery to drive this would be three or four cells of the chromic-acid type, the whole of which, including motor, could be made to fit in a space 5in. by 6in. by 12in. S. Bottone.

[75258.]—**Pulse Tubes.**—Probably ether. Sm.

[75258.] — **Pulse Tubes.**—Alcohol, coloured with alkanet, or similar colouring matter, is usually employed. Ether is also sometimes used, when very delicate tubes are required. The air is exhausted from the tube, to allow of the rapid evaporation of the liquid. S. Bottone.

[75261.]—**Paper Wood.**—The substance this querist inquires about is actually paper. I think there is no very special manner of preparation of it. It is made into a pulp, and moulded under enormous (hydraulic) pressure. "Oak" is wrong in saying it is "taking the place . . . . of metal in wheels for railway carriages." Experiments have been made to substitute the paper for the wood now used, but have proved failures, as the paper wheels are found to warp and give under the strains to which they are subjected. F. E. P.

[75262.]—**Gramophone.**—In answer to this query, a microphone or telephone will not increase the reproducing power of a gramophone. If querist will fit a larger diaphragm to his machine, at the same time making it very tight, he will find the machine speak much louder; but remember that a small diaphragm gives more distinctness in reproduction, and the tighter it is the more perfect is the result. H. G. Suggett.

[75264.]—**Yeast.**—Yeast is a plant. There is no hard and fast division between the animal and vegetable kingdoms, so far as I am aware. I should say that disease-germs occupy, as near as possible, the position of debate. Sm.

[75264.]—**Yeast.**—Yeast is a plant, a genus of budding fungi. The line between the animal and vegetable kingdoms is at present undetermined. One attempt to define them places organisms containing oxygen, hydrogen, carbon, and nitrogen among animals, and those where nitrogen is absent among vegetables. Another endeavours to mark the two kingdoms by the nature of the food consumed. Plants flourish by imbibing as it were nature's raw material, gases, minerals, &c., while animals require nature's manufactured article—i.e., substances which have undergone the influence of that mysterious something which we call "life." Neither definition is absolutely correct.

Maldon. F.

The total length of the track in the United States on December 31st, 1890, was, according to "Poor's Manual," 166,817 miles.

Invention in India.—A report on the working of the Indian Invention and Designs Act during last year, which has just been issued, states that the total number of applications for patents was 319, as against 336 in the previous year, of which 96 were referred to experts, the remainder being dealt with by the officer appointed under the Act. Permission to file specifications was accorded in the case of 176 applications and refused in 37, while 106 applications remained pending at the close of the year. Many of the latter were filed under section 25 of the Act, after an application for a patent had been made in England, and awaited the completion of the patent there. The Government of India, however, have ruled that the granting of an application for a patent should not, save in exceptional cases, be delayed in future until the sealing of the English patent. Out of 192 specifications of inventions which were filed, 18 were connected with railways and tramcars, 16 dealt with processes for the treatment of fibres and cotton in various stages of their conversion into textile fabrics, and 12 were connected with the manipulation of mineral ores. There were seven inventions dealing with the various stages of tea manufacture, five relating to the preparation of indigo, and six intended to facilitate and improve methods of irrigation: three dealt with agricultural implements, and eight inventors of punkah machines were granted exclusive privilege during the year. The public made more use of the provisions of the Act for the registration of designs in 1890 than in the previous year; 49 designs, the majority of which were patterns of textile fabrics, were presented for registration, of which 44 were registered. The fees collected amounted to Rs.10,406, including amounts paid for the inspection of registers and for copies of specifications and drawings.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

74766.	Rolling Press, p. 413.
74778.	Sulphur in Spent Oxide, 414.
74784.	Fan Blast, 414.
74785.	Gelatine, 414.
74805.	Gas-pipes, 414.

74985.	Adjusting Mirror of Reflector, p 510.
74990.	Townley's Electric Bells, 510.
74992.	Preparing Accumulator Cells of Red Lead and Litharge, 510.
74999.	Grain in Steel, 510.
75006.	Spectroscope, 511.
75017.	River Steamers, 511.
76025.	Musical Bells, 511.

QUERIES.

[75265.]—**Piano Pedals.**—I want to make a set of pedals to fix under my piano for organ practice. Can any of "ours" inform me how to proceed, and about what would be the probable cost? I should like them to speak independent of the piano, and to slide under when done with. Would it matter about their tone being different to the piano, as this is a little "harsh" in the bass?—Pedals.

[75266.]—**Raising Water.**—I wish to raise 34 gallons of water per hour, 20ft., from a small brook. How can it be done? A sketch will oblige.—Hydraulic.

[75267.]—**Crown Iron in Concrete.**—If I set a rod of crown iron 100ft. long in a concrete wall 2in. inside the surface, will it be affected by the unequal temperature of summer and winter so as to break the iron or split the concrete?—M.

[75268.]—**Inertia.**—1. What causes the apparent contradiction of the first law of motion—i.e., the law of inertia in the following case: On a railway journey I have frequently noticed that in the act of stopping at a station passengers are thrown slightly in a direction opposite to that in which they are moving. Can this be explained to one who has a slight knowledge of mechanics? 2. Will "F.R.A.S." or any other competent authority explain to a layman what is the theory which has induced some astronomers to doubt the theory of gravitation, substituting in its stead an ultrauniverse repellent force?—C. R.

[75269.]—**Harmonium.**—We have a harmonium which is too heavy in the bass, but otherwise good. How may this be remedied?—E. E. C.

[75270.]—**Dynamo.**—Would Mr. Bottone kindly inform me of the best amount of wire to use for F.M.'s of the simplex type of dynamo; F.M. core, 5in. high by 2½in.; armatures composed of cog punchings, 5in. between cogs, 2in. deep, which is wound with nearly 3lb. of No. 20 d.c.c.? Please say what lamps it should light? and oblige.—Tyro.

[75271.] — **Furnace.** — Will some correspondent kindly give me design of a furnace for the destruction of refuse (chips) from wood-planing machine? It must be arranged to cause no nuisance from smoke: I could adapt a chimney 28ft. high to the purpose.—J. M. F.

[75272.]—**Telescopic Optics.** — "F.R.A.S." has made matters so clear in connection with the above, that I am tempted to draw further upon that gentleman's fund of knowledge, and, I fear, patience. Would "F.R.A.S." be kind enough to clear up one or two points further? How may I gauge the relative illuminating power of a telescope, say of 30in. focal length, with and without erecting lenses? How is the power of an eyepiece determined? Suppose an eyepiece composed of two lenses, whose focal lengths are 1in. and 2in., what power would such an eyepiece give to a telescope with a 30in. o.g., and with a microscope objective what would be its multiplying power? What advantage has the 1 to 3 ratio over the 1 : 2 for telescopic eyepieces? Under what magnitude are Jupiter's satellites classed, and what power is required to observe distinctly their occultation?—Tyro.

[75273.]—**American Organ.**—I should feel greatly obliged if some reader will inform me how to get over the following difficulty? I cannot make some few of the reeds speak at all in their proper cavity; they belong to the upper octave of the 8ft. row, and are voiced and tuned. if placed in a cavity of the same size in another row they speak at once, or if I put the reed an octave lower, in the cavity from which I removed the reed that will not speak, it speaks quite freely. I have about six like this, and am greatly puzzled to find where the fault lies. It cannot be in the reed, and I cannot discover anything wrong with the cavities, from the fact that other reeds will sound in them perfectly.—Spring.

[75274.]—**Steam-Engine for Boat.**—Would an engine with a 3in. bore, 6in. stroke, with a pressure of, say, 50lb per square inch, be able to propel a boat 14ft. long against a stream of about four miles an hour? Also, what size of a boiler should I require to supply the above engine? Any information will oblige.—Neva.

[75275.]—**To Mr. S. Bottone.**—Kindly let me know the best speed, the number of lamps it will light, the candle power of lamps, and the voltage of lamps of dynamo; armature 5in. diam., wound with 3lb. of No. 20 B.W.G.; the field-magnets 9in. long and 2in. diam., wound with 12lb. of 20 B.W.G., and oblige.—J. B. S.

[75276.] — **Carbonising Wool.**—I wish to ask "Nun. Dor." for his advice as to the best and cheapest way to carbonise vegetable fibre in rags or other mixed vegetable and animal fibre. If, as I expect, chloride of aluminium is the best carboniser, what is the value, and where can it be obtained? Also, the best and cheapest plan of drying closet for about ¼cwt. at each drying. Any other particulars in connection will oblige.—Fibre.

[75277.]—**Iodine.**—(1) Will any chemist inform me how to recognise the presence of iodine in the human body? It is said to be absorbed when applied externally, and to be present in the urine and saliva; but I cannot find that it is so by the usual test (starch paste). (2) Would anyone also recommend me a modern manual of analysis, giving the tests for alkaloids, proteids, peptones, ptomaines, toxines, &c.?—M. A.

[75278.]—**Cut-out.**—In a charging circuit an automatic cut-out is arranged to take 25 amps, 100 volts, and afterwards the plant is increased to take 50 amps, 100 volts, and having another automatic cut-out for 25 amps, how should I arrange them in parallel or series to work at the 50 amps, and break circuit at 10 amps?—T. A.

[75279.]—**Coil Boiler.**—I should be much obliged for a few hints concerning the above. I wish to make a coil boiler for an engine 1½in. bore, 3in. stroke. I wish to make coil from solid-drawn copper pipe, say, ¾in. bore. How many feet should I require? Also what size of pump to supply the coil? Please give diameter of ram, length of stroke, and diameter of valves. I intend working pump over head in water, so as to make it sure. What thickness metal ought copper pipe in coil be? I can get it No. 12 B.W.G. thick. I want to work at over 100lb. per square inch. What length of ¾in. bore copper pipe would a 2in. bore engine require, and size of pump? Can I drive a 3in. centre lathe for light work with 1½in. bore engine?—Nan.

[75280.]—**Earth's Longitude.**—I do not see why there should not be a table of this as well as of the sun's. May I ask if any of our readers know where such a table is given, or how the earth's radius vector for any given date can be computed? The position of the earth in its orbit is rather important, and I think our so-called textbooks and tables are remiss in this respect. What is the meaning of log. *q* usually given in the elements of a cometary orbit?—A. B. C.

[75281.]—**Distortion of Object in Refractor.**—I should be much obliged for information on the following point:—In using my refracting telescope I notice a slight distortion or prolongation of the image of a planet or star towards the left hand (as seen with an inverting eyepiece), with a little haziness of outline on that side. This, I presume, indicates that the object-glass is slightly tilted on that diameter, so as not to be accurately at right angles with the axis of the tube. Should the edge of the object-glass on the left (the same side as the distortion in the optically-inverted image) be pushed forward or drawn back by the adjusting screws? —X. Y.

[75282.]—**Oars.**—Now and again I have oars to make. Has any of our readers seen a device in the shape of a band-saw worked by hand—one that could be easily fixed and removed, shop being small?—Nero.

[75283.]—**Case-hardening.**—Will some reader tell me how to case-harden small articles, such as gun fittings, and where can I get the bone-dust or other materials which it is done in?—Back Centre.

[75284.]—**Shunt.**—When you are charging accumulators with a shunt machine, is it necessary to have a resistance in dynamo circuit? If so, how is it arranged? Sketch would oblige. Also, why can't the series winding of a compound dynamo be used for charging accumulators? What advantages do you gain by cutting same out?—T. A.

[75285.]—**Glass Painting.**—I wish to do a trade in this, and knowing how to set about it, could any of our readers kindly inform me of which are the principal transparent colours connected with the art?—J. A. Bellringer.

[75286.]—**Heliograph.**—Can any of "ours" describe the heliograph used for telegraphing? It would be of great use to many of your readers, especially those who live in the Colonies.—Colonist.

[75287.] — **Unfermented Wine.** — Can any of "ours" say what antiseptic is used as a preservative of unfermented wine? I had a small quantity some time ago in the shape of white powder, used by an English firm for this purpose, but unfortunately had no opportunity of testing it chemically. It had a bland taste, and was inodorous. Martindale in his "Extra Pharmacopœia" says boric acid, even in a small quantity, favours the conversion of glycose into alcohol, so I doubt whether it was boric acid, and the taste did not suggest salicylic acid.—Colonist.

[75288.]—**Dry Battery.**—Will Mr. Bottone or any of "ours" give me instructions for making a dry battery for electric bell work? It has to fit into a space 8 by 1¼ by 3¼. Will you give exact quantities of materials? Case to be made of zinc.—W. C. Phillip.

[75289.]—**Electrical.**—An electrified drop of water, supported by a conductor, evaporates. Assuming that the vapour is not electrified, what changes will the potential of the drop undergo?—Frictional.

[75290.]—**Electric Clock.**—Would any reader help me in the working of an electric clock I have? Maker's name on dial is Alexander Bain's Patent Electric Clock. I can get it to go; but so easily does it stop, that it is a little puzzling to get it to go. Perhaps some reader may know this man's clock; if so, he can understand what I am driving at. The motion gets up, and falls off; when I say so, I mean that the long piece of steel that works on top of two sockets goes sometimes further along this socket. One, on the left side, has a piece of brass, half a circle; the other half, a jewel or polished pebble, grooved with round file. A little from the centre edge of this pebble is a piece of brass wire, flush (one of the connections). It is cut like the head of a screw. Is it originally thus, or cut through friction, I would like to know? I have cleaned out the movement, and it looks well, being a first-class finished article. I must clean all the connections. How am I to proceed? It has not been going for the last ten years. About the stopping of it: I can get it to go by shifting this socket from side to side. Is there any way of putting this same clock on beat? Just now I have the movement out, and the pendulum swings on, never stopping, causing no little amusement. Is the Leclanché battery strong enough? Should anyone be so good as to communicate with me by saying so, I shall be obliged.—Bain's Electric Clock.

[75291.]—**Dissolving of Elements, &c.**—Will someone kindly give me the dissolving-point of the various elements, or tell me in what work I could find the various elements, such as iron, gold, silver, copper, and other chemicals enumerated with the degree of heat, or electric force necessary to melt them or dissolve them into a gaseous state?—Ra-Osiris.

[75292.]—**Perfumes and Music.**—Will some correspondent give me a brief explanation of Mr. Septimus Piesse's theory on above question? The Press briefly stated the fact recently from, I think, an American journal, but am anxious to gain fuller knowledge thereon. —Ra-ma-sra.

[75293.]—**Small Furnace.**—Will any reader kindly inform me how to make a small furnace to melt about 2lb. or 3lb. of brass at a time, without using a blowing apparatus? I have a chimney about 20ft. high which I can utilise. An answer and sketch from an experienced person would greatly oblige.—T. E. G.

[75294.]—**Colour for Oil.**—Is there a stain or dye that will permanently colour oil a bright red; alkanet root suits admirably as regards colour; but speedily fades when exposed to light, being therefore useless for my purpose?—A. C. Brook.

[75295.] — **Skin Eruptions.** — "Mallett," letter 75173 on skin eruption, advises a dose of powdered charcoal. Does he mean ordinary wood charcoal made of any sort of wood? Would "Mallett" kindly answer?—H. Morgan, Stansted.

[75296.] — **Amateur Soap Making.** — Can any reader inform me what to mix with soap to make carbolic soap, and in what quantities? Also the colouring used to produce the brown of the carbolic soap of commerce. I make a quantity of soap from waste fat, which I get in large quantities, but it all turns out yellow, with rather an unpleasant smell. I use the Greenbank 98 per cent. alkali.—Alkali.

[75297.]—**Dynamo.** — To Mr. Bottone or Mr. Askew.—I have a small dynamo armature wound with 86 yards No. 20 on 8 section drum; F.M. wound with 3¼lb. No. 22 in one coil; shape of machine, near to the "Simplex," and well put together; 20 yards of the armature coil are active, diameter of A. = 2¾in. I should get 20 volts at 1,800 revs. per minute, but it takes nearly 4,000 per minute. Have I the right proportions of wire? On a short circuit I have taken six ampères of current from it for a short time, but the voltage was only about three. How am I to get the E.M.F. increased? I am making a new armature for it of the Siemens type and winding with about 50 yards of No. 18 wire. Will you please say how many volts I may expect?—as I want about thirty volts with three amperes of current. If I have room I will compound the armature, so as to send a constant current round the F.M. coils.—J. T. B.

[75298.]—**Valves for Water-Engine.**—I should be much obliged if any of your readers would give me a sketch and particulars of a good valve for opening and closing the inlet and exhaust ports of a water-engine. Would an ordinary slide-valve as used in steam-engines do?—A. M. M.

[75299.]—**Photometer.**—I want to make use of a grease-spot photometer, but I do not know what a "standard candle" is. Would some kind reader tell me what to use?—Lux.

[75300.]—**Dutch Bogie Expresses.**—Will some reader send particulars, and, if possible, a sketch of one of the bogie express engines No. 362 class, built by Messrs. Sharpe Stewart (1889) for the Dutch rail-railway? They run the boat expresses, and are magnificent engines.—C. F. Dendy Marshall.

[75301.]—**Gilding Steel.**—Would some of your correspondents kindly inform me how to get a good brass colour or gilt appearance on steel—if it can be done by dipping in acids (if so, what acids), or any other method? I have some steel spurs, and have to get them to appear as brass.—Gilt Bronze.

[75302.]—**Theosophy.**—To "Sigma."—What do you think about Theosophy and "the Mahatmas"? I ask *you*, because I have noted in past replies that you seem, either in the course of travel or otherwise, to have had actual experience of, and insight into, these matters. Is "occultism," in your opinion, merely another vulgar imposture, or are the claims advanced by Mrs. Besant for the possibility of conquest over matter by "spirit," or call it what you will, founded on any—even the slenderest—fact?—Kappa.

[75303.]—**Small Electric Motor.**—I am desirous of making a small electro-motor. I want to drive it by two or three No. 2 Leclanché cells or one chromic-acid bottle battery, for about 20 minutes at a time. Can any reader kindly give me information how to make it? or a small drawing would greatly oblige.—W. G.

[75304.]—**Locomotive Query.**—Will some kind reader please tell me the highest pressure of steam worked by the express to Scotland—London and North-Western and Great-Northern respectively.—T. Conyer.

[75305.]—**Electric Bell to Clock.**—I have a continuous-ringing electric bell which I desire to place to a wooden case pendulum alarm clock. I have tried to join it up by placing one wire on the alarm bell of the clock, and one for the hammer to make contact when it struck it (the alarm bell), but it does not act. I presume the rapid beats of the hammer do not allow the current sufficient time to magnetise the cores of the bell. I should require it to ring at various times. I cannot find anything to help me in books.—Ignoramus.

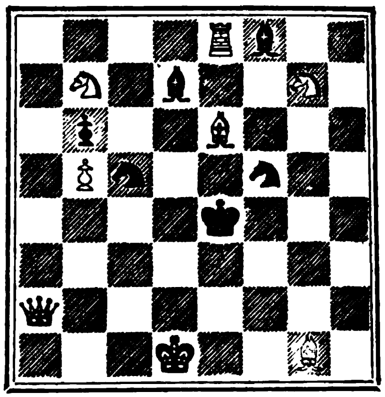
Of the entire human race it is estimated that 500,000,000 are well clothed—that is, they wear garments of some kind; 250,000,000 habitually go naked, and 700,000,000 only cover parts of the body; 500,000,000 live in houses, 700,000,000 in huts and caves, and 250,000,000 have virtually no shelter at all.

CHESS.

All communications for this department must be addressed to "J. Pierce, Knollside, Yawl, Lyme Regis, Dorset."

PROBLEM MCCLXXI.—By H. J. Guest.

Black.



White. [8 + 6

White to play and mate in two moves.

Solution to 1269.

White.	*Black.*
1. Q-QB 6.	1. Any.
2. Q or Kt mates.	

NOTICES TO CORRESPONDENTS.

Correct solutions to 1269 by J. Johnston, T. H. Billington, A. Fellows, H. Fellows, C. Bright, Biene, W. T. Hurley. F. J. Wardale, J. Ashworth, E W. Houghton, E. Bygott, Jacobus, and G. Collins. To 1268 by E. Bygott, T. H. Littlewood, Jacobus, J. Ashworth, T. H. Billington, and J. Johnston.

T. H. Billington.—Duals in twoers are not required. Sorry you overlooked that duals are necessary to give when they exist, even if problem is unsound.

W. T. Hurley.—The second solution to a two-mover scores the same as the author's—2 marks. To a three-mover, 2 marks; but the author's 5.

P H. Williams.—The problem was published twelve weeks ago.

C. Bright.—A triple constitutes really two duals in the same variation; a quadruple three duals; a quintuple four duals in the same variation. A dual arises when, in a three-mover, white can proceed in more ways than one after black's first move.

J. Nield.—We have made a note of the correction.

The *Bristol Mercury* is just starting new problems and solution tourneys. The prizes offered are of the total value of £20. The supplement (in which the problems appear) will be sent post free for 1s. 8d. a quarter. For solution and problem tourney rules see *Bristol Mercury Supplement* of September 5 and 12.

The formal opening of the St. Claire Tunnel under the Detroit River is to take place on the 19th inst. This tunnel is the largest yet built on the Greathead system, and was carried through the soft mud of the river bottom with surprisingly little trouble.

An experimental demonstration of Joule's law has been furnished by Prof. Robert Spice, of Brooklyn. The method employed is to send a current through a known resistance, immersed in a known quantity of liquid, and also to immerse in the same liquid one set of junctions of a small thermo battery connected with a galvanometer. The other set of junctions are immersed in another vessel in a known volume of the same liquid, in which is another known resistance. If both quantities of liquid are heated by the current to the same temperature the galvanometer will remain at zero, but not otherwise. The results of the experiments show that the rise of temperature of the liquids is proportional to the electrical energy expended.

A Perfect Ink.—An ink which is said to be permanent and unaffected by the application of acids, alkalis, &c., and which renders forgeries and erasures, additions, or alterations easy of detection and difficult to accomplish, is said to be made as follows: To carbon black (preferably prepared by the action of concentrated sulphuric or other acid on sugar) are added a solution of gum or other mucilage, caustic soda, oxalic acid, and Indian ink. Vanadium in any form, Aleppo galls, nut galls, and a small quantity of an aniline dye are then added, along with sufficient water to make the ink flow readily. The following proportions yield good results: Nut galls, 20 per cent.; Aleppo galls, 5 per cent.; carbon black, 10 per cent.; vanadium, 1 per cent.; Indian ink, 10 per cent.; oxalic acid, 3 per cent.; aniline dye, 1 per cent; rain water, 50 per cent. The whole is boiled, filtered, and strained.

ANSWERS TO CORRESPONDENTS.

**** All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, September 9, and unacknowledged elsewhere:—

Elettro. — Pattern. — Efil. — Waterloo. — J. T. M. — Manchester.—D. Lowden.—An Amateur.—E. R. Dale. —Detective.—Lohengrin.—S. J. B.—Sea-side Farmer. W. A. B.—T. J. W.—W. Gillett.—James Thomson.— —Metria. — J. H. Truscott.—A Fellow of the Royal Astronomical Society.—C. G. M. Bennett.— F. C. Allsop.

C. H. Thompson. (We think it better to insert your communication as a letter. It may bring offers of help. You see, there are not many of you, and it is a little difficult to get information. Thanks for your other offer; we expect "Eos" is familiar with the work, but it shall be sent to him if you forward it.)—J. Bush. (The "best way" to take a patent out is to seek the assistance of a patent agent—many of the best advertise in our columns. The cost varies according to the work that has to be done—searching, drawing up specification, making drawings, &c. The fees for stamps are £1 on application, and £3 when the complete specification is filed; then the agent's fees in a simple case might amount to, say, £3 or £4 more. If the article is the same, one patent will suffice, no matter how many ways there are of carrying out the invention.)—Phoenix. (Any elementary work on Physiology would answer the question; but briefly, the use of the intestines is to supply aliment to the body.)—Cinctus. (The question of stays for men has been debated many times—frequently in our columns. They are worn by men, who say they experience benefit from them, and they are specially made for men by the dealers in surgical appliances and by stay-makers generally.)—Simple Simon. (We do not know of any work of the kind described; but there are several works containing papers on the subject, and many useful ones could be found in the back volumes, in the *Chemical News*, and in the *Transactions* of the chemical societies.)—Trigon. (Such publishers as Lockwood and Son, Macmillan, Longmans, &c., all have good works on such subjects as spherical trigonometry, conic sections, &c.)—English Mechanic. (Please see "Hint" No. 4 above. Any of our advertisers in the line will be pleased to supply you with all the chemicals and apparatus you may require, and with the best textbooks for beginners. All the leading publishers have works on experimental chemistry, and the choice would depend on the price to which you are prepared to go. Longmans', Macmillans', Lockwood's, and other catalogues will give an idea of the difficulty of making a selection.)—Aigburth. (Experienced men say that it does not pay to have files recut in small quantities. In most shops they can be used for other purposes. An advertisement in the Sale Column would bring you an offer, no doubt, if the quantity is stated, and some idea of the sizes is given.)—S. H. R. (Any work on mathematics, and many of the larger treatises on arithmetic, explain what is meant by the "equation.")—F. O. Miles. (Any musical instrument dealer ought to be able to get them for you. Try some of those advertising in our columns.)—C. H. C. W. (There is a work on "Boot and Shoe-Making," published by Lockwood and Son, Stationers' Hall-court, E.C.; there are many letters and replies on the subject in back volumes; but there is very little art in nailing on a heel or sole.)—Ignoramus. (What is the nature of the dirt? The water can be siphoned off from the mercury or be absorbed, and then the metal could be distilled and obtained pure; but for any more definite advice it will be necessary to give some idea of the nature of the "dirt.")—Spot. (You might find the names of such firms in the Directory; but perhaps you would get more closely to the people who actually do the work by advertising in the Wanted Column. The processes have been described in back numbers.)—Fait Accompli. (We think we answered you not long ago. Apply to the correspondent named direct—the address is sufficient—or give a full description of your symptoms to Dr. Allinson, and watch for his reply in the *Weekly Times and Echo*. Have you consulted a medical man and given him an opportunity to examine your heart and lungs?)—Adelaide, South Australia. (Remove all grease from the piano keys by means of benzoline, turpentine, or other solvent, and expose them to sunlight with glass between them and the sun. That is about all that can be done; but if the ivory is thick, it would perhaps bear scraping and repolishing.)—An Old Subscriber. (Please see the index issued with this number, and refer to the many sketches and replies about [illegible] in previous volumes. All the information required can be found, and you can easily see the volumes in Manchester. To insert your sketches would mean the occupation of more than a page, while the mere dimensions would have been sufficient, with a description of the make.)—R. Pownall. (The instrument of which you send photographs is a double flageolet. It is a comparatively rare instrument. If anywhere, you will get a tutor for it at Lafleur's, Green-street, Leicester-square.)

"Want of Vital Force &c."—Drugs a failure.—Chas. Powell, Esq., of 63, Conway-street, Liverpool, writes: "A month ago I procured one of Harness' Electropathic Belts. I had been suffering severely from want of vital force, physical exhaustion, indigestion, and flatulence, without deriving any material benefit from the several doctors who had treated me. Since wearing your appliance I am glad to say my health has very much improved, the digestive powers are considerably better, and I am altogether much stronger." Thousands of similar cures have been effected by this genuine and convenient Electric Belt, and all suffering men and women who are unable to call and avail themselves of a free personal consultation, should write at once to the Medical Battery Company, Limited, 52, Oxford-street, London, W., for copy of their descriptive pamphlet and book of testimonials.

Wolfram Mining in New Zealand.—Wolfram, or tungsten, belongs to a group of rare metals, and until a comparatively recent time was known only to the chemist, and its value was known only in the laboratory. With the invention of 100-ton guns the demand for tungsten soon made the previously obscure metal well known throughout the mining world. It was soon found that the steel tube lining the bore of these enormous guns could not resist the shock entailed by discharging many shots without becoming fractured. Experiment proved that the addition of a small quantity of tungsten to the fine steel employed in gun-making rendered the latter metal wonderfully elastic, so that the steel tube will expand under the tension of firing and contract again to its normal size a great many times before the quality of the metal is in any way impaired. The German gun factories absorb most of the tungsten found in the world, and from being a mere curiosity seen only in the laboratory of the chemist, this rare metal has acquired considerable value. Wolfram generally occurs in combination with iron in Europe, but it is also found in Scheelite, or tungstate of lime. It is in the latter form that it occurs in Otago. The metal itself is of a white colour, extremely brittle, and heavy, the specific gravity being 19·1, that of gold being 19·3. It will thus be seen that tungsten is a very heavy metal, being only very slightly lighter than gold.

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*** It must be borne in mind that no Displayed Advertisements can appear in the "Sixpenny Sale Column." All Advertisements must be prepaid; no reduction is made on repeated insertions, and in cases where the amount sent exceeds One Shilling, the Publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O.'s.

The address is included as part of the Advertisement, and charged for.

Advertisements must reach the Office by 1 p.m. on Wednesday to insure insertion in the following Friday's number.

TERMS OF SUBSCRIPTION.

PAYABLE IN ADVANCE.

5s. 6d. for Six Months and 11s. for Twelve Months, post free to any part of the United Kingdom. For the United States, 13s., or 3dol 25c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (via Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

The remittance should be made by Post Office Order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 4d. each to cover extra postage.

Messrs. James W. Queen and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 3d. each copy, to cover extra postage.

Vols. XXIV., XXX., XXXII., XXXVI., XXXIX., XL., XLII., XLIII., XLIV., XLV., XLVI., XLVIII., XLIX., L., LI., LII., and LIII., bound in cloth, 7s. each. Post free, 7s. 9d.

All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post free from the office (except Index numbers, which are 3d. each, or post free, 3½d.)

Indexes to Vol. XLIX., and to subsequent vols., 3d. each, or post free 3½d. Cases for binding, 1s. 6d. each.

Rupture.—Mr. Henry James, of Farleigh-road, Stoke Newington, London, N., says it is over three years since he was cured of a troublesome rupture of nineteen years' standing by the Sherman Treatment, and that he is as sound as any man. We advise sufferers to write Mr. James for particulars; also to send to Mr. J. A. SHERMAN'S Consulting Offices, 64, Chancery-lane, London, for his Book of Information, post free 7d.

NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the Office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a Pink Wrapper, as an intimation that a fresh remittance is necessary if it is desired to continue the subscription.

Holloway's Pills overcome all obstructions tending to produce ill-health, and institute regular actions in organs that are faulty from derangement or debility. The dyspeptic, weak, and nervous may rely on these Pills as their best friends and comforters. They improve the appetite and thoroughly invigorate the digestive apparatus.

OUR EXCHANGE COLUMN.

The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.

Stamp Collection wanted. Will give good exchange. Also will exchange Duplicates with collector.—Edward W. Drury, 126, Coltman-street, Hull.

Microscopic—Wanted, mounted and unmounted, Objects of every description; especially Cockchafers, Crickets, Sawflies, Hornets, Locusts. Foreign exchanges invited.—Henry Essage, Framlingham, Suffolk.

Wimshurst Machine, 17in. discs, pretty pattern, four jars, taken first prize at the recent exhibition, Agricultural Hall. Offers to £4 value.—Randle, Crown-street, Kettering.

Wanted, Harmonium, American Organ, or Musical Box out of repair; cheap. Exchange.—Harding, 196, Holloway-road.

"English Mechanic, Vols. XXXIII. to LII., complete with index, unbound, good condition. Exchange for Star Microscope.—Middleton, 4, Dolcliffe-road, Mexborough.

Telescope, Wray 2¼in. objective, Lancaster's mounting, cost £8 10s. Wanted, Photographic Outfit, small Transit, good Chemical Balance or what offers? Particulars free.—Hutton, Broadbottom, Manchester.

What offers? **Bench Lathe**, 5ft., dove-tailed, no hand or slide-rest, lathe flywheel, five speeds, two standards for treadle lathe, plumbago foundry pot, 60lb., tongs.—4, Colls-road, Peckham.

Scale Model of Great Northern Railway Locomotive Boiler (with steam dome attached), fitted to engine frames. Also pump, clack valve, wheels, &c. Scale 1-16th. First class workmanship. Exchange for Microscope, or, preferably, Pocket Achromatic Spectroscope. Must be in perfect order.—J. W. McKellen, 23, January-street, Manchester.

Dynamo to light 20 and 30 lamps. Exchange new cushion tire Safeties, 53 Racing Ordinary, Harrison Knitting Machine, or part cash.—Boydell, Ironfounder, Leigh, Lancashire.

Finest Japanese **Grass Mats**, 9 large size, 36in. by 54in.; 11 small, 26½in. by 45in. Coloured borders, new, value £6. Exchange for small Gas Engine, or good Dynamo.—Percival, Denbigh-terrace, Levenshulme, Manchester.

"English Mechanic," 17 Vols., Vol. XXXVI. to LII. inclusive, clean, unbound, in good condition, with indices complete. Will exchange for ¼-plate Camera, or anything to value 60s. —A. Rowley, 11, Clowes-street, Macclesfield.

Splendid 1¾ cushion-tired **Safety Bicycle**, balls all over, ball socket steering, cost £15. Little used. Exchange good Screw-cutting Lathe.—3, Airedale-street, Eccleshill.

"Holtzapffel's Turning and Mechanical Manipulation," Vol. IV. Also "Every Man his own Mechanic." Exchange Lantern Slides.—E. Partridge, Kelsey, Ipswich.

Will exchange 20 first-class **Lantern Slides** for Watkin's or Decoudun's Photometer, good scenic background, revolver, or anything useful. Offers.—O. Appleton, Priestgate, Darlington.

Edison Mimeograph, foolscap size. Prints thousands of copies from one writing. Best reduplicating device ever invented, cost 60s. What offers?—Lamberton, Hatter, Sheffield.

Gem **Air-Gun** (No. 3), complete, with pincers, darts, slugs. Splendid weapon for indoor or outdoor sport. Not a toy, cost 35s. What offers?—Lamberton, Hatter, Sheffield.

Cuckoo Clock, natural tone cuckoos, wings open and close automatically. In handsome carved case, new, just cost 40s. What offers?—Lamberton, Hatter, Sheffield.

Small **Treadle Lathe**, 6in. centre, 3ft. wooden bed, two T rests, one face-plate, one chuck, and several other tools, all in good condition. Exchange Polishing Lathe.—Below.

Mahogany box **Camera**, 3¼ by 3¼, double lenses, very powerful, and stand, by Cox, London. Exchange Model Engine or horizontal slide-valve Cylinder.—Below.

Games.—One Horse Racing Game, complete, cost 15s.; one miniature Bagatelle, complete, cost 10s.; one Crystal Board and Marbles, complete, cost 2s. Exchange anything useful.—Below.

"Royal Illustrated History of England," bound in morocco leather, brass edges, by J. Mordock, London, cost £4. Exchange anything useful.—P. Muckle, 2, Bowles-place, Whetstone, N.

Will exchange superior **Pneumatic Bell**, 4in. gong, and three electric pushes, for Silver Albert value 14s. Offers 20 Lt. Armature, complete, brush holders, wood patterns.—Hurst, 1, Osborne-place, The Downs, Bowdon, Cheshire.

Demon Camera, lamp, book, roller, and bags, cost 9s. 8d., nearly new. Will exchange Book or Printing Press.—F. O. Miles, Devizes-road, Salisbury.

Wanted, first-class **Safety Bicycle**. Exchange ½-horse compound Engine, £6, or ¼-horse Engine with Boiler, £6.—Particulars C. Adams, Beverley-road, Colchester.

New polished oak **Easel**, 5ft. high. Exchange for Rubber roller Hand Wringer, in good order.—V. C., 40, Upper Westbourne-street, West Brighton.

Double-barrel **Gun**, in case, cost £10. Exchange for good Safety.—Full particulars Eastaugh, 18, Long Wyre-street, Colchester.

New Pulvermacher galvanic **Chain Battery**, 120 cells, handles, complete, two three-way bell switches, quantity static electrical apparatus. Useful offers.—E. W. Young, Aylesbury.

Will exchange Cottam's 1891 **"Charts of the Constellations,"** reduced scale, for good Tourist Telescope.—Bassett 82, High-street, Stoke Newington, N.

Exchange good **Hand Camera**, holds 12 quarter plates, simple changing, rectilinear lens, finder, time and instantaneous shutter, cost 70s. Want Slide-rest, Lathe, Chucks, Drills, Tools.—P., 11, Exchange-street, Blackburn.

Exchange **Electrical, Mechanical, and Engineering** Books. Wanted, on Arc Lamps, Telephony, and Incandescent Wiring; also Kempe's Testing, Thompson's Dynamo, &c. State books required in exchange.—C. E., Charlbury, Oxon.

Wanted, 7-octave Cottage Piano, by good maker, in exchange for genuine Ormonde Safety Bicycle, in splendid condition, a new and superior Dynamo, about 80c.p., and very fine Guitar by Gavoli.—G. Brown, 15, Sulgrave-road, Shepherd's Bush, London.

Coil.—Large very powerful Medical Coil, with battery, cost 40s. Wanted, Dynamo or Optimus, R.R. lens (¼ plate). Particulars.—Willetts, Shrubbery, Dudley.

Two slow-combustion **Stoves**, small iron Safe, bronzed Hall oil Heating Stove, seven-stringed Banjo, plated rim, 24 brackets, quantity useful Furniture Exchange Safety, or offers.—J. Sanford, Cambridge-street, Aylesbury.

Bright vertical **Model Engine**, 2in. bore, 3¼in. stroke, bright governors, turned flywheel and pulley, the best of workmanship. Valuable exchange. Pair of coupled Horizontal Model Engines, cut-off gear direct from governors, 3in. bore, 4½in. stroke, bright governors, the best workmanship; made for exhibition. Valuable exchange.—W. D., Leeds-terrace, 279, St. Philip's-road, Sheffield.

Grand 1½in. scale **Model Locomotive Engine** and Tender, Flying Dutchman, perfect working model, built by locomotive manager, and made regardless of cost; boiler and firebox and tender all riveted, 3ft. 6in. long, cost £400. Half cash, half exchange. —W. D., Leeds-terrace, 279, St. Philip's-road, Sheffield.

Good **Model Engine**, horizontal, slide-valve cylinder, ½in. by 1in., good condition, cost 21s. What offers?—John Taffe, 3, Ashburton-terrace, High-street, Plaistow, E.

Handsome **Medical Coil and Battery**, portable, in case; 4 double-pole Telephone Receivers. Want Silver Albert, or offers.—1, Great Western-road, Gloucester.

Violin and Bow, small Magic Lantern and Slides. Exchange Medical Battery, Portable Electric Lamp, or anything useful.—Lilly, 35, Colston-street, Bristol.

Wanted, Stringed Dulcimer, in exchange for good second-hand Royal Organette, perfect, original, cost 42s.—W. Nairn, Waterloo, Chorley, Lanc.

Offers in exchange for polished oak **Battery Stand**, value 10s 6d.; six gross terminals, parts for Letheby photometer. Wanted, old brass.—Cremer and Cheeld, Chesham.

Tinfoil Phonograph, out of repair, two diaphragms, also small model H armature motor, new. Exchange anything.—S. Richardson, 157, Normanton-road, Derby.

£100 Provident Association of London Bond, over £6 paid, in exchange £4 10s. value, tricycle, bicycle, or invalid's perambulator.—Lane, Tytherington, Frome.

Wanted, a good Portable Forge (or Fan Forge). State make and size. Exchange.—A. J. S., 194a, Mare-street, Hackney.

Nice **Model Horizontal Engine**, slide-valve cylinder, ¾in bore, 1½in. stroke, with pump, in good working order, value 25s. Exchange. Photo and particulars sent.—Below.

Model Engines and Boilers, separate parts; castings, rough or finished; cameras, lenses, &c., exchanged on best terms.—Engineer, 75, East-road, West Ham Park, E.

Printing Press, 17lb. Roman type. Also other type, furniture, leads, brass rule, &c. Press all iron, prints 6 by 8; also R.R. lens, good maker, 5 by 4, suit hand camera, Waterhouse stops and Instantaneous shutter. Exchange. Wanted, Portable Forge or Bellows and Drilling Machine. Write only.—Herring, 10, Talbot Mansions, Museum-street, W.C.

Dynamo, 50 volts, 18 ampères; Engine for same; arc lamp, incandescent, for good Gas Engine.—Taplin, 95, Clifford-crescent, Southampton.

Canary, cock, and Cage, cost 10s.; Bagatelle Board, cost 15s.; Gents 9ct. Gold Ring, with handsome stone, cost 15s.; Gold Pin, cost 5s. 6d.—Below.

New **Clothes Box**, 30in. long, 21in. wide, 18in. deep, brass lock, cost 21s. Offers. Stamp for reply.—F. Arthur, The Crescent, Stamford-hill.

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H. Jones and Co., Viaduct-street, London, E. Lamp repairs a speciality. Glasses, wicks, burners. Correspondence invited.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, SEPTEMBER 18, 1891.

THE EXPIRATION OF THE MICROPHONE PATENT.—II.

By F. C. Allsop.

Author of "Telephones: their Construction and Fitting," "Practical Electric-Bell Fitting," "Electric-Bell Construction," &c.

SINCE the apparently untenable nature of certain claims in the patents referred to in the last article can only definitely be decided by an actual trial at law, we must therefore, failing such a test case, consider these claims—or, at any rate, the least doubtful of them—as genuine. The special parts or methods of mounting certain parts of a microphone transmitter that we are not entitled to use, or which, at least, it will be as well to avoid for a year or two, may then be summed up as follows:—

1. Blake's method of supporting the diaphragm by spring pressure.
2. Blake's method of mounting the second or platinum electrode on a spring.
3. Blake's combination of the two electrodes on springs.
4. Blake's special form of adjustment.
5. Hunnings' transmitter, with powdered carbon between thin or thick metallic or metal-covered diaphragms.
6. Crossley's microphone, or any compound microphone with more than two pencils.

The 1st, 2nd, 3rd, and 4th of these may not be used till after Jan. 20, 1893; the 5th till after Sept. 16, 1892; and the 6th till Feb. 1, 1893.

Without trespassing, however, on any of the six above-mentioned claims, there are two forms of the microphone transmitter that we can legally make and use. We can adopt either a two-carbon pencil form with wooden diaphragm, or else a modification of Edison's (Fig. 10) having a thin iron diaphragm with platinum contact in the centre, against which presses the carbon block on the end of a light spring, somewhat resembling the Blake arrangement. Either of these forms will give an efficient and reliable instrument, the carbon pencil form being, perhaps, the most easily made, and the one which we shall describe first.

Fig. 1 is a view from the front of the complete instrument, while Fig. 2 shows the case open, disclosing the interior construction. Fig. 3 is a section on Fig. 1, some parts being in elevation and some in section. Figs. 1, 2, 3, and 4 are about half-size, while Figs. 5, 6, 7, and 8 are full-size, similar reference letters denoting similar parts.

In constructing the transmitter we commence first with the carbon pencils, for which purpose we procure some carbon rod (such as is used for arc lights, but not "cored") about ¼in. in diameter, and having fixed it in the lathe-chuck, turn down the ends as shown in Fig. 5, which represents full size the finished pencil. Two of these pencils must be made, and the operation of turning down the ends (which is best done with a hand tool) must be performed with considerable care, as the points are easily snapped off. Having completed the pencils, we proceed with the two carbon supports, one of which is shown full size in Fig. 6. These are best made out of square carbon rod of the section shown; but if this is not to be procured, they can be filed out of carbon plate, such as some old battery plates. Two holes of the size shown are drilled on one face to receive the ends of the carbon pencils, and another at right angles to it (as indicated by the dotted lines), through which passes the small bolt that secures the supports to the diaphragm.

The carbon pencils and supports being finished, we next turn our attention to the diaphragm, to construct which we must procure a piece of well seasoned pinewood, 3¾in. long by 3in. wide and ⅛in. thick, taking care to see that the grain of the wood runs in the direction of the greatest length. This board should be well sand-papered down and finished, which must be done as carefully as possible, so as to preserve a uniform thickness throughout, and when completed be served both sides with a coat of varnish to prevent its subsequent warping from the moisture precipitated upon it from the breath while in use.

To fasten the diaphragm to the inside of the lid we require two clamps (shown half-

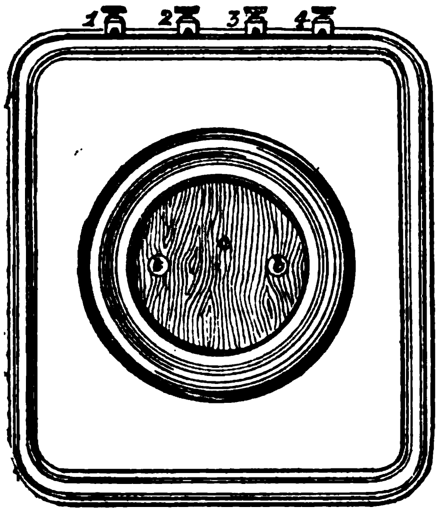

Fig. 1.

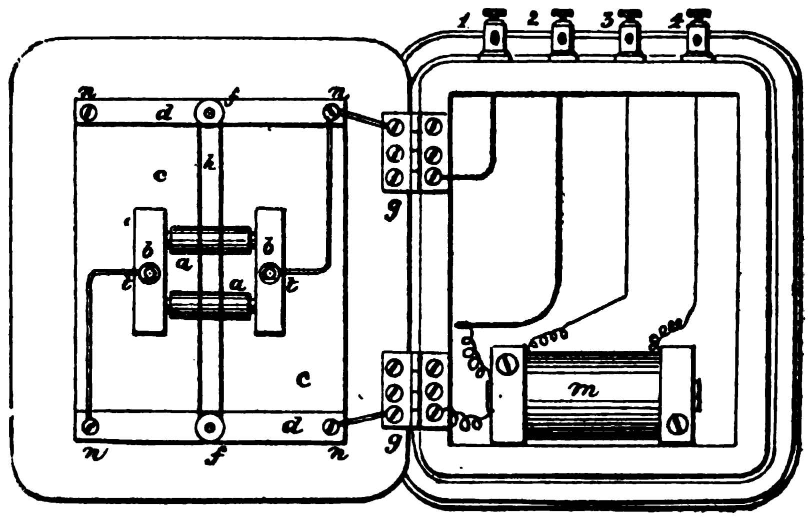

Fig. 2.

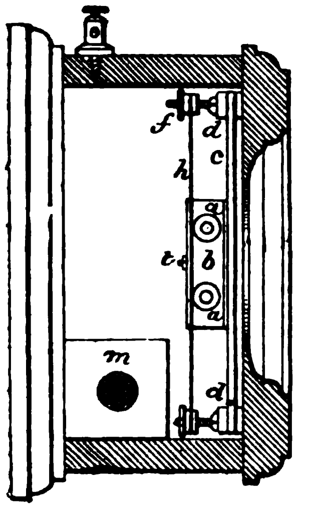

Fig. 3.

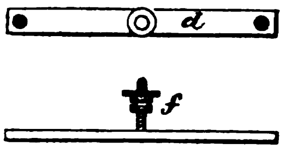

Fig. 4.

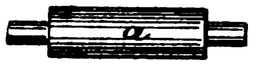

Fig. 5.

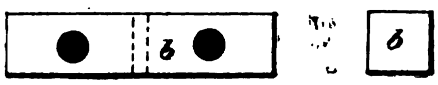

Fig. 6.

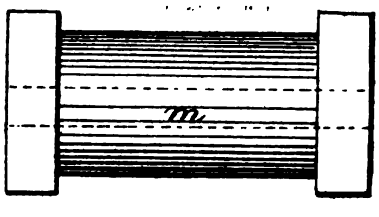

Fig. 7.

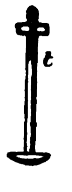

Fig 8

size in Fig. 4), which can be cut off some brass rod of the section shown. These clamps are 3in. in length, and have a hole drilled at each end, through which pass the screws that fasten down the diaphragm. To the centre of each clamp is fixed a threaded piece of brass rod on which runs a nut, by means of which the pressure of the pencils against the carbon blocks is adjusted, as will be shortly explained. It will be noticed on inspecting Fig. 4, that a groove is cut round the body of each terminal.

Having made these clamps, the diaphragm, and carbon pencils, it will be best, before we proceed further with the interior construction of the instrument, to make the containing case so that each part can be fitted at once in its place as it is finished. This case, which is best made of walnut or teak, is 4¼in. by 4in. inside dimensions, and 2in. deep. The body is made out of ½in. stuff, and the lid and bottom of ⅝in., the bottom and lid having a moulding run round, as shown in the illustrations. The lid is hinged to the body of the case as shown, and in the centre of the lid is cut the mouthpiece, the opening in which is 1⅞in. in diameter, and is surrounded by a moulding, a section of which can be obtained from Fig. 3. At the top of the case are fixed the terminals marked 1, 2, 3, and 4—Nos. 1 and 2 being the primary, and 3 and 4 the secondary.

The case being finished, it must now be polished, which being done, we can proceed to fit the different parts in it. Referring to Figs. 1, 2, and 3 (*a a*) are the carbon pencils, (*b b*) the supports, and (*c*) the diaphragm. The two clamps are marked (*d d*), and (*f f*) are the two adjustable terminals, stretched across which is the elastic band (*h*), the pressure of which against the carbon pencils can be adjusted by turning the terminals. The two hinges are lettered (*g g*), and (*m*) is the induction coil fixed in the body of the case.

To fix the diaphragm to the lid, a thin section of cork about $\frac{1}{16}$in. thick, and as wide as the clamps, will be required. The clamps are first held in their place at the top and bottom of the diaphragm, and the holes marked, which holes must be drilled of sufficient size to allow the screws (*n n n n*) that secure the clamp to pass through. The centre of the diaphragm must then be marked with a lead pencil, and the diaphragm held against the inside of the lid, and when the pencil mark is in the centre of the mouthpiece, the position for the diaphragm can be marked by running a pencil round. We can now proceed to definitely fix the diaphragm, and to do so, a layer of the $\frac{1}{16}$in. cork is laid between the diaphragm and lid at both the top and bottom, and likewise also between the diaphragm and clamp. The clamps are then laid on, and the screws passed through the holes and screwed down, when the diaphragm should be properly fixed. Do not, however, screw the screws any tighter than will cause the clamp to just grip the diaphragm, and see that in the screwing down the diaphragm is not warped out of shape. If the diaphragm does not appear to set nice and flat, it will generally be found that the layer of cork is not even, and this must be adjusted until the diaphragm is level.

The diaphragm being all right, we next fix the carbon blocks and pencils on to it. To do this the carbon blocks must be laid on the diaphragm, as shown in Fig. 2, and the proper place for the two holes through which pass the securing bolts be marked. These bolts consist of ⅜in. brass rod $\frac{1}{16}$in. thick, with a thin flange on one end and a nut on the other, as shown in Fig. 8, which represents the bolt full size. Two of these bolts are required one for each carbon block. The holes having been bored in the diaphragm, we can now permanently fix the carbon supports. We first cut out two pieces of cork as large as the supports, and $\frac{1}{16}$in. thick, which pieces we lay one between each carbon support and the diaphragm. The two bolts are then passed through, and everything inspected to see that all is right. The carbon pencils must fit loosely into the carbon supports, with the amount of clearance shown in Fig. 2. If everything appears correctly in place, a mark should be made round each support to denote its place, and this being done, the different parts are then slipped off, a thin coating of hot Prout's elastic glue applied to both sides of the cork layers, the parts quickly replaced, and nuts on the bolts run firmly down. These nuts must not, however, be run down too firmly, otherwise the carbon supports may snap, and it is advisable to use a metal and a leather washer under each nut, the leather washer being next to the carbon block. This part of the microphone is now complete, and would speak fairly well as it is, except that it would be subject to disagreeable rasping and other noises, owing to the very loose contact between the pencils and blocks. To obviate this, therefore, it is necessary to have some method of adjusting this pressure, and also of keeping the pencils pressing against the *sides* of the holes, which gives better results, and also enables the vertical position of the diaphragm to be retained. There are many ways of doing this,—either a bar, the face of which is padded with a thick layer of cotton wool, can be stretched across the two adjustable terminals, or a light spring may be used. It is possible, also, by giving a special shape to the supports and carbon pencils, to do away with any necessity for spring pressure; but what gives very good results, and is best suited for our present purpose, is the elastic band adjustment, as shown in Figs. 2 and 3. This band, which should not be a very stout one, is stretched across the two terminals (*f*, *f*), and by turning these terminals backward and forward, the pressure on the carbon pencils can be adjusted to a nicety.

We can now proceed to make the coil, a piece of apparatus which, if properly proportioned to the receivers with which the microphone is intended to work greatly improves the results. This coil is shown full size in Fig. 7. It consists of two walnut-wood ends 1⅛in. square and $\frac{3}{16}$in. thick, and joined together by a core consisting of a bundle of soft iron wires, the diameter of this core being about $\frac{3}{16}$in. The primary coil is wound with No. 22 B.W.G. double silk-covered copper wire to a resistance of ·5 ohm (about 1¼oz.), and the secondary with No. 40 B.W.G. double silk-covered copper wire to a resistance of 250 ohms (about 2oz.) Before winding on the primary a layer or two of notepaper should be wound round the iron core, and directly on this the primary wire may be wound. Another layer of paper must also be placed between the primary and secondary coils. As will be seen from Fig. 2, the two ends of the primary are brought out on the left-hand side of the core, and the two secondary on the top. The coil is fixed by two screws, which pass through the two wooden ends and screw into the back of the case, as shown in Fig. 2.

The four terminals having been fixed at the top of the case, we can now proceed to connect-up the different parts, and the instrument will be complete. A wire is first run from terminal 1 to the top hinge *g*, and from there to the top clamp. From the top clamp a wire is run to the right-hand carbon support, the left-hand one being connected to the bottom clamp. From the bottom clamp a piece of wire is run to the bottom hinge, and from there to one end of the primary, the other end of the primary being connected to terminal 2. Terminals 3 and 4 are connected one to each end of the secondary coil. For the primary connections a smaller-gauge wire than No. 22 should not be used; but the ends of the secondary coil can be taken direct to the two terminals.

The instrument is now complete, and can be connected up and tried. For this purpose we fix the instruments in an upright position against the wall, and connect one No. 2 Leclanché cell to terminals 1 and 2, and the terminals 3 and 4 are connected to the distant receiver. The microphone, however, must first be adjusted, which is done as follows: Tighten up, by turning the screws (*f f*), the elastic band till a firm pressure on the carbon pencils is obtained, and then slack out the terminals, half a turn at the time, till the best results are obtained, trying the instrument by speaking on to it after each fresh adjustment. It will be found that if two cells are used instead of one, a firmer pressure of the elastic band will have to be maintained. In speaking, the best position is about 10in. to 12in. off the mouthpiece.

(*To be continued.*)

HOW TO CONSTRUCT A PHONOGRAPH.*—VII.

By W. Gillett.

30.—The Electro-Motor.

THE motor is of the well-known "Manchester" type, the armature being very narrow and having its spindle mounted vertically. Fig. 37 gives the dimensions and shape of the carcass. It can, with a little time and patience spent on it, be cut from ordinary soft bar iron, or, if this time cannot be spent on it, a pattern of the yokes *a a* can be made from wood and a casting taken; but, of course, if cut from soft iron it is much better. In any case, the cores *b* should be of soft iron with the ends turned down as in the figure, so that a shoulder is formed which fits accurately against the flat surface of the yokes. The ends of the cores have threads cut on them as at *c*, on which are fitted some hexagonal iron nuts. These nuts, when screwed up, hold the iron frame firmly together. It should, perhaps, be mentioned that the holes in the yokes through which the cores pass should not be bored too large, but the cores should fit tightly in them, so that the magnetic reluctance at the joint may be reduced to a minimum. The diameter of the armature tunnel is 2½in.

The armature is built up of plain, soft iron rings, the diameter of which is given in the figure. Its width is ½in., and the rings are riveted together by three rivets; a piece of paraffined paper being placed between each ring. A brass "spider," like Fig. 39, is sweated on a piece of ¼in. steel rod, the centre being 1⅜in. from the end of the rod, and the other side being cut off at ⅞in. from the centre of "spider." The ends of the spokes are then turned down so that it will fit tightly into the armature ring, and the spokes firmly soldered to the ring, the ring, of course being filed bright inside previous to the fitting of spider therein. The armature, it should here be said, revolves between two steel points as bearings, so the holes in the ends of the spindle, by which the spider was turned, should be left, and not injured in any way. A view is given in part section at Fig. 38 of the armature mounted on its spindle. The top of the spindle is turned down to $\frac{3}{16}$in. diameter for ½in. in length, as seen at *a*; and on the bottom of the shaft a double pulley is sweated, which can conveniently be made from ¾in. diameter brass rod. The interior of this wheel, it will be observed, is turned out hollow for ¼in. in depth and $\frac{7}{16}$in. in diameter. The width of a wheel, exclusive of boss, is $\frac{3}{16}$in., the bottom of the V-grooves being ½in. in diameter.

The carcass is mounted on four small brass pillars, the bottom stems of which are screwed into the holes, already mentioned, in the bed-plate, Fig. 36, p. 517. The length of the pillars between the shoulders is 1in. The top stems of them are longer, so that they may pass through the yokes, and have an hexagonal nut screwed down on top. The drilled bed plate can be used as a template for marking off the holes on the yokes; the length of the bed plate being parallel to the cores. The holes into which the tops of the pillars pass are shown at *c c c c*, and they should of course be all at the same distance from the centre of the tunnel—or, in other words, a

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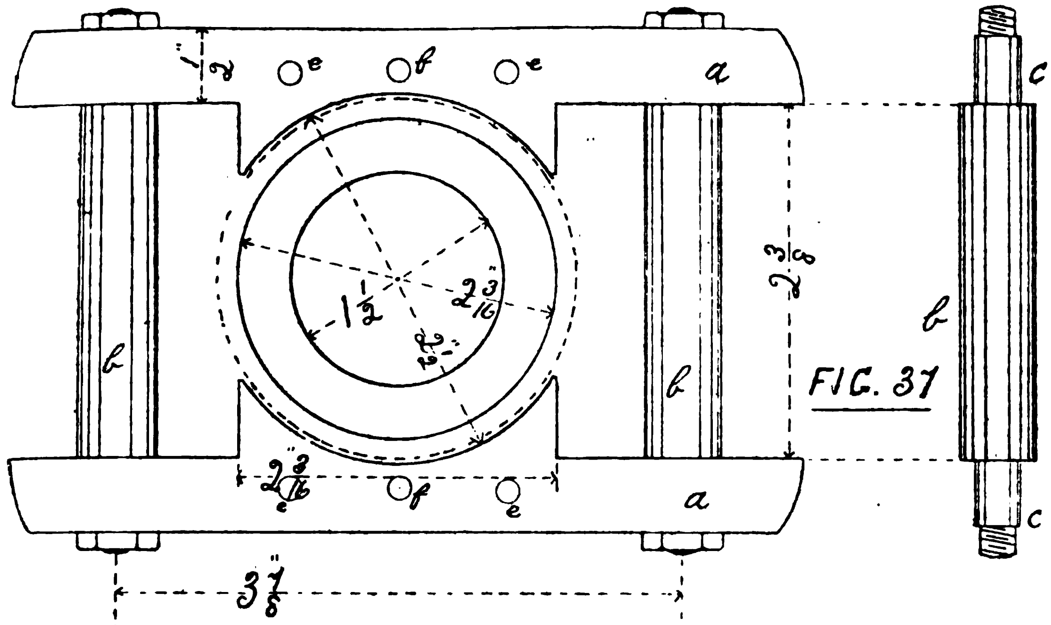
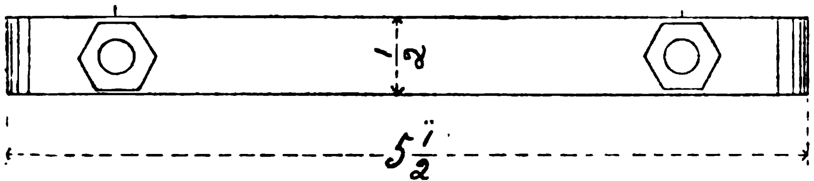


FIG. 37



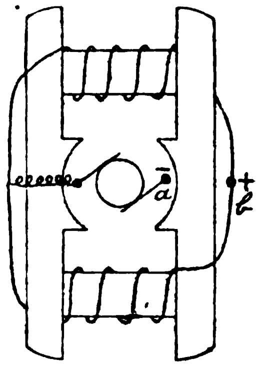


FIG. 46

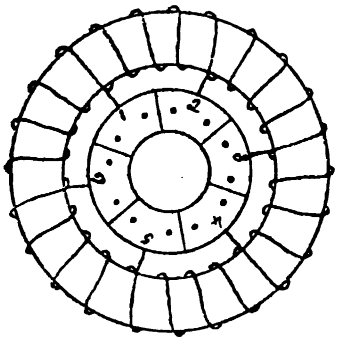


FIG. 40

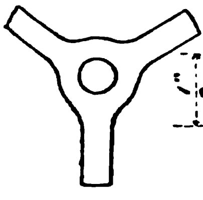


FIG. 39

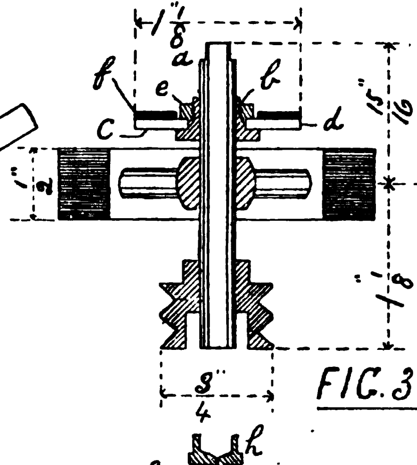


FIG. 38

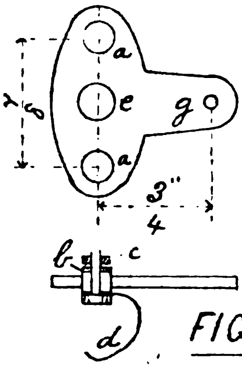


FIG. 41

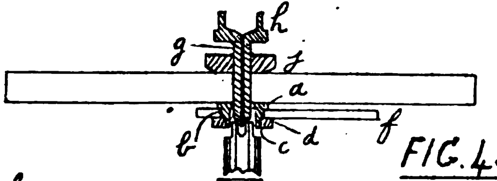


FIG. 43

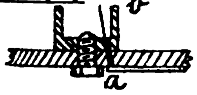


FIG. 44

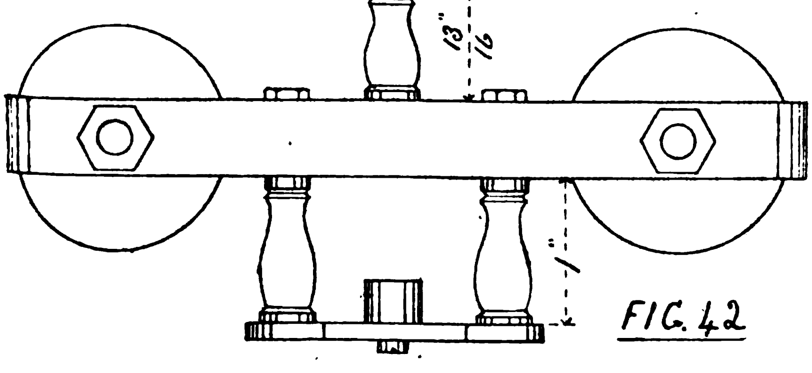


FIG. 42

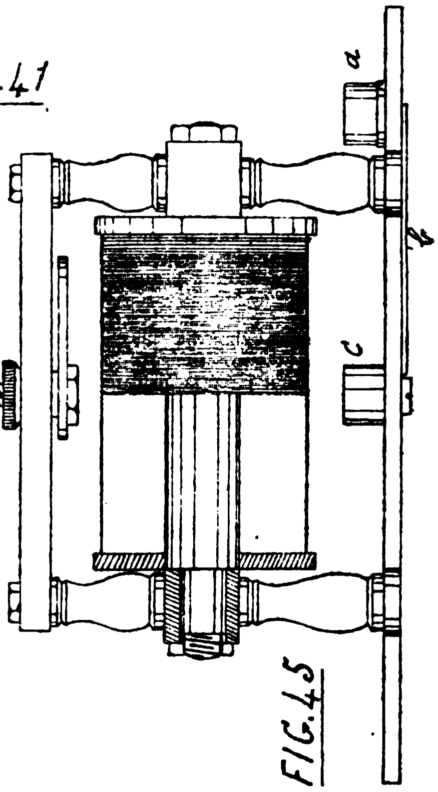


FIG. 45

circle struck from that centre should pass through all four holes. Two other holes, *f f*, having a ¼in. thread, are also made on top of the yokes, these being in the centre in a line with the other two holes, as seen in the drawing. Into these holes two short pillars are made to screw, the distance between shoulders being $\frac{13}{16}$in. The top stems of these pillars should be ⅜in. in length, threaded and fitted with a small hexagonal nut. By referring to Figs. 42 and 45 the position that all the above pillars occupy may be seen.

A bar of brass having its sectional area ⅜in. × $\frac{3}{16}$in. has a hole drilled at each end in order that it may fit on the top stems of the shorter pillars, where it is fixed by the nuts already mentioned. The centre of this bar is drilled, and a ⅛in. thread cut into it. At the bottom of this bar, and concentric with the centre hole, a small brass cap is soldered, its largest part, *a*, being ⅜in. in diameter, and the next part, *b*, for $\frac{1}{16}$in. in length, is $\frac{5}{16}$in. in diameter. The end *e*, Fig. 43, is $\frac{1}{4}$in. diameter, and has a thread cut on it, to which is fitted a small nut, *d*. The interior of this cap has a hole of $\frac{3}{16}$in. diameter, extending nearly through to the bar.

The cap just described is intended to take the bar on which the brushes are fixed. The bar is shown in plan and section at Fig. 41, and is cut from $\frac{1}{16}$in. brass. The holes *a a* are about $\frac{3}{16}$in. in diameter, and have screwed into them a short plug of ebonite or bone, which projects a little on each side. Through the centre of each of these insulating pieces a hole is drilled, in which may slip a $\frac{1}{16}$in. screw with a rather large flat head. A small round brass washer, *b*, threaded to fit the screw, is screwed down over the projecting end of the screw, and an hexagonal nut, *c*, also fits on the screw to serve as a terminal. At the bottom, under the head of the screw, the brushes are fastened. They are cut from thin hard brass, being about 1in. in length and $\frac{1}{4}$in. in width. One end has a hole which fits over the screw, the other end having one or two slits so as to insure good contact on the commutator. The brushes are bent to somewhat the shape seen at *d*.

The hole *e* is of such a size to fit nicely on the cap described above, between the hexagonal nut and the top flange. It is seen in position at *f*, Fig. 43. The projecting piece *g*, Fig. 41, is intended to serve as a lever by which a centrifugal governor can be attached, and thus, if necessary, keep the speed of the motor constant by altering the line of commutation as the current varies; but I do not propose to describe the governor, as with care in making up the battery solutions, the speed of the motor will remain practically constant. Those few, however, who may wish to add this on account of appearance, can easily do so by connecting the governor by suitable levers to the projecting ear on the brush rocker. I have also taken the governor into account by putting two wheels on the motor shaft, the top one of which can be used to drive it.

On the motor shaft above the armature the commutator is fitted, which is of the flat disc form. A collar, *b*, Fig. 38, is sweated on the shaft, so that the face *c* is $\frac{3}{16}$in. from the top of shaft; and disc of ebonite or bone *d*, $1\frac{3}{8}$in. in diameter, is bored with a $\frac{3}{8}$in. hole, so that it may fit nicely on the collar, where it may be fixed by means of the nut *e*, the nut being as small as possible, so as to leave room on the insulating disc for the metal. A ring of brass, shown in section by the dark portion at *f*, is cut from $\frac{1}{16}$in. brass of the same size as insulating disc, and having an internal diameter rather larger than the nut *e* is outside. This ring of brass is riveted to the disc below by small brass rivets, these being spaced round the metal as shown in Fig. 40. After being riveted it should be fixed on the spindle, and its surface and edge turned true. It may then come off again, and the metal portion be divided into six equal portions, as in Fig. 40, by taking three fine sawcuts right across the disc, care being taken not to run the saw into the insulating disc, or to leave any metal dust at the bottom of the cuts. After being satisfied that any one piece is insulated from the others, which, of course, is easily done by means of a battery and galvanometer, the sawcuts may be wedged up with slips of mica or run in with melted sealing-wax. The final surfacing off should be left until it is in its place and the connections completed.

In the steel centres or bearings of the armature shaft I have made arrangements so that they can be kept well lubricated when in motion, for, as the speed is high and the bearing surfaces small, it would soon run dry if not kept continually oiled. In Fig. 43 the top bearing is seen in section. The steel screw *g* has sweated on the top a brass cap, *h*, part of which can have a milled surface, the inside of the cup being about $\frac{1}{4}$in. in diameter. From the centre of the cup to the point of screw a fine hole extends. (The steel screw must of course be drilled and tempered before the cap is sweated on.) This hole will then serve to convey the lubricant from the cup to the centre of shaft below. The screw is fitted with the usual milled-headed lock-nut, *j*, to lock the screw in position. The screw itself is about $\frac{3}{8}$in. in length.

The bottom centre and oiling cup is shown at Fig. 44. The point of the hardened steel screw *a* projects about $\frac{1}{8}$in. above the surface of the plate. Concentric with this screw is fitted the cup *b*. It can conveniently be fastened down by screwing similar to a lock-nut. The outside diameter of the cup is $\frac{3}{8}$in., the inside being rather more than $\frac{4}{16}$in. The interior of this cup is connected by means of a small tube with another cup fixed near the edge of the bed-plate. This cup is seen in elevation at Fig. 45 at *a*, *b* being tha tube which connects it with the centre cup *c*. The tube may be fixed under the bed-plate by solder, the ends of the tube plugged up, and communication made between the two cups by drilling a small hole, *e*, through the bottom of cup and bed-plate into the tube. The outside cup *a* may be fastened down by a single screw like the cup *c*, or the bed-plate may have a hole drilled and tapped nearly through, the cup having a small part of the bottom turned down small, on which is cut a thread which fits into the hole. In the latter method of fastening the cup down, communication can be made with the tube by drilling a hole through the *centre* of cup, and remaining thickness of bed-plate.

The cores of the field-magnets are fitted with a disc of ebonite or boxwood at each end, to form a reel, on which the wire may be wound. If the ends are driven on tight they will be quite firm. The cores previous to winding must be well covered with paraffin paper. The wire is wound on them to a diameter of nearly $1\frac{3}{8}$in., the wire being of No. 26 B.W.G. single silk-covered. This size of wire will also be used for the armature, a few ounces over the pound being required altogether. The elevation of Fig. 45 shows part of the coil wound, and part in section.

Before winding the armature, the commutator should be taken off and the iron ring covered with silk ribbon soaked in paraffin-wax. The spokes will also need protecting in the same way for a short distance from the iron ring. It can then be wound with the same size wire as the cores, the wire being in six sections. Fig. 40 shows the manner of winding, the end of one section and the beginning of the next being twisted and soldered together. Before the ends are twisted together, however, the wire must be tested for continuity and insulation, in a manner to that done in the case of the commutator. The armature, when wound, should be $2\frac{7}{16}$in. in diameter, and if the wire is wound on carefully, about four layers can be got on. After the winding is finished the whole ring should be immersed for a few minutes in hot paraffin-wax, which will increase the insulation. In winding the ring a piece of wood about 6in. or 8in. long, forked at each end, in which forks the wire can be wound, will be found very convenient for passing through so small a space. After the winding and paraffining of the armature are finished, the commutator should have a hole drilled radially from the edge in the centre of each section, and when fastened in its place on the shaft, the two wires which were twisted and soldered together may be inserted into these holes and soldered. These connections are shown in Fig. 40 at 1, 2, &c. Fig. 46 is a diagram of the connections. The two field-magnets, it will be seen, are in parallel and put in series with the armature, the brushes being shown thus for simplicity. The terminals *a* and *b* are for connecting with the battery, although, of course, it does not matter to which poles of battery they are attached.

The motor will be fastened down to the base-board in the same way as the bar which supported the counter-shaft; but instead of the small pieces like Fig. 29, page 517, being screwed down on the top of the wood, they are let in the wood nearly flush with the surface, so that the bottom wheel on the motor shaft may be in the same horizontal plane as the larger wheel A, Fig. 32, p. 517. The centre of the motor shaft will come at the same distance from the centre pillars on the right-hand side of the machine as the counter-shaft is on the left. The surface of the wood will, perhaps, need a little cutting where the oiling tube and steel screw come.

In the next article, which will be the last, I will give the method of casting the wax cylinders, and also a few hints of the kind and shape of battery to be used.

PRACTICAL HINTS IN BOILER DESIGN.—II.

By W. C. Carter.

Furnace.

WE have now to apply the principles of the foregoing formulæ to the consideration of the strength of the furnace, and a very little thought will show that the problems are practically identical. The only difference to be observed is, that the pressure is applied *outside* instead of *inside*. Let us recapitulate the formula already established, as it refers to the furnace, making use of Fig. 1 for the purpose. The external pressure may be dealt with in exactly the same way as before, always remembering that what were in the former case *tensile* stresses are now *compressive*. The only difference in the value of any of the factors is in taking the measurement D, as the rectanugular plate A B C E must now contain the two side plates (A B, C E) of the semi-cylindrical box as the pressure is applied outside of everything. D must therefore be measured over all, and is the outside diameter instead of the inside, as in the former case. We have, therefore, readjusting formulæ (*a*) and (*b*)—

(*c*) Compressive stress upon furnace plating = $D \times L \times WP$.

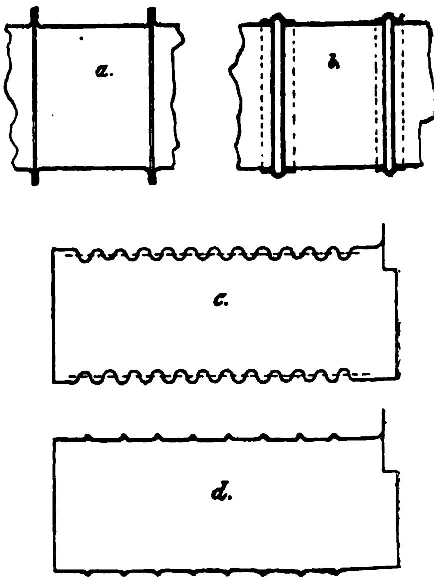
(*d*) Area of metal resisting this stress = $L \times 2T$. And by striking out L, we obtain, as before, the variable factors $D \times WP$ and $2T$. The pressure allowed upon the material must be proportionate to its crushing strength, and should not exceed 4,000lb. per square inch for iron, and 4,400lb. for steel.

When, therefore, $4{,}000 \times 2T \times 1'' = D \times WP \times 1''$, or (transposing) when—

$$\frac{8{,}000 \times T}{D} = WP \ldots\ldots \text{(iii.)}$$

we have the correct proportions for a wrought-iron tube in compression; and by substituting 8,800 for 8,000 we make the necessary correction for steel. It should be observed that we do not concern ourselves with th weakness produced by the joint in this case as, when the edges of the plate are properly fitted and the workmanship good, ther is practically no loss of strength as long a the joint is not exposed to tension. We now hav to notice an important limitation which prevent us extending any further the analogy of the shel formulæ. In the case of the shell we found w were able to strike out the factor L as immaterial but when the length of the furnace exceeds certain ratio of the diameter, varying with th thickness of plate and the method of constructio at the joint, the tube collapses at a less pressur than that given by the preceding formula, an this, indeed, is the case more frequently me with in practice. It appears from experiments carried out by Sir Wm. Fairbair and others, that the varying dimensions tubes under external pressure affect thei strength in much the same way as they affec that of long columns, and the laws, if not identical, are evidently closely allied. A detaile mathematical treatment of this point will b found in Unwin's "Machine Design." Withou going more closely into the matter, we may no the following facts:—First, that the strength, resistance to collapse, varies approximately

FIG 2.



the square of the thickness *directly*, and we may therefore expect to find some such quantity as T^2 in the numerator of the formula expressing the strength in question. Second, that the strength varies as the length *inversely*, and as the diameter also inversely, and we shall therefore expect to find these quantities in the denominator of the formula. The expression given by the Board of Trade Boiler Rules, is as follows:—

$$\frac{\text{Constant} \times (\text{Thickness in inches})^2}{(\text{Length in feet}+1) \times \text{Diam. in inches}} = \text{W. P.} \quad \text{(iv.)}$$

The constant for the highest class of work with furnaces truly circular, and with double butt strap joints, is 90,000 for wrought iron and 99,000 for steel. Deductions are made by the Board of Trade for departures from these conditions, and as the rules in question are very complete and reliable, they can be confidently referred to as representing thoroughly safe practice, if not very adventurous, and should be obtained by the reader for reference. They may be obtained from the Queen's printers for a few pence.

For the benefit of those who are not versed in algebra, we will transpose formula (iv.) to suit different unknown quantities.

To find thickness—

$$\sqrt{\frac{WP \times (L+1) \times D}{C}} = T \ldots. \text{(v.)}$$

To find diameter—

$$\frac{C \times T^2}{WP \times (L+1)} = D \ldots. \text{(vi.)}$$

To find length—

$$\frac{C \times T^2}{WP \times D} - 1 = L \ldots. \text{(vii.)}$$

Every furnace should be tried by both formulæ (iii.) and (iv.) for the sake of safety.

Several methods have been used to eliminate the effect of the length of a furnace upon its strength by subdividing it by means of rigid rings into short sections, which can be considered as so many separate furnaces. For comparatively low pressures, stiffening rings of various well-known forms, attached by rivets to the short sections of the furnace tube, have been successfully used. As examples of these, see Fig. 2. *a*, the Adamson ring; *b*, the Bowling hoop. These methods were efficient until the advent of triple expansion engines, and the use in large marine boilers of pressures such as had previously been confined to locomotives and similar non-condensing engines. The plain plate furnace was now found to be quite inadequate to support these high pressures, even when stiffened as far as was convenient by the ordinary rings. The reader will very naturally say: "Why then do you not make the plate thick enough to carry any required pressure?" This is done as far as is considered advisable, but there has been a strong prejudice amongst engineers against making a thick furnace, for fear the thickness of metal should so hinder the transmission of heat from the fire as to cause the plate to be burned. For some time furnaces were never made more than $\frac{1}{2}$in. thick for this reason; but further experience has shown that these fears are to some extent groundless, and furnaces are now made $\frac{5}{8}$in. thick and even more, and it seems probable that these thicknesses can be still further increased without serious trouble arising, though the evaporation would not be so rapid. However, it was still necessary to adopt some new method of strengthening, and just when the necessity arose Mr. Sampson Fox introduced a furnace in which was applied the same principle which obtains in the well-known Paragon umbrella frame—viz., the removing of metal from a position where its strength was of little use, and placing it where its greatest value could be obtained.

In mathematical language, the object was to get as much material as possible at a distance from the neutral axis of the section. The meaning of this will be plain by a reference to the theory of flanged beams. Fox's corrugated furnace is shown at *c* in Fig. 2, the neutral axis being indicated by a dotted line. It is due to this invention of Mr. Fox that the high pressures necessary to obtain the benefit of triple-expansion engines were made possible at that time in the case of marine boilers. More recently, a very successful rival to the Fox flue has appeared in the shape of the Purves ribbed furnace, which is shown at *d* in Fig. 2. This consists of stiffening ribs rolled solid with the plate, and is a highly-satisfactory furnace. It is claimed for this furnace that, owing to the absence of hollows, there is not such a tendency to collect scale as in the case of the corrugated flues, and also that it possesses more longitudinal stiffness. With this latter object a flue has been introduced, having the corrugations spiral instead of circumferential.

The last mentioned special forms of furnace not being yet referable to any well tried series of experiments, have to wait their time before being finally placed upon the Board of Trade Rules.

The formula for Fox's flues is, for Board of Trade—

$$\frac{\text{Constant} \times \text{thickness}}{\text{Diameter}} = WP \ldots\ldots\ldots \text{(viii.)}$$

$$\frac{WP \times D}{C} = T \ldots\ldots\ldots \text{(ix.)}$$

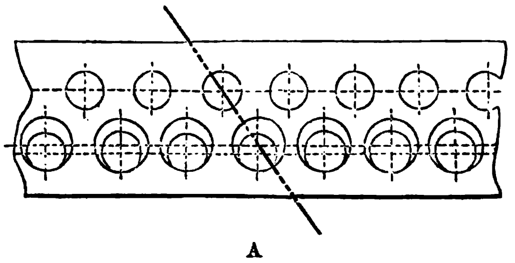
$$\frac{T \times C}{WP} = D \ldots\ldots\ldots \text{(x.)}$$

The constant for Fox's steel flues is 12,500, and that for Purves's furnaces, though not incorporated in the Board of Trade Rules, is stated by the makers to be 14,000, this figure agreeing with furnaces that have been approved by the Department.

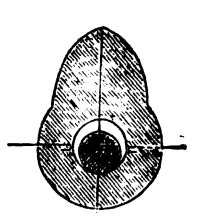
Errata.—In Article I. p. 31—middle column —line 4, for "having" read *leaving*. In same column, line 7 from end of article, for "steel" read *shell*.

PUGH'S CUSHIONED TIRES FOR CYCLES.

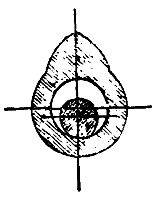
IN the annexed illustrations we show the cushioned tires for cycles, patented by the Rev. F. Pugh, of Swindon, whose object has been to combine the advantages of the pneumatic, the cushion, and the solid tire in one. Spherical air cavities are formed in the substance of the rubber tire in one or two lines as may be required. Elastic balls about two-thirds the size of cavities are inserted loose in the same. The balls to be formed solid, or more or less hollow, to suit weight of machine, and to prevent tire from flattening at point of contact with the road. The rubber or other elastic substance used in forming the tire should be of a tough but sufficiently yielding nature, and not liable to crack or unduly harden by atmospheric influence. Balls are of the same material.



A

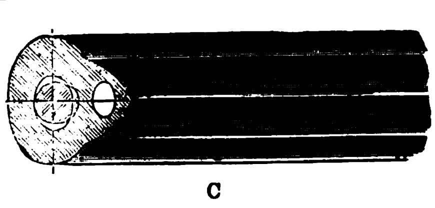


B



D

No specific size of tire is set forth in the specification, as the invention is intended to be adapted to different kinds of velocipedes and common road carriages, and must be made proportionate to the weight and size of the vehicle to which it is applied. The drawings give only a general view of the relative proportions of the tire, the air cavities, and the balls insered therein. The air cavities are to be placed nearer together or further apart, to be left entirely void, or to have solid or hollow balls inserted as best may suit the weight of the cycle or carriage. The tires will be made at first in three sizes: $\frac{7}{8}$in. by $1\frac{1}{2}$in., 1in. by $1\frac{3}{4}$in., and $1\frac{1}{2}$in. by 2in., with cavities and balls differently arranged. The invention is also intended to be applied to the making either of single or double tires; one line of air cavities being, as shown in drawing, used for the single, and two lines used for the double tire. The drawings represent cross, longitudinal, and oblique sections of the single and double tire, and of air-balls as follows: A is a longitudinal section of double tire; B a cross section of the same; C is an oblique section of double tire, showing section of air-ball inserted; D is a short section of the single tire having only one line of air cavities.



C

The tire, whether single or double, is made in longitudinal halves, the air-balls being loosely inserted in the cavities, and the halves united, leaving the air cavities perfectly air-tight, and the air-balls free to move about in the same.

GEOLOGY FOR STUDENTS.

By Edward Aveling, D.Sc. Lond., Fellow of University College, London.

Chapter XIV.—The Igneous Rocks.

IN the last chapter, the most important rocks entering into the composition of the crust of the earth were classified. The definitions and descriptions given of them were necessarily meagre. In the present chapter, a more complete account will be given of the igneous rocks. In the next chapter, a more complete account will be given of the metamorphic rocks. The aqueous rocks will not have any special chapter devoted to them, as their characteristics will be worked out in detail, when we come to consider the various formations and systems of formations into which they enter.

The general plan upon which all rocks, formations, and systems of formations, will henceforth and always be studied in these articles, may now be stated. In every case where it is possible and necessary we shall give A. The derivation of the name of the rock, formation, or system. B. Its nature—the what of the rock, formation, or system. This falls under the two heads of (1) general *structure*; (2) chemical *composition*. C. The localities in which it appears, its occurrence or distribution; the where. D. Palæontology (p. 66). E. The method of formation; the how. F. The economics of the rock formation or system; the use of it to man.

TABLE VI.

Plan for Geological Study.

A. Derivation.
B. What { (1) Structure.
          (2) Composition.
C. Where.
D. Palæontology.
E. How.
F. Use.

The Igneous Rocks Generally.

A. Derivation.—We have already seen that their general name is derived from *ignis*, fire. Another name sometimes given to them is that of pyrogenous rocks. πυρ (pur) fire; γενναω (gennao), I produce.

B. What.—The nature of these rocks, already broadly noted, will be worked out in detai further on in this chapter.

C. Where.—Their places of occurrence will also be noted at length; but a word or two upon the general question is necessary here.

First, the igneous rocks do not, like the aqueous, present any definite order of succession from above downwards. Their essentially eruptive nature prevents any definite order of superposition, and the irregularity of their eruption only allows, at most, of an approximate guess at the age of an igneous rock relatively to the ages of the rocks it bursts through, or overlies, or is interstratified with.

Second, the plutonic igneous rocks are deep-seated in their origin. Hence, except in the rare cases in which they have broken right through all overlying strata, the granites, basalts, and their allies are only exposed to view after long ages of denudation by the geological agencies enumerated in Chapters VIII—XI. Hence, again, the fact that most of the plutonic rocks known to us are connected with the early formations and times; and hence the false idea that the plutonic rocks are *only* formed in connection with those early formations and times. As a matter of fact, they have been ejected from within in all ages. Thus, in the western islands of Scotland, where the process of denudation is very powerful, plutonic rocks have been exposed that were formed in, geologically speaking, comparatively recent times.

D. Palæontology.—As the igneous rocks contain no fossils, nothing can be said under this head.

E. How.—Two different theories have been suggested in explanation of the origin of igneous rocks. (1) That of central heat, already mentioned, and the proofs of which have already been given. (2) That of chemical action within the crust of the earth. Many chemical actions are attended with great rise of temperature. If the soft metal potassium or sodium, e.g., is thrown upon water, the latter is decomposed with great giving out of heat. Undoubtedly, within the earth's crust, many chemical actions are constantly going on, attended with much evolution of temperature. And these may give rise, in whole or part, to the many and varied phenomena of eruptive or igneous action.

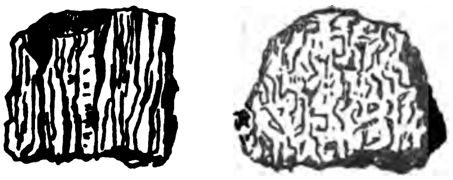


Fig. 43.

Possibly, in this case, as in so many others in science, the actual truth is between the two solutions. Both the antagonistic theories may be correct. Igneous action may be the result of internal or central heat *and* chemical action within the crust.

F. Use.—The uses of the various igneous rocks will be considered in connection with each member of the group.

Granite.

A. Derivation. — From *granum* (a grain). The name dates back as far as 1596, when it was first used by the Italian naturalist, Cæsalpinius.

B. What.—(1) *Structure.* — Granite is irregular, amorphous. It is crystalline, the crystals showing no trace of water action, and is holocrystalline. That is, granite is composed wholly of crystalline material, with no interstitial glassy or other matter between the crystals. ὁλος (holos), whole. Further, the crystals are uniform in size. As to its texture, granite ranges from a close-grained, compact rock, to a coarse, loose aggregation of crystals.

(2) *Composition.*—Granite, in its typical form, consists of quartz, felspar, and mica. Of these, quartz is much the hardest, and granite weathers by the wearing down of the felspar constituent especially.

Whilst, typically, granite consists of the three minerals, quartz, felspar, and mica, and is therefore a ternary compound (*ter*, three times), there are also granites with two or four minerals entering into their composition.

Graphic granite, Fig. 43, is a binary granite (*bis*, twice), consisting only of quartz and felspar, without any mica. The quartz is arranged within the felspar as a ground basis or matrix. And the quartz runs in long, imperfect parallel columns; see the left-hand figure in Fig. 43, which represents a section parallel to these columns. The right-hand figure represents a section at right angles to the columns of quartz, and shows the quartz appearing in the felspar matrix as irregular lines that look like Arabic letters. Hence the name, graphic granite. γραφω (grapho), I write.

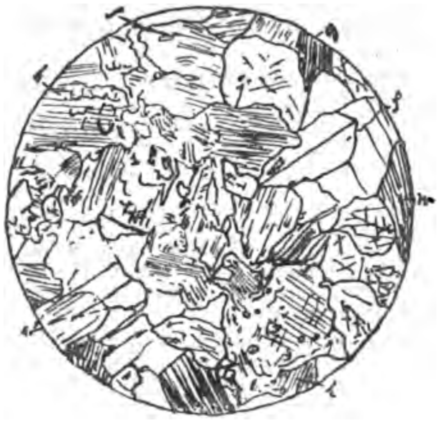


Fig. 44.

And there are also quaternary granites (*quater*, four times), such as hornblende granite, i.e., granite with hornblende crystals in addition to the usual quartz, felspar, and mica.

In Fig. 44 a section of hornblende granite is represented as seen under the microscope.

Fig. 45.

q, *f*, *m*, and *h*, respectively, are quartz, felspar, mica, and hornblende crystals.

C. Where. That which was said above of the igneous rocks generally, holds of granite in particular. Deep-seated in origin, although it may be, and apparently has been, formed at almost any period in geological history, it has always either to break completely through all the rocks lying above it, or to be exposed, later on, by the wearing away of the superincumbent rocks through which it may not have forced its way. Granite, therefore, may be found among rocks of all ages; and it occurs in dykes, veins, or mountain masses.

Fig. 46.

In noting the distiibution of granite over the surface of the earth, i.e., the places where it has come, or has been brought, to the surface, the use of the atlas, insisted upon so strongly on p. 174, is absolutely necessary. If, as was there said, the student has not at command a geological atlas, he *must*, at least, look out on an ordinary atlas, or, better on a globe, the places at which granite is found. And, of course, this vital principle holds equally in respect to every other rock and its distribution.

In the account of rock distribution in this case, and in all other subsequent cases, the plan will be followed of giving the distribution in Europe first, then in Asia, Africa, America (North and South), Oceania (including Australasia and Polynesia). As to Europe, we shall begin always with England, Wales, Scotland, and Ireland, and, naturally, devote most attention to the occurrence of rocks in these countries. Then will follow the distribution in the countries of the Continent.

TABLE VII.

Plan for Study of Distribution.

Distribution in
- 1. Europe
  - a. British Isles
    - i. England.
    - ii. Wales.
    - iii. Scotland.
    - iv. Ireland.
  - b. Continent.
- 2. Asia.
- 3. Africa.
- 4. America
  - a. South.
  - b. North.
- 5. Oceania
  - a. Australasia.
  - b. Polynesia.

Let us apply this plan to granite.

1. Europe. *a.* British Isles. (i.) England.—Working from south to north, and west to east always. Malvern Hills, Wellington in Shropshire, Nuneaton, Ercal Hill in Leicestershire, Charnwood Forest, Stockdale and near Grizedale Tarn in the Lake District, Eskdale, Skiddaw, in the Cheviot Hills, near Staindrop Rigg, and Hedgehope.

(ii.) Wales.—Skomer Island and Ramsey Island, both off the coast of Pembroke; St David's, many places in North Wales, such as Twt Hill and Llanfallog.

(iii.) Scotland.—Dalbeattie, Criffel, Cairnsmore of Fleet, New Galloway (all in Kirkcudbright), Loch Doon, Ben Nevis and Ben Vuroch, Aberdeen, Peterhead, and the islands of Arran, Mull, and Skye.

(iv.) Kerry, Waterford, Wexford, Wicklow, Mount Leinster, Killiney Hill near Dublin, Mourne Mountains, Galway, Mayo, Carlingford, Newry, Donegal.

Fig. 47.

(*b*) The Continent.—The Pyrenees, the Alps, the Dovrefeld ranges.

2. Asia. — The Oural and the Himalayan ranges.

3. Africa.—The hills of Damara and Namaqua land, the central range of the islands of Madagascar, the Abyssinian range.

4. America (*a*) South.—The Andes.

D. Palæontology.—See above.

E. How.—Granite and all the granitic rocks have been formed as the results of very deep-seated igneous outbursts under immense pressure. They alter greatly the rocks through which they pass, hardening and metamorphosing them. Limestones, in contact with them, become crystalline marble, and the aluminium silicate rocks are turned into clay-slates. In Mount Leinster, in Ireland, this "contact zone" of metamorphosed rocks extends as far as a mile away from the granites themselves.

F. Use.—Granites are used as building stones for heavy structures, for street-pavements, for ornamental purposes.

Indirect products of the granites are:—(1) Kaolin, the fine China clay—the name is Chinese—an aluminium silicate, used in making the very finest porcelain. Kaolin is the result of the weathering of granites that contain much felspar, which is, as we noted above, the least-resisting constituent of granite.

(2) Felspar itself, which is used for making pottery, enamels, and artificial teeth.

(3) Mica—in large plates, used as a substitute for glass.

(4) Talc.

(5) Meerschaum (magnesium carbonate $NgCO_3$).

(6) Asbestos.

(7) Apatite. απατη (apatè), deceptive. This is a crystallised calcium phosphate (Ca_32PO_4) found in veins running through granite in Norway and Sweden, and is of value as a manure.

(8) Precious stones, such as the coloured varieties of rock-crystal known as cairngorms, garnet, beryl. These are often found, see Fig. 45, in well-defined cavities within the granite. Such cavities, whether they contain crystals or not, are known as geodes. γηοδης (géodés), earthy.

Syenites.

A. DERIVATION.—The word Syenite is derived from Syene, in Egypt, where the celebrated quarries of granite are. As a matter of fact, the rock met with in these quarries is a quaternary, hornblende granite (see Fig. 44 above). But the name is retained for a modification of granite whose nature is given in the next paragraph.

B. WHAT. — (1) *Structure.* — Like granite, syenite is crystalline throughout (holo-crystalline), presenting no ground mass or matrix. It is coarse-grained.

(2) *Composition.* — Felspar (orthoclase) with hornblende, or augite, or mica, i.e., always orthoclase—felspar, and a silicate of iron, or of magnesium, or of both. Quartz is either wanting in syenite, or occurs in very small quantitie.

C. WHERE. — 1. Europe. *a.* British Isles. (i.) England. No syenite occurs in England.

(ii.) Wales. Doubtfully in the north-west of Carnarvon, at Llanfaglen, and Glan-y-Mor.

(iii.) Scotland. Skye, and the small island of Ramsay, lying east of the northern half of Skye.

(iv.) Ireland. No.

b. The Continent. The Foya Hills in Algarve, the southernmost province of Southern Portugal; Ditro, in Transylvania, the extreme east of Austria; the rock of the Plauenscher Grund, Dresden; Loven and Brevig, in Southern Norway.

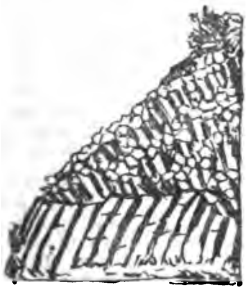


FIG. 48.

(2) Asia. The Ilmen mountains near Miask. Kangerdluarsuk on the south coast of Greenland.

(3) Africa. No.

(4) America. (*a*) South. Rio de Janeiro and Minas-Geraes in Brazil. (*b*) North. No.

D. PALÆONTOLOGY, and E. HOW.—See above.

F. USE.—See granite. The student must not forget that the Syene stone is really a hornblende granite, and, therefore, that the obelisks and monoliths of Egypt are not of syenite, as it is geologically classified to-day, but of the hornblende or syenitic granite shown in Fig. 44.

Porphyry.

A. DERIVATION. πορφυρεος (porphureos), purple. Because the name was originally applied to a red igneous rock, Rosso antiquo, met with in Egypt.

B. WHAT.—The terms porphyry and porphyritic are now applied to a rock of any colour, which contains larger crystals imbedded in a matrix of smaller ones. See Fig. 46. Hence there are several very different rocks grouped rather vaguely as porphyries. Here, and now, we are only concerned with the porphyritic granites.

These in (1) *structure*, and (2) *composition*, resemble granite. The larger crystals are, very generally, of felspar.

C. WHERE.—In their distribution, porphyritic granites follow the granites generally. In England (1, *a*, i.) they are especially found in Devon and Cornwall. Five large masses of them, besides many smaller masses, occur at Land's End, Carn Menelez, and St. Austell (all Cornwall), and Brown Willy and Dartmoor (both Devon). At Shap, also, in the Westmoreland lake district, porphyritic granite occurs.

(ii.) Wales. St. David's.

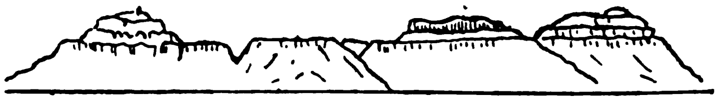


FIG. 49.

(iii.) Scotland. The Hebrides.

D. PALÆONTOLOGY. See above.

E. HOW.—In the formation of porphyries, there appear to be two distinct phases of crystallisation. In the first phase, the larger crystals are formed in what is at that time a molten matrix. This phase takes place before the eruption of the rock from within the earth, and is known as the intra-telluric phase. *Intra*, within; *tellus*, the earth. In the second phase, the smaller crystals are formed from the molten matrix, and thus make the ground-mass in which the larger appears imbedded.

F. USE.—See above. The original porphyry, Rosso antiquo, is used for sculptures.

Greenstone or Diorite.

A. DERIVATION.—The derivation of greenstone is from its general colour. Another common name for this rock, in Scotland, is whinstone. By some writers the name diorite is used as equivalent to greenstone. See the Science and Art syllabus given on p. 6. In the present state of confusion as to the "greenstones," I propose to follow this plan, and to describe here the rocks as diorites. The derivation of diorite is from διοριτος (dioritos), separated.

B. WHAT. — Diorite is taken first of the trappean rocks, as it is to some extent a transitional form between the granites and basalt.

(1) *Structure.*—Crystalline, granular holocrystalline. Less compact, more granular, more tabular than basalt.

(2) *Composition.*—Like syenite, of felspar and a silicate of iron, or of magnesium, or of both. But the felspar is plagioclase, not orthoclase. The other mineral is generally hornblende, but it may be mica or augite.

C. WHERE.—(1) Europe. (*a*) British Isles.

(i.) England, Jersey, Guernsey, Cornwall (Pen Voose), Malvern Hills, Nuneaton, Charnwood Forest.

(ii.) Wales. South of Haverfordwest in Pembroke, Penmaenmawr in Carnarvonshire.

(iii.) Scotland. Arran, Glen Tilt in Perthshire, Assynt.

(iv.) Ireland. Wicklow.

D. PALÆONTOLOGY.—See above.

E. HOW.—The diorites, and, indeed, all the trappean rocks are, speaking generally, younger than the granites, older than the volcanic. They are undoubtedly of igneous origin, and are products of the cooling and consolidation of molten rocks. They have been formed under great pressure, and in some cases under water. And they have acted both mechanically and thermally [θερμος (thermos), heat] on the rocks above and around them. They have produced faults, fissures, dip, contortion, and metamorphism. In Fig. 47 the effect of certain injected dykes of a trappean rock (basalt) is shown. The sandstone through which it passed has been rendered prismatic.

F. USE.—Diorites are used to some extent for building. They are very durable; but hard to shape, and ugly to see. But they are very useful in the making of roads and streets. They used to be employed for lining ovens, and by the Hindoos, Persians, and Egyptians for sculpturing.

Basalt.

A. DERIVTION.—Basal, an Ethiopian word, signifying an iron-bearing stone. The name dates back as far as Pliny at least, according to whom, from Ethiopia the first basalt came into Europe. By some writers the name dolerite is used as equivalent to basalt. See Science and Art syllabus, given on p. 6. Dolerite is derived from δολερος (doleros), deceptive.

B. WHAT. (1) *Structure.* A compact, heavy, crystalline rock; in fact, the compactest, heaviest, most crystalline of the trappean rocks; hard, tough, close-grained, and dark in colour. Its colour is often due to the presence of iron oxides. Very frequently columnar in structure (see Fig. 48). (2) *Composition.* Of felspar (plagioclase) and augite essentially; hornblende, mica, and other minerals may be present. As the metals, aluminium, iron, calcium, magnesium, sodium, potassium, of these different minerals, make up on the average 55·7 of basalt or dolerite, and the silicon dioxide or silicic acid (SiO_2) only 43 (the odd 1·3 is water), these rocks are often called basic.

C. WHERE. — Basalt or dolerite occurs in great beds or flows that form plateaux and hills (see Fig. 49), or it occurs in great columns, as in the Giant's Causeway, County Antrim, Ireland, or in dykes. See Fig. 50.

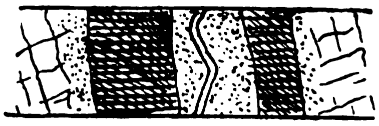


FIG. 50.

As to Geographical Distribution.

(1) Europe. (*a*) The British Isles. (i.) England. St. Minven in Cornwall, Ashprington and Tavistock (both in Devon)—Brent Tor, near Tavistock, is a worn-away volcano; Miller's Dale, Tideswell Dale, and near Matlock (Derbyshire), the hills of Cumberland, and the Cheviots.

(ii.) Wales. St. David's, in Pembroke, and at Rhobell Fawr, five miles north-east of Dolgelly, in Merioneth.

(iii.) Scotland. The Lion's Haunch, near Edinburgh; Douglas, ten miles north-west of Glasgow; Hill of Dun, three miles east of Dumbarton; Stitchill, north of Kelso; the islands of Arran, Mull, Staffa (Fingal's Cave), and Ramsay.

(iv.) Ireland. North-east, notably Antrim (Giant's Causeway).

D. E. F. PALÆONTOLOGY, HOW, USE.—See Diorite.

Clinkstone.

A. DERIVATION.—From the ringing sound this rock gives out when it is struck with a hammer, a more technical name is phonolite. φονος (phonos), sound; λιθος (lithos), stone.

B. WHAT.—(1) *Structure.*—Clinkstone is less compact than basalt, and is grey or brown in colour. Relatively compact when fresh, it weathers easily, and becomes laminated and fissile, and can easily be broken up into slaty fragments.

(2) *Composition.*—Of felspar, in a glassy form of orthoclase known as sanidine, *s*, Fig. 51, hornblende, *h*, and a silicate of potassium, sodium, and aluminium, known as nepheline, *n*, and allied to felspar. σανιδος (sanidos), flat, as it often occurs in large, flat tables; νεφελη (nephele), a cloud.

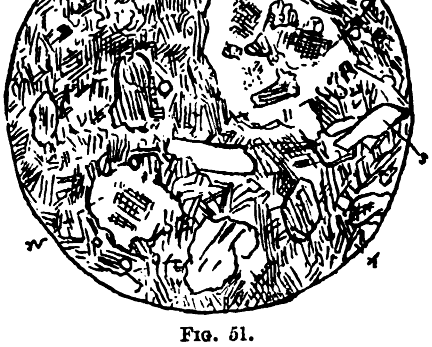


FIG. 51.

C. WHERE.—(1) Europe. (*a*) British Isles. The only known specimen of phonolite in the British Isles is the Wolf Rock, off the coast of Cornwall.

(*b*) The Continent. As dykes and veins in Auvergne and Bohemia,

D. E F. (See diorite and dolerite.)

Trachyte.

A. Derivation. — Trachyte, or greystone, is derived from τραχυς (trachus), rough. The name was originally applied to any volcanic rock that felt rough to the finger. It is now restricted to such rocks as present the characteristics mentioned in the next paragraphs.

B. What. — (1) *Structure.* — Many minute, colourless or light-coloured, needle-like crystals as a matrix, and others, tabular or granular, diffused through this. Not by any means necessarily rough to the finger. Often trachytes are porous.

(2) *Composition.*—The matrix of sanidine (i.e., glassy orthoclase felspar); the larger crystals also of sanidine and mica generally. In trachyte, unlike basalt, silicon dioxide (the acid constituent) is in excess of the metals; and therefore, trachyte is often called an acid rock.

If the orthoclase sanidine is replaced by plagioclase, we have andesite, so named from its entering largely into the structure of the Andes. In Fig. 52 a section of andesite is shown, as seen under the microscope: *m* are mica, *f* are plagioclase crystals. The mica of andesite is often replaced by hornblende.

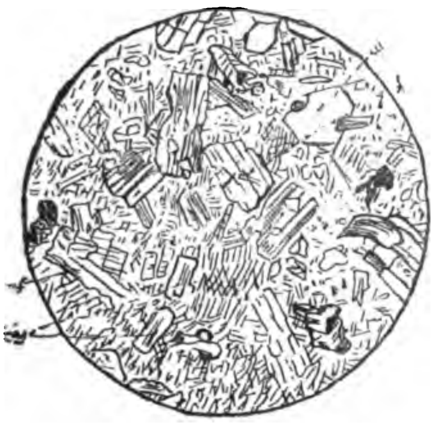


Fig. 52.

C. Where. — (1) Europe: (*a*) The British Isles. Not known.

(*b*) The Continent: In most volcanic districts; Auvergne, the Bay of Naples, the Euganean Hills, Transylvania, the Siebengebirge, Nassau.

(4) America: (*b*) North. The Henry Mountains.

(5) Oceania. (*b*) Polynesia; New Zealand.

D. (See above.)

E. Probably formed more superficially, and under less pressure, than basalt.

F. Uses.—Of no special economic importance.

Volcanic Rocks.

Of the volcanic rocks, as distinct from the trappean and the plutonic, enough has been said in the preceding chapters, with the exception of a note on their distribution and uses, with which this chapter ends.

For A, Derivation; B, What; E, How; see Chapter XI.

C. Where.—There are between 200 and 300 volcanic craters, more or less active, at the present time.

(1) Europe (*a*)—British Isles. None known. (*b*) The Continent. Sicily, Etna; Naples, Vesuvius; the Azores; Iceland, Hecla.

(2) Asia. The shores of the Caspian, the Levant, the Red Sea, the Indian Ocean islands; those of the Indian Archipelago, the Philippines, Japan, the Aleutian Islands.

(3) Africa. Ascension, Cape de Verde, Canary Islands.

(4) America. (*a*) South. Tierra del Fuego, the Andes, the Rocky Mountains. (*b*) North. The West Indian islands.

(5) Oceania. (*b*) Polynesia, New Zealand, the Sandwich Islands.

F. Use.—Lavas make a light building stone; pumice is a polishing stone; obsidian, for looking-glasses and knives. Indirect products are sulphur, borax, sal-ammoniac, ores of many metals, such as iron, manganese, copper, mercury, gold; precious stones, such as agates and chalcedony.

ON THE RHYTHMICAL GROUP OF HYDROGEN LINES VISIBLE IN MANY STELLAR SPECTRA.

By A. C. Ranyard.[*]

As all readers of *Knowledge* know, a prism or wedge-shaped piece of glass breaks up a beam of white light into a series of coloured beams arranged fan-wise, the blue or violet rays being turned through the greatest angle. If such a prism be placed in front of a telescope, so as to send the refracted rays from a star down the axis of the telescope, an observer looking in at the eye end will see the image of the star spead out into a narrow line of light, blue at one end and red at the other. This narrow band or spectrum is not continuous, but is interrupted by small dark gaps, which are not very easy to see; but if the narrow spectral band of light is made to appear a little broader by looking at it with a cylindrical lens, the dark gaps become visible as lines across the spectrum, and appear similar to the dark lines across the stellar spectra shown on the plate.

The spectra reproduced in the plate [in *Knowledge*] were, however, photographed without a cylindrical lens. The narrow spectral streak of coloured light was turned so as to be at right angles to the direction of the star's diurnal motion, and, by slowing the driving clock of the telescope, the spectral streak was caused to sweep across the sensitive plate in a direction at right angles to its length, thus producing a trail or trace with dark lines across it, corresponding to the dark gaps in the spectral streak. The upper four stellar spectra on the plate are from photographs kindly given me by the Brothers Henry, and the lower four are copied from photographs published by Prof. E. C. Pickering in connection with the spectroscopic work of the Draper memorial.

The method of observing stellar spectra with a prism in front of the object-glass, and a cylindrical lens, was devised by Fraunhofer—nearly 80 years ago—in 1814. This remarkable man turned a telescope, with a prism in front of the object-glass, to the stars, and noted some of the chief variations in their spectra. He found that the spectrum of Pollux closely resembled the spectrum of our sun, while there were recognisable differences in the spectra of Capella, Betelgeuse, and Procyon—they were all crossed by narrow dark lines, some of which he identified with solar lines. On the other hand, the spectra of Sirius and Castor were seen to be of a different type, and to be crossed by three massive dark bars, two in the blue and one in the green.

After a lapse of 45 years Prof. Kirchhoff, of Heidelberg, found a key which enabled him partially to read the hieroglyphic language of the Fraunhofer lines, but much more remains still undeciphered until some Daniel shall arise who can interpret the story clearly written in letters of light upon the heavens. Kirchhoff passed a beam of sunlight across a space occupied by burning sodium vapour, and perceived with astonishment that the dark Fraunhofer line D, instead of being blotted out by the luminous rays of the same refrangibility as that given out by the flame, were rendered blacker and thicker by the superposition. He tried the same experiment, substituting the continuous spectrum derived from the light of a Drummond lamp for sunlight, but a dark line, corresponding in every respect to the solar D line, was seen to cross the spectrum. The inference was irresistible that these dark lines were produced by absorption of light corresponding in wave-length to the bright lines given out by the vapour, and that there must be an absorbing layer of sodium vapour about the sun. This discovery was quickly followed up by the examination in the laboratory, by Prof. Kirchhoff, of the bright lines from other incandescent metallic vapours, and many of the bright lines from such vapours were identified with dark lines in the solar spectrum. But in spite of all the work done by Prof. Kirchhoff and his assiduous pupil, Dr. Bunsen, and in spite of all the careful measuring and photographing of the lines in the spectra of terrestrial elements since their day, not one-fourth of the dark lines of the solar spectrum have as yet been identified with lines in the spectra of terrestrial elements; and there are many mysterious discrepancies between the spectra of the elements, as observable under laboratory conditions, and the corresponding dark lines of the solar spectrum. We are, therefore, very far from having read the riddle of the solar spectrum, and we are much further from having learnt all that may be deciphered from the spectra of the stars.

Soon after the publication of Kirchhoff's and Bunsen's results, Father Secchi set himself to the task of making a spectroscopic survey of the heavens. He examined the spectra of 4,000 stars, and grouped them into four great classes, with the first of which we are at present more especially concerned. It contained Sirius and Vega, and more than half of the stars, which he examined. Their spectra are characterised by the great strength of the hydrogen lines, which are wide, hazy bands, much like the H and K of the solar spectrum, though these lines in the solar spectrum do not belong to hydrogen but to calcium, an element which is closely associated with hydrogen in the solar prominences, but it is very different from it in atomic weight and chemical qualities. In the spectra of the stars of Secchi's first type the K line is generally faint, and it is sometimes entirely absent.

As early as 1863 Dr. Huggins attempted to photograph the spectrum of Vega, and succeeded in getting an impression of the spectrum, but without any of the lines. In 1872 Dr. Henry Draper, at Dobbs's Ferry, on the Hudson, succeeded in obtaining a photograph of the spectrum of Vega, showing, for the first time, four of its hydrogen lines. (The photographic record of Dr. Henry Draper, and his father, Dr. J. W. Draper, is very remarkable. The father, nearly half a century ago, obtained the first photograph of a human being, as well as the first photograph of the solar spectrum, and the son obtained the first photograph of a nebula—the Orion nebula, which was photographed by him on the night of the 30th September, 1880—as well as the first photograph of a stellar spectrum showing lines.) The introduction of more sensitive dry plates in 1876 induced Dr. Huggins to turn again to the photography of stellar spectra, and he soon succeeded in obtaining pictures showing many lines.

In a paper published in the *Philosophical Transactions* for 1880 on "The Photographic Spectra of Stars," he called attention to the arrangement of 12 strong lines in the spectrum of Vega, remarking that the group possesses a distinctly symmetrical character, as the refrangibility increases the lines diminish in breadth, and the distance between any two adjacent lines is less; and he hazarded the suggestion that the lines must be "intimately connected with one another and present the spectrum of one substance."

In this paper Dr. Huggins designates the nine most refrangible of the 12 lines photographed by him by the Greek letters, α, β, γ, &c., ι being the last one seen on his photographs. He adds: "A circumstance of great importance is the entire absence of any lines in the spectrum beyond ι. The spectrum, which then becomes continuous, is strong, and extends beyond S in the ultra violet. In solar photographs, taken with the same apparatus, the lines in this region are well defined for some distance beyond S, and therefore this abrupt cessation of lines cannot be referred to an instrumental cause."

Dr. Huggins seems to have thought it strange that the group of lines was not continued further, and that if the lines belonged to a degrading series, and were due to a common physical cause, the group ought not to end abruptly at ι. His suspicion had been confirmed, for the photograph of the Brothers Henry, from which the uppermost spectrum on the plate had been copied, shows at least three more lines on the more refrangible side of ι. (Prof. Geo. E. Hale, with whom I have had the advantage of examining the photographs given me by the Brothers Henry, pointed out four lines beyond Dr. Huggins' line ι, and thought that he saw a suspicion of a fifth line.) Two of them may be seen in our reproduction, though they are very faint, and only just visible. There is a spot on the line ι, corresponding to a flaw on the negative of the Brothers Henry, which will enable the line ι to be easily identified, and the two faint lines will be seen beyond it, making in all sixteen[*] lines which can be counted on our reproduction.

All the lines of the group are of the same character—that is to say, they are broad and winged at the edges, and they become less intense and better defined in the order of their refrangibility. At the date of Dr. Huggins' paper in 1880 the lines of the hydrogen spectrum had only been photographed in the laboratory as far as δ, and their wave-lengths as given by Dr. H. W. Vogel corresponded within the limits of probable error with the wave-lengths of the typical lines measured by Dr. Huggins.

	Vogel's numbers.	Dr. Huggins' numbers.
H	λ 3968	λ 3968
α	3887	3887·5
β	3834	3834
γ	3795	3795
δ	3769	3767·5

On the strength of this evidence, Mr. Johnstone Stoney wrote in a note published with Dr. Huggins' paper:—

"There can remain very little doubt that your typical lines are due to hydrogen. The evidence of their all being members of one physical system is made very plain when their positions are plotted down, for it then becomes conspicuous that they lie on, or very near, a definite curve, which could not happen by chance.

"This question of whether they lie actually on, or only near, a definite curve is, if I mistake not, of

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[*] Extracted from *Knowledge*, September.

[*] This includes the K line, which does not belong to the hydrogen spectrum, and the F line, which was not shown in Dr. Huggins' photograph.

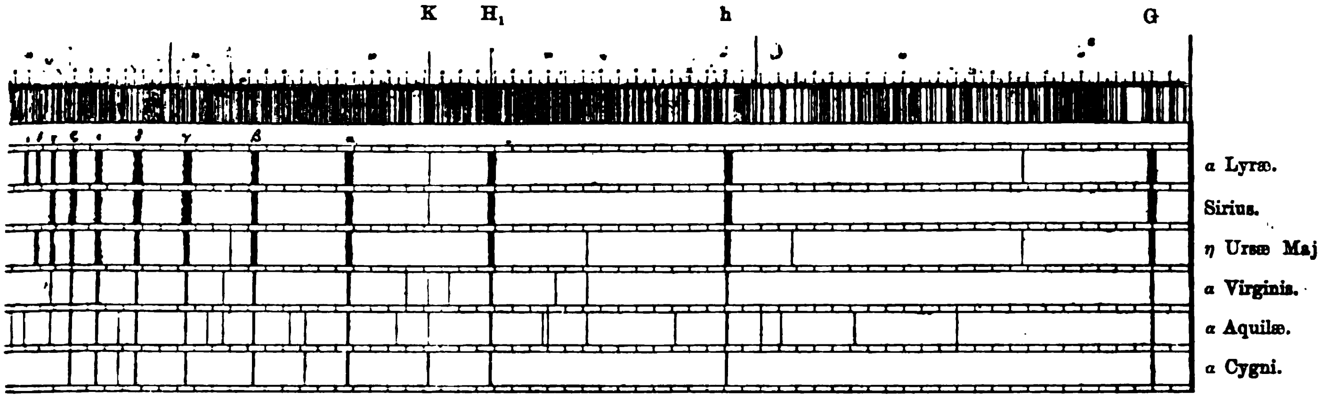
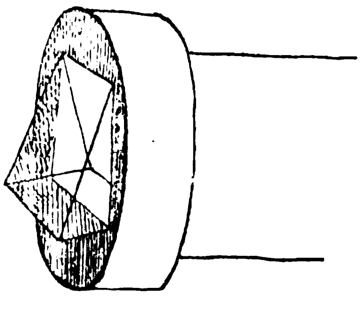


Diagram showing the relative intensity of the lines of the Hydrogen Spectrum in six Stellar Spectra, photographed by Dr. Huggins, copied from his paper on the Photographic Spectra of Stars in the *Phil. Trans.* for 1880.

Prism breaking up a ray of white light from S into a spectrum RV.



Prism in front of Object-glass.

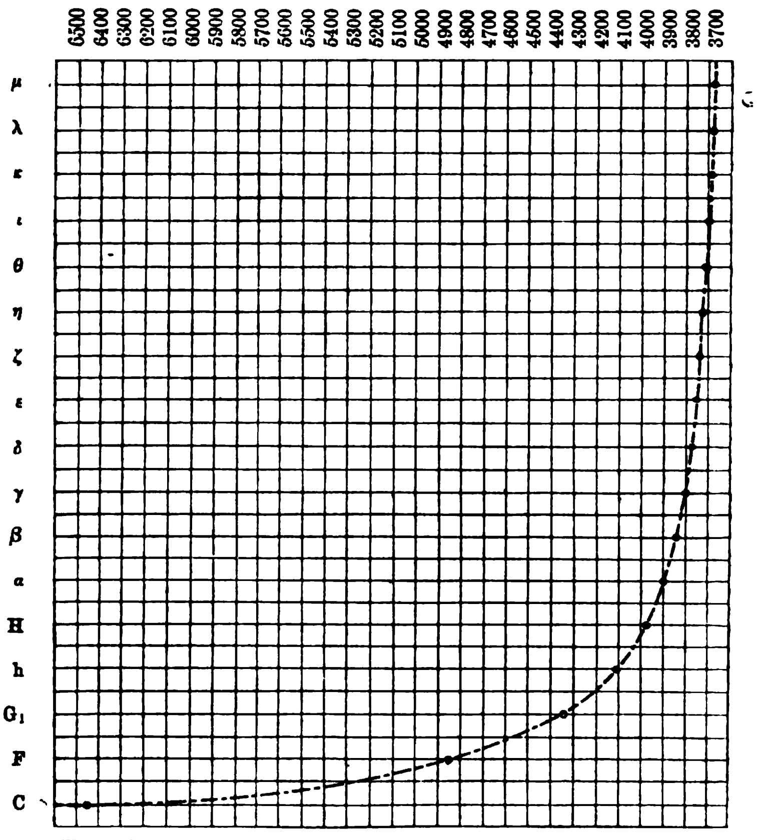


Diagram illustrating the relation of the Wave-Lengths of the Stellar Series of Lines in the Spectrum of Hydrogen.

very great significance in the theory. If they lie *on* a curve obeying any exact mathematical law, their connection must, I think, be attributed to their corresponding to the *consecutive* partial tones of some vibrating system (like those of an elastic rod or bell, for example). If, on the other hand, they lie near but not on the curve, this circumstance would support the hypothesis that the visible lines are members of harmonic series, most of the members of which are invisible, those only being seen whose positions chance nearly to fulfil a definite condition."

Mr. Johnstone Stoney converts Dr. Huggins' wave-lengths into wave-frequencies in air, and comes to the conclusion that, assuming that the irregularities in the second differences cannot be referred to errors of observation, the positions of the lines do not lie on but lie near to a definite curve. He then points out that the wave-length of H and the line near G are connected harmonically, being exactly the 35th and 32nd harmonics of a vibration whose fundamental is $\frac{\tau}{72{\cdot}003}$ when τ is the time in which light travels a millimètre in air—a connection which is rather far fetched and unsatisfactory.

One of the most remarkable facts with regard to the vibrations of molecules which become visible to us as lines in the spectrum is that no simple harmonics are observed. Very good photographs of the solar spectrum have been taken, extending from above wave-length 3,000 tenth-mètres to below wave-length 8,500 tenth-mètres; but no repetitions of the lines and groups of lines are found to exist at positions in the spectrum corresponding to double the wave-length, or at two-thirds or any other simple multiple of the wave-length, as would probably be the case if a molecule were constituted like a bell or a tuning-fork, and gave out overtones corresponding to the chief vibrations with which it was pulsating.

Much interest naturally attaches to any relations that may be noted between the wave-lengths given out by an element, as they may teach us something with regard to the internal architecture of molecules. The strange groups of lines in the solar spectrum and the numerous similar pairs and triplets indicate that there must be many such co-related lines, but the exact law of relationship needs to be worked out and traced back to its probable physical cause.

Some slight advances have been made in this direction. Prof. Hartley has called attention to a most remarkable relation connecting the lines in the series of triplets in the spectra of magnesium, zinc, and cadmium. He corrected the wave-lengths for atmospheric refraction, and then calculated the wave-frequency, and found that the differences o these frequencies for each triplet in any one series is a constant quantity within the limits of probable error of the observations used. That some such relation exists between the wave-lengths of the lines of the hydrogen spectrum was evident from the date of the publication of Dr. Huggins' paper.

In 1885 J. J. Balmer gave a formula for connecting the wave-lengths of this group of lines of the hydrogen spectrum, which approximately agreed with the positions of the lines as then known, and subsequent observations have shown that the formula is remarkably accurate. Balmer's formula is:—

$$\lambda = 3647{\cdot}20 \frac{m^2}{m^2 - 4}$$

where m takes in succession the values 3, 4, 5, &c. The value of λ, given by making m equal 3, corresponds to the wave-length of the C line; $m = 4$ gives the wave length for the F line, and so on.

Prof. J. S. Ames, Assistant in Physics at the Johns Hopkins University, has, in a very important paper published in the *Phil. Mag.* for July, 1890, given an account of his verification of this formula. Cornu and Hasselberg had already examined the spectrum of hydrogen in the laboratory, under various conditions of electrical tension, and had succeeded in getting all the lines of the stellar series as far as θ, as well as many other lines which are spoken of as belonging to the "secondary" spectrum of hydrogen. Prof. Ames repeated their experiments, taking every precaution in the measurement of the positions of the lines, and his places agree remarkably well with Balmer's formula when they are corrected so as to correspond with the refractive indexes in vacuo. Prof. Ames remarks that he was entirely unable to obtain the stellar series of lines by itself, although he says, "I am confident my hydrogen was pure and I varied the tubes, the current, the vacuum, and the exposure. I also introduced large condensers without any noticeable change." We therefore do not seem at present to be able to imitate in the laboratory the conditions under which hydrogen exists in stars having the first type of spectra, and the same remark applies to nearly all the spectra of elements recognisable in the solar spectrum.

The accuracy of Prof. Ames' measures are confirmed by their agreement with Prof. George Hale's measures of the positions of the hydrogen lines in the solar prominences. There is some slight doubt about the proper correction for atmospheric refraction, but using the numbers adopted by Prof. Ames we have

	Places calculated $= 3647{\cdot}20 \frac{m^2}{m^2-4}$	Places observed by Ames, corrected for atmospheric refraction.
C	6564·96	6564·97
F	4862·93	4862·93
G_1	4341·90	4342·00
h	4103·10	4103·11
H	3971·4	3971·40
α	3890·3	3890·3
β	3836·7	3836·8
γ	3799·2	3799·2
δ	3771·9	3771·9
ϵ	3751·4	3751·3
ζ	3735·6	3735·3
η	3723·2	3722·8
θ	3713·2	3712·9

The position of the next three lines, ι, κ, and λ, calculated from Balmer's formula, are 3705·1, 3698·5, and 3692·9, which agrees very satisfactorily with the positions of the lines shown on the photograph of the spectrum of Vega given me by the brothers Henry.

We may, therefore, feel some confidence that Balmer's formula corresponds to a physical fact, and that one series of tremors with which the hydrogen molecule vibrates when it is disturbed are related, so that the length of the waves produced, when plotted as in the diagram, fall upon a curve having an asymptote at wave-length 3647·20.

If m be made equal to 2 in the formula, we get an infinite value for λ; which indicates that there ought to be one line of the series forming the limit of the spectrum at the extreme red end. When m is made equal to 1, we get $\lambda = -1215{\cdot}4$. It would be interesting to determine whether this negative value of the wave-length may be interpreted as meaning a wave of opposite phase. If so, we should expect to find a line of the series at wave-length 1215·4—a region of the spectrum which has not yet been explored.

METHOD OF REDUCING THE INTENSITY OF NEGATIVES.*

THE *clichés* may be too intense either from yellow fog, over-development, or local opacities. We have nothing to say on the means employed to remove yellow fog—they do not alter the character of the picture, nor on those which attenuate the contrasts or local opacities, which, if done by redevelopment, answer pretty well; but we think that the reduction of *clichés*, generally too intense, is effected by chemical actions which are often objectionable. Among the processes employed for the purpose in question, the old one, that which we first employed, both in the calotype and the collodion process, consists in treating the *cliché* with a solution of potassium cyanide. It is the best on account of its simplicity, and of not requiring much after-washing. The drawback in the gelatine process is that the solution of the commercial article, KCy, has, on account of its strong alkalinity, a tendency to produce blisters and frilling by softening the film. This can, however, be easily prevented by using pure potassium cyanide in solution in alcoholised water. The next process in order of publication is that devised by Alexis Gaudin. The reduction is effected by ferric sulphate (Monsel's salt). This process requires to eliminate the iron salt by first washing the gelatine film in a diluted solution of hydrochloric, citric, or oxalic acid, &c. It is little employed. Then come Spiller's process, which consists in treating the *cliché* by a solution of cupric bromide and common salt; that of Farmer, who uses potassium ferricyanide in solution with sodium thiosulphate; and, lastly, Monckhoven's process, by which the reduction is effected in attacking the silver with ferric oxalate, the silver salt formed being dissolved by sodium thiosulphate, as in Farmer's process. The latter processes—those of Farmer and Monckhoven—require prolonged after-washings to eliminate the thiosulphate. For this reason the process of Mr. John Spiller is preferable, as the solvent of the cuprous and silver bromides is simply the common salt, an entirely harmless compound, should any traces of it be left in the film.

As it is seen, in all these processes *the intensity is reduced by dissolving the metallic silver forming the image.* If employed for the reduction of *clichés* generally too intense from over-development, the relative value of the local intensities may be little altered, provided the operation be conducted with great care, otherwise—and, indeed, this is of frequent occurrence—it happens that the penumbras and the details in the shadows, being formed by their layers of metallic silver, are dissolved, and, as a consequence, that the *cliché*, if not spoiled past remedy, has lost that admirable gradation from lights to shades, that delicacy of details, which makes a photograph such a beautiful realistic image of nature.

A rational process would be to reduce the intensity not by dissolving the silver, but by transforming the colour of the image into one more actinic, or rendering the *cliché* more transparent, so that not only the desired deintensification would result, but if the intensity were too much reduced it would always be possible to strengthen it.

For example, the *cliché* previously soaked in water is immersed in a very diluted solution of nitro-bromhydric acid or of nitro-chlorhydric acid (aqua regia). In the solution of the image, viewed by transparency, seems to intensify on account of the formation of the silver bromide (or chloride), but when exposed to sunshine for a certain period, it becomes more transparent from the reduction of the silver haloid, and turns to a bluish or violet-black, that is, a more actinic colour than the original one. The operation should be made by diffused light, and the *cliché* allowed to dry before exposure to the luminous action, for, if dried in the light, the silver reduction would be of unequal intensity, the parts drying first being the lightest. In fact, when exposed under water, or, better, in presence of an absorbent of chlorine or bromine, the reduction is more complete and darker, which is generally advantageous. Of course, the deintensification is proportionate to the more or less complete transformation of the metallic silver, the image, into silver haloid. And it is in this where resides the difficulty of the process; it requires some experience to succeed. There is, however, little danger of spoiling the *cliché*, for should it be too much weakened from being bleached through, the remedy is at hand; it suffices, *after the insolation*, to re-develop with a very weak developer—pyrogallol, eikonogen, &c., or to intensify with mercuric chloride, or by any other intensifying processes. No fixing is required after these operations. It is only necessary to well wash the *cliché*.

We have also experimented with iodohydric acid, and, in lieu, with iodine; but the results were not generally as good. The silver iodide does not blacken in the light, and remains apparently not acted on, and when treated by the developer gives rise to a great increase of intensity. This can be regulated during the redevelopment, and an after-treatment with a solvent of silver iodide, sodium thiosulphate, &c. The iodide process has given us satisfactory results for the intensification of very weak negatives. As said above, the redevelopment should be done after insolation, and with diluted developers, in order to have the action well under control.

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* By P. C. Duchochois, in *Photographic Times*.

HONES.

THE finest whetstones known for the sharpening of fine-edged tools are obtained from Arkansas, so says Curator Merrill, of the Smithsonian Institution. In that State are beds of what is called "novaculite," which is what is scientifically known as an "altered schist." This means a deposit of a flinty nature, usually combined with limestone, the rock thus produced being changed in such a manner molecularly, by processes not altogether understood, as to supply a surface most suitable for grinding. Arkansas furnishes the entire supply of novaculite for the United States, also filling a large part of the export demand, which is very considerable. The main deposit of the material is in a single hill about 500ft. high. For the sharpening of keen-edged tools, razors excepted, this novaculite is unrivalled. It is a very beautiful stone, of snowy whiteness, and is quite costly, because it has to be cut by diamond dust, owing to its extreme hardness.

Next in point of quality for whetstone purposes is a grey, fine-grained sandstone from Orange County, Ind. It is called indifferently "Hindustan stone" or "Orange County stone." Very commonly it is made into long spikes for sharpening knives upon in the kitchen, and for this purpose it is far better than steel. Another sandstone employed for the same purpose is quarried in Cortland County, N.Y., and is called, without any reason that I know of, "Labrador stone." It is a dark grey colour.

A still coarser whetstone for scythes and other such tools is made from Berea grits, a sandstone found in the neighbourhood of Berea, Ohio. Also there are certain qualities of fine-grained mica schists—a crystalline rock of quartz and mica—which are obtained from New Hampshire and Vermont, and utilised for hones wherewith to grind tools of the bigger sort. But it must be understood that there is hardly such a thing as a whetstone quarry. Nearly every quarry from which whetstones are derived is worked chiefly for obtaining building stone, the small pieces of particularly fine grade only being utilised for making whetstones.

Three stones imported from abroad are employed in America for whetstones. The best known of these is the German razor hone, which is commonly used by barbers for sharpening their razors, and is in all probability the best substance for the purpose known. It is found chiefly near Ratisbon, Germany, in the old river bed. During the period of early geological formation the river brought down to that point mud which was deposited on the bottom. This mud varied in material from one season to another, depending upon the source from which it was derived, so that during one year it was white and during another blue. Subsequently, in the course of ages, the mud became stone, and now the white layers serve to sharpen the blades by which civilised men all over the world keep their faces clean of hair. Because the white stone is costly it is usual to back a thin slab of it with another slab of the cheap blue stone, fastening the two together with cement. Such is the ordinary razor hone of commerce. These German hones cost only a fraction of what is charged for novaculite scraps of the same size, but there is a duty upon them, which, together with the expense of transportation, renders them about as high in the market. There are two other foreign whetstones commonly used in this country. One of these is a fine-grained schist from Scotland known as the "Water of Ayr," and used much by carpenters and stone-cutters for rubbing down the surface of other stones. The other is the "Turkey oilstone," resembling novaculite.

The stones used in this country for grindstones are mostly from Ohio and Nova Scotia, the latter supplying the best grade, which does excellently for scythes. Of foreign grindstones most come from England. Of all whetstones the most curious and interesting are those which are utilised by engravers to sharpen their engraving tools. They are of every shape imaginable, from long needle-like points to fine-edged sticks, the object being to grind the little points and edges of the steel instrument, which could not be sharpened upon an ordinary stone.

A FEW HANDY TOOLS.*

THERE is oftentimes work that requires to be nearly exact, say within a hundredth or so, and upon which it is more convenient to use a fixed caliper or solid gauge than the ordinary calipers or sliding rule. The steel gauges of commerce are expensive, and though they are desirable for much of the work, they are not really needed for the kind in question. Such a problem came to the writer once upon a time, and the solution was reached in the following manner: A solid gauge was the desired end, and required accuracy within ·01in.; not very close, some will say, but that does not alter the need for a gauge. Taking a piece of ⅜in. square steel about 9in. long, the first move was to offset the ends as shown in the upper part of the sketch Fig. 1, for the measuring faces; these offsets were about ½in. in length in the faces inside, or that were to be inside when completed. Then bending the steel into a ring, as shown in the lower part of the sketch, the caliper began to assume some shape. It was then hardened at a low heat, and not drawn in the least. Then, by holding it on a level table that was on the tool-grinder, the inside faces were ground off reasonably true, and to size as near as required. Had it been filed up and then hardened it would probably have sprung so as to render grinding necessary after all, and so it was done in the manner shown to save time. It is not pretended that this is an accurate gauge or caliper; but it is offered as being useful in many cases, and very easily and cheaply made, and as these are often the main considerations, it may find a useful place in many tool-rooms of small shops. Fig. 1 shows the idea in detail.

Where an adjustable caliper is required, one might be made as shown in Fig. 2. The frame could be made of malleable iron or steel castings, and the screws, as shown, are intended to be cone-point, though that is a matter of taste or requirement.

Lock-nuts could be used; but as they frequently disturb the adjustment when being tightened, the screws, as shown, to bind the screws in the frame, are thought best for the purpose. This makes a solid tool—i.e., without any spring, as is the fault of many tools of this kind, and though many measure by the spring of the tool, it takes practice to be accurate in that respect. In fact, it is not so easy as might be thought to measure accurately with any tool without some practice, though it is easier with a solid tool, of course.

About the meanest kind of work that comes to the turret lathe is that similar to cut, Fig. 3. The work to be done is that of boring the hole A.

That open side makes a first-class place for the tool to dodge, and it will do it every time if the ordinary form of boring-tool is used—in fact, it is apt to try it to a certain extent with any form of tool; the only hope is to find the tool the most free from this objection. The single-point tool that the

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* By Fred H. Colvin, in the *American Machinist*.

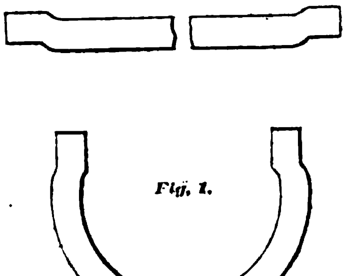


Fig. 1.

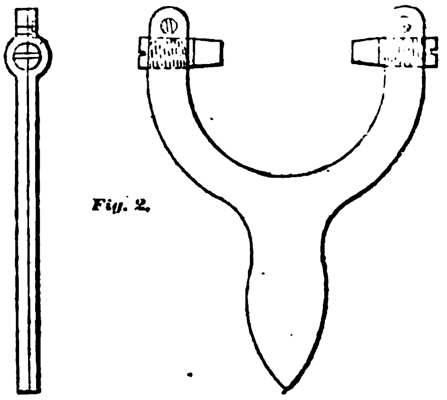


Fig. 2.

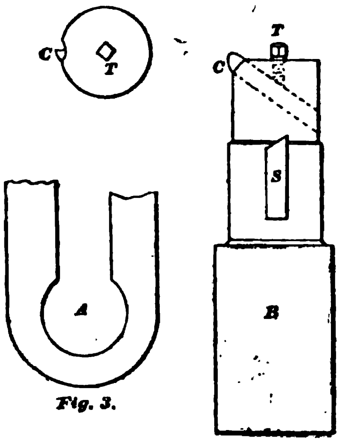


Fig. 3.

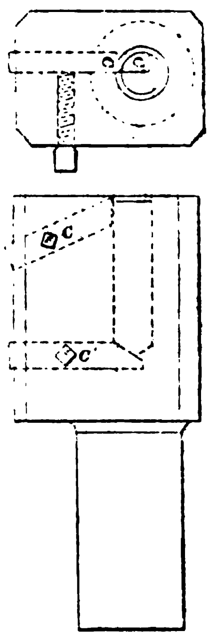


Fig. 4.

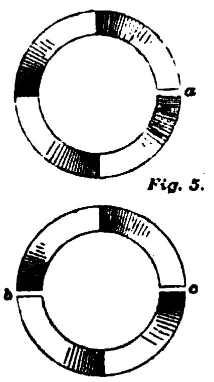


Fig. 5.

Fox-lathe men use in the back head is about the best model to work from, as it has the least tendency in that respect of any that I know of; but as the tool itself cannot well be adapted for the turret, a modification must be made.

In Fig. 3 the work, as described, and the tools for its performance are shown. The tool completed is shown by B. Working from the single-point tool idea, the cutter C is inserted on the angle, as shown, so as to give room for the set-screw T to hold it in any position, as, if it is not adjustable, part of its efficiency is lost. This cutter will cut quite true; but where the work requires to be accurate, it is best to have a finishing or sizing cutter to follow this single-point cutter. In order to reduce the number of operations, this is put into the same bar, as shown by the cutter S, set back far enough to allow the first cutter to get through the work before this last or sizing cutter enters. This is simply a piece of flat steel mortised through the bar in the ordinary way. To obtain the best results, the bar should be flush with the cutter, and the only clearance necessary is the slight lead of the finishing cutter ahead of the shoulder, as represented.

The accuracy of the hole depends upon the bar filling the hole as fast as the cutter sizes it out, otherwise the cutter will dodge, and make a hole anything but true. An end view of the cutter is shown, to give an idea of the relation to the back-head tool of the Fox lathe; sort of first cousin.

There often comes into any brass shop—or other shop, too, for that matter—some job which must not be passed by, yet which requires some special fitting up in order to do it cheaply and accurately. The main object, then, is to get the tools up so as to cut as little as possible, and still do the work in a satisfactory manner.

This was the case in a place where this kind of work was a speciality, and the tools as gotten up by the tool maker were cheap and effective. The job consisted of milling some short, straight rods to a uniform size, and finishing the ends of them to about the angle that is left at the bottom of a drilled hole.

A pattern was made for a tool like that shown by Fig. 4 in two different views, one a top and the other an end view. The shank was turned for the turret, and then the hole bored true with the shank of the required size *before finishing*—i.e., before the finishing milling tool had been run over them; this allowance was a little over a hundredth of an inch, and proved to be sufficient. The two tools shown at C and C' are simply pieces of square steel cut from the commercial bar of steel, of the required length, and the points ground as shown. They are inserted into round holes so as to fit on the corners, and a set-screw holds them as shown.

Some object to this, and insist on filing out the holes square to suit the steel; they do not like the looks of a square piece of steel in a round hole. It may not look as well, but it does the work just as well, and saves time in making the tool. There should be two or three holes drilled in the bottom of the holder, so as to permit the chips to fall to the floor and not clog the tool, and the mouth should be bevelled out to receive the casting and guide it until it is held steadily in place by the sides of the holder, and the knives are getting in their fine work.

For a finishing-mill there are several schemes which can be tried, and which seem capable of doing the required work. About the cheapest of these is shown in the cuts, Fig. 5. At first glance they may appear to be the same thing, but a closer examination will reveal the difference.

The upper one is just a plain steel brushing of the required size with four teeth on the end, and split on one side only, the spring of the steel being used to adjust whatever difference is required.

The other is similar, except that it is cut on both sides, and is what might be called a half cutter. In use it is packed between the sides, and held apart at the required distance by the packing brass strips or paper. Both of these forms will give good service, if a few points are remembered in connection with the work they ~~have to~~ do. Too often in a case of this kind we find the cutters made with a flute inside to give a cutting edge there; just the place it is not wanted. As a consequence, it is not a rare occurrence to find these tools giving trouble from the chips collecting in these flutes, and scoring the work as it passes through. The cutting edges should be on the end, and there only, the rest of the mill acting as a burnisher. Unless the lathe is exactly in line (which is seldom found in a turret that has been run for any length of time) it will be found advisable to recess the mill after leaving a length of half an inch for the burnisher part of the work. This will relieve the work of undue strain after passing through the mill, and prevent the end being actually worn smaller than the size in the passage through.

Other kinds of milling tools might be devised for this work, and perhaps better ones. These have done the work well and cheaply. It is these small tools that often give the trouble, and a saving in these means a saving in the whole work of the shop.

It may be stated that the work from these mills was required to be a good working fit, which means a leeway of about ·01in.

RUBBER SUBSTITUTE.

THE term Rubber Substitute, in a manufacturing and commercial sense, is often misleading. In soft rubber its use is so small a proportion of the whole, that the term addition would be strictly true, says the *Indiarubber World*. In the hard rubber line there are many substitutes which have little or no rubber in them, and which are composed of various compounds and placed upon the market by persons totally unconnected with the legitimate trade. In soft rubber, however, nearly every broker has his line of substitutes, which he carries along with his Parás, Centrals, and Africans. The substitute, if properly made, is not considered deleterious, and is very largely used. In clothing it is considered an improvement in the finish, making the goods soft and pleasant to the touch. Its use is larger abroad than in this country, the skill in using it having received more attention in Europe than here; and, in this way, poorer grades of rubber can be worked up across the water than is yet practicable here. The number of mills making substitutes is computed to be 26, of which there are 6 in this country [U.S.] The compounds have for their ingredients principally oil and chloride of sulphur. The oil is, as a rule, either rapeseed or linseed, preference being given to the former. There are other sorts composed of gun-cotton and devulcanised rubber, of devulcanised rubber and rapeseed oil, and of resin and oil treated with chloride of sulphur. The difficulty in all these compounds is, at the proper time in manufacture, to free the compound of the sulphur in a way so as not to make it deleterious to the goods to be treated. In America ammonia is often used to neutralise the acid, which the foreigner claims to be an injury.

One difficulty in the use of a substitute is that the quality is not capable of a test until it is incorporated in the goods and goes into the consumer's hands. The customer tests it, and, of course, he does not know what is the matter. The goods are simply poor, and he changes his place of dealing, just as he may be particular or indifferent in the expenditure of his money. Place a half-dozen white substitutes in the powder on a large sheet of paper. Take them separately without reference one to another, and a soft mealy touch is the characteristic of each. If they were not side by side you could perceive no difference. But compare one with the other, and in the best grade there is a delicate feathery touch, almost indescribable, but very perceptible, which marks it from its fellows. Keep them in jars for a length of time, and the poorer grades will get sodden and rot.

Niagara.—Many estimates have been made of the rate at which the Niagara Falls are wearing back the precipice over which the river tumbles. The latest is a report made by Mr. Bogart, State Engineer of New York. He comes to the conclusion, after comparing the survey made in 1842 and the results arrived at in 1890, that the annual recession at the American Fall has been 7·68in., and at the Canadian and Horseshoe Fall 2ft. 2·16in. During this period the crest-line of the American Fall has sunk from 1,080ft. to 1,060ft., and that of the Canadian has risen from 2,260ft. to 3,010ft., while the area of rock which has been carried away during these 48 years is 32,900sq.ft. at the American, and 275,400sq.ft. at the Canadian fall. These estimates are very much lower than those made by some American geologists, who would have led us to believe that in the course of a thousand years, more or less, Erie and Ontario will be united by one long, fall-less rush of water.

SCIENTIFIC NEWS.

◆

THE position of Wolf's comet for Berlin midnight on Sept. 24 will be R.A. 4h. 17s. 45s., N. Dec. 17° 1·4'; brightness, 10½ times that at the date of its rediscovery. For diagram see p. 5. It is now visible in a moderate sized telescope.

Encke's comet is passing into Leo, and on the 25th will be at Berlin midnight in R.A. 9h. 55m., N. Dec. 22° 25' 7", a little north of Regulus. It will be seen better, however, at the beginning of next month. Two more small planets have been discovered: No. 313 by M. Charlois, of Nice, on August 28th, and No. 314 by Dr. J. Palisa, of Vienna, on August 30th.

Prof. Tacchini gives in the *Comptes Rendus* his usual note on sunspots from observations made during the second quarter of the year at the Roman College. Spots and faculæ were noted on seventy-three days, about equally divided over the three months, April, May, and June.

The death is announced of Dr. Leopold Just, professor of botany at the Carlsruhe Polytechnic, and director of the botanic garden belonging to that place. He was a pupil of Ferdinand Cohn. Dr. Just was only fifty.

Mr. Smith Ellis, who devoted so much of his time to the study of what is known as "rust" in wheat, is dead. He was a Yorkshireman, but went out to Australia about forty years ago. It is stated that he believed he had discovered the cause of "rust," and that his widow has his papers, and hopes to be able to give to the world the results of his labours. Mr. Smith Ellis was sixty-five.

By the death of Miss E. C. Villers-Wilkes, the sister of the late Mr. Salt-Wilkes, the Midland Institute shares with the Birmingham General Hospital the sum of £100,000.

Prof. Hermann von Helmholtz has been celebrating his seventieth birthday in the Sarca valley; but the formal celebration will be held on November 2, when the first Helmholtz medal will be presented to him. The fund which has been raised in his honour will be under the control of the Academy of Sciences of Berlin, and a portion will be set aside to pay for a bust, while the interest of the remainder will be devoted to the production of a "Helmholtz medal," to be awarded every two or three years to that investigator whose researches in the field of physics are considered the most valuable since a previous award. Amongst the honours already received by the distinguished professor is that of "honorary member of the Berlin Medical Society," in consideration of the great services rendered by him to Medicine by the invention of the ophthalmoscope.

It is a moot point whether the increasing number of spectacles seen is due to an increase of myopia in the children attending schools, or whether it is due to a recognition of the fact that spectacles correct defects (perhaps temporary) in the optical organs. All ophthalmogists know how important it is to compel children to wear spectacles on the first signs of short sight making themselves evident, because myopia is, as a rule, progressive. In a paper recently read before the Paris Academy of Sciences, M. Javal referred to the influence of heredity in the production of myopia. According to M. Motais, heredity is a highly important factor in the evolution of this condition of the visual organs. M. Javal does not altogether agree with that view, but believes that it is possible, by the exercise of proper precautions, to prevent children so predisposed from becoming myopic. Astigmatism, on the other hand, he considers to be purely hereditary, and, no doubt, it is a potent factor in the production of myopia. This heredity in astigmatism is not only a question of family, but is also a characteristic of certain races. The Israelites, for example, have an inverse astigmatism; with them the horizontal lines are more clearly defined than the vertical. The children of all myopic parents should, therefore, be carefully examined for astigmatism, which, if found to exist, should be corrected early.

The second part of the Catalogue of Mammalia in the Indian Museum, Calcutta, by Mr. W. L. Sclater, has just been issued. The first part was compiled by Dr. Anderson, the late superintendent. The total number of species included in the Catalogue amounts to 590, of which 276 are found within the Indian Empire, and 314 are exotic.

The following statement may be of interest to scientists: it is gravely published by many "respectable" papers:—"Blue roses have hitherto been ranked among the things unattainable. By the most modern method of culture, however, all difficulties are said to vanish. For example, water a pure white rose-bush continuously with a solution of Prussian blue, and the ensuing buds will take on a sympathetic tinge. In like manner proceed with green sulphate of copper, and hope for a similar satisfactory result. Will suburban gardeners please report progress?"

The Electrical Exhibition at the Crystal Palace is, it appears, to be opened at the beginning of the year, and will be duly certified as an international exhibition under the provisions of the Patents, Designs, and Trade Marks Act. The Government will show an historical collection of exhibits arranged under the direction of Mr. W. H. Preece, F.R.S.

The Australasian Society for the Advancement of Science will hold its meeting at Hobart in January, 1892, when the Governor of Tasmania, Sir R. G. C. Hamilton, will deliver an address as president.

M. Hormuzescu has communicated to the Paris Academy of Sciences the details of experiment showing that when an electric current is passed continuously through a wire at a certain tension in the open air, the wire is found to vibrate. The author accounts for the effects by supposing that the exchange, or, rather, the passage, of heat from the wire to the air sets the former into motion.

In a recent number of the *American Meteorological Journal*, Franklin's kite experiment is described by A. M'Adie, who also describes similar experiments recently carried on at the Blue Hill Observatory, near Boston, U.S., the chief advance being that at every step the electrical potential of the atmosphere was measured by an electrometer. The kite was sent up on several days, and at a height of 1,000ft. sparks over ⅛in. in length were obtained, while abnormal movements of the stream of water from the electrometer during electrical disturbance always foretold when a flash of lightning was about to occur.

It is stated that the electric lighting of trains is not so satisfactory—at any rate, commercially—as it was expected to be, and will probably be soon discontinued on the railway which was one of the first to take up the "new" light. Even in the United States the oil-gas method is taking the place of the electric light.

Prof. Bruylants, of the University of Louvain, is credited with a curious little experiment. He writes a word with a pencil on a sheet of paper resting on several other sheets, from which he draws one bearing no trace of the pencil marks. On exposing it for a few minutes, however, over a heated capsule containing iodine, the paper is seen to grow yellowish, and the letters of the word stand out of a violet-brown colour. On moistening the paper the letters appear as violet on a blue ground. M. Leconte, who gives an account of this experiment, says that it will also reveal the words effaced from paper by a correspondent.

The last Bulletin of the Geographical Society of the United States contains an interesting paper on the curious discovery of human remains under the Tuolumne Table Mountain of California. Bones of men and grinding instruments were there found by Prof. Whitney, embedded in auriferous gravel under lava at the foot of the mountain. Remains of plants belonging to the tertiary age, and the bones of extinct mammalia, such as the rhinoceros of the West and the American mastodon, are also met with in the same strata. Pestles, mortars, and broken spearheads are the most remarkable of the implements discovered.

M. D'Arsonval has recently succeeded in stimulating muscles by means of light. A freshly-prepared frog's muscle was suddenly illuminated by the light of an arc lamp deprived of its heat rays by traversing a lens of a solution of alum. The muscle showed a slight tremor, and when the investigator further mounted it on a skin diaphragm stretched over a funnel the tremors accompannying each impingement of the light emitted a sound which could be heard in the funnel.

LETTERS TO THE EDITOR.

◆

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

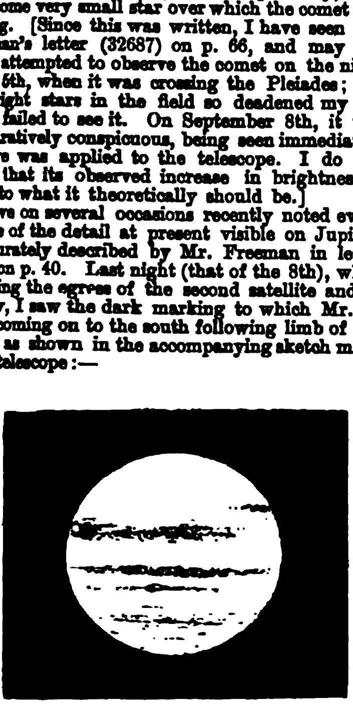
◆

PHOTOGRAPHING THE SOLAR-PROMINENCE SPECTRUM—WOLF'S COMET—JUPITER—SOLAR DISTURBANCES AND TERRESTRIAL MAGNETISM—LIGHTNING—SCIENTIFIC (?) ADVERTISING—BODIES CROSSING THE SUN—ASTRONOMICAL TELESCOPES—MARKINGS ON MARS—SPACE OF FOUR DIMENSIONS—OPTICAL DUPLICATION OF LINES—AMATEUR ASTRONOMICAL SOCIETIES—VOLCANIC ROCK; OR SNOW?—MARTIAL WATERWORKS—INERTIA—GRAVITATION—TELESCOPIC OPTICS—MAGNITUDES OF JUPITER'S SATELLITES, &c.—EARTH'S LONGITUDE—DISTORTION OF OBJECT IN A REFRACTOR.

[32706.]—SINCE seeing the paragraph in your "Scientific News" on p. 13, in which you notice Prof. Hale's paper on "The Ultra-Violet Lines of the Solar Prominences," I have had an opportunity of reading that essay *in extenso*, and a very remarkable one it is. That Prof. Hale should have succeeded in photographing the prominence spectrum at all without an eclipse furnishes a striking illustration at once of his fertility of resource, and of his intimate acquaintance, both theoretical and practical, with his subject, and with the difficulties to be overcome. But not contented with the achievement of, as it were, a mere *tour de force*, he has utilised his results in a manner which cannot but materially advance our comparatively scanty knowledge of the physical condition of the sun's surroundings. "Never," said a famous countryman of Prof. Hale's, "prophesy unless you know"; but I feel fairly safe in predicting that among all our younger spectroscopists Prof. H. is eminently "the coming man." A short description of the manner in which his photographs are taken may be interesting to those who possess no means of access to the original paper. Briefly, then, a large solar spectroscope (of which the object-glasses both of the collimator and the observing telescope have an aperture of 3¼in. and a focus of 42½) is attached rigidly to the eye-end of the 12·2in. equatoreal of the Kenwood Observatory. The spectroscope is furnished with a 4in. Rowland grating, ruled with 14,438 lines to the inch, and as the telescopes are fixed at an angle of 25°, different orders of spectra are brought into the field of view by simply rotating the grating. The spectrum can be viewed by a diagonal eyepiece after the photographic plate is in position. The apparatus is thus used. Supposing that a photograph is to be taken, with a radial slit, in the H and K region of the spectrum. The C line in the second order is brought into the field, and the spectroscope rotated until the slit is radial over a prominence. Then the driving clock is started, and the telescope clamped so as to keep the image of the sun stationary on the slit-plate. A small strip of metal, pushed in just behind the slit, excludes the light from the sun's disc, save a very small portion near that part of the limb on which the prominence is situated. Then the collimator is moved until the slit is brought to the proper focus of the great telescope for K, and the collimator and observing telescope are focussed for the same line, these foci having been previously determined experimentally and tabulated. The sensitive plate in its dark slide having been placed in position, and the grating turned round until the K line in the fourth order is in the middle of the field, the slit is covered, the slide drawn, and the proper exposure made. The simplicity of the means by which Prof. Hale has successfully obtained such very important results, suggests an irresistible reminiscence of Columbus and the Egg.

I am somewhat puzzled by the first paragraph in your "Scientific News" on p. 38, in which Mr. Fleming is said to have picked up Wolf's comet on the 28th ult., it being then only "indistinct, and requiring a full aperture of 12¼in. to see it fairly well"; because on the succeeding night (that of the 29th) I saw it without difficulty—though, perhaps, best by averted vision—with an achromatic of less than 4¼in. in aperture, and a power of 42. It seemed to me, at moments of the best vision, to have a very minute stellar nucleus; but this may quite possibly, or even probably, have been some very small star over which the comet was passing. [Since this was written, I have seen Mr. Freeman's letter (32687) on p. 66, and may add that I attempted to observe the comet on the night of the 5th, when it was crossing the Pleiades; but the bright stars in the field so deadened my eye that I failed to see it. On September 8th, it was comparatively conspicuous, being seen immediately the eye was applied to the telescope. I do not fancy that its observed increase in brightness is equal to what it theoretically should be.]

I have on several occasions recently noted every feature of the detail at present visible on Jupiter, so accurately described by Mr. Freeman in letter 32661 on p. 40. Last night (that of the 8th), while observing the egress of the second satellite and its shadow, I saw the dark marking to which Mr. F. refers coming on to the south following limb of the planet, as shown in the accompanying sketch made at the telescope:—



In this position it was apparently isolated, and no one looking at it would have guessed that it formed a portion of a *belt*. Next to the shadow of satellite II. it was notably the darkest object visible on the entire disc, the northern equatorial belt being perceptibly lighter.

In the absence of any reference to previous observations of the coincidence of magnetic storms and auroræ with the appearance of spots, &c., on the sun's surface, I failed to guess that Mr. Shearmen's paper (reproduced on p. 449 of your last volume), was intended, as he now states (letter 32664, p. 40), to point out that "the disturbing energy is, like light, propagated in a straight line," and must apologise to its author for my own obtusity.

The query put by Mr. Lecky (in letter 32665) on p. 40, is a very interesting one. It seems to me, as it does to him, that the explanation of a flash of lightning (including what is called "the return stroke") given in popular works on electricity, certainly fails to account intelligibly for the very remarkable phenomena occasionally, if not even frequently, observed. Now, in common with other parts of England, during this most delightful summer, the district in which I reside has been favoured with an abnormal amount of thunder and lightning; and I will select two accidents which have happened in this neighbourhood to illustrate what I mean. In the first case the lightning "struck" a tree, in the park of a friend, low down, stripping off the bark, and then made a deep hole in the ground at the base of the tree. Simultaneously it seems to have run along the wires of a wire fence just behind the tree until it met with a wooden gate, the top rail of which it split in half. It is difficult to render this all quite intelligible without a sketch; but my point is that, on the accepted theory that lightning goes to earth by the shortest conducting route, the course apparently taken by it in this case, was absolutely inexplicable. But further, a bailiff and another man were walking through the park at the instant of the flash, and the former was "struck," and turned quite round, his companion expecting to see him fall to the ground. He, however, contrived to keep his feet; but sustained such a severe nervous shock that he was under medical care for a fortnight. Now, I have been questioning this man about his sensations, and I confess that his answer has astonished me. Knowing well, from juvenile experience, the feeling of concussion in every joint through which a Leyden jar is discharged, I was quite prepared to hear that he had felt a hard jarring blow; but, to my surprise, he informed me that it seemed to him "that some large soft substance pushed his shoulder, and spun him round." So much for an unexpected physiological effect of lightning: now for one of its physical vagaries. Four miles from where I am writing the lightning "struck" the parish church. It did not strike the metallic vane, but the shingled spire, close to its base, blowing or shattering a circular space in the shingles, a little way above the clock, of a foot or 18in. in diameter. Having done this, it should, theoretically, have found its way into the ground through the belfry beneath; but it did nothing whatever of the sort; proceeding rather after the fashion which has amused Mr. Lecky, for it seems to have travelled along the entire length of the church, knocking down plaster, &c., and finally to have passed through the chancel, and gone to earth by a metallic rain-water pipe. In this case, very obviously indeed, it took about as circuitous a route that it could well have selected. Like Mr. L., I should much like to hear the opinion of so eminently practical and common-sense an electrician as "Sigma" upon these, to me, unintelligible phenomena.

"It will," writes Mr. Slater (in letter 32765), on p. 42, *in re* the British Association, "be also necessary to suppress the growing attempts of some men to advertise their particular branch of business," which one of your contemporaries calls a "laudable object"! I have not the most distant idea what contemporary it is that thus advocates the degradation of the Parliament of British Science; but a surer way to insure its extinction than that of allowing it to become the organ of the Pears, Enos, Beechams, Hudsons, and Brookeses of the scientific (?) world it would be impossible to devise. After all, though, this particular abuse is so rampant in the world of science (falsely so called) at the present day, that its intrusion into the British Association is almost a necessary consequence. I have not the slightest hesitation in saying that the overwhelming majority of real workers in science are practically unknown to the British public, who have been taught to look upon the quack and the impostor as "eminent men" simply from always having their names kept before them in print. Nor is this wretched system, I grieve to say, wholly confined to the miserably cadging crew to whom I have referred, for, incredible as it may appear, the Council of the Royal Astronomical Society were not above suffering one of their own officials to be advertised as a tradesman employed by South Kensington in their very last annual report!

Perhaps I may be allowed to add to Mr. Mee's reply (75187) on p. 45, that all three of Canon Stark's observations of bodies which he saw (or fancied he saw) crossing the sun, and which he published in 1820, 1821, and 1827, are given by him as those of a supposed *planet*. He never for one instant suspected the cometary nature of either of them, nor does it appear that they by any possibility can have possessed it.

In reply to Mr. Wake (query 75239, p. 46), Adams was a well-known London optician during the earlier part and middle of the 18th century, and a genuine Gregorian reflector of his manufacture ought to be a good instrument. As for calculating the magnifying power of his, Mr. W. had very much better measure it by the method given, *usque ad nauseam* in these pages before—i.e., first focus his telescope on some celestial object. Now, in daylight, turn the open end of the tube up to the sky, and look at the eye-glass from a distance of a foot or so, and he will see a little circle of light. Measure the diameter of this by the aid of an eyepiece micrometer, or very finely-divided scale. Measure the diameter of the large speculum, and divide it by that of the little circle (which is its own image); the quotient is the magnifying power. For example: suppose the little circle on the eye-glass has a diameter of ·028in.; then, as my querist's speculum is 4in. in diameter $\frac{4}{\cdot 028} = 143$, very nearly, indeed, and the telescope with that eyepiece must magnify 143. Should, however, Mr. Wake have any special object in calculating the power of his Gregorian, he may do so by the following formula. Calling F the focal length of the large speculum, f' that of the little mirror, and f that of the eyepiece, and putting M for the magnifying power, we say—

$$M = \frac{F + f'}{f'} \times \frac{F}{f}$$

Substituting his own figures in this equation, we get

$$M = \frac{17 + 1\cdot625}{1\cdot625} \times \frac{17}{1\cdot5},$$

which comes out 129·9; so that on the assumption that his data are correct, his instrument, with the eyepiece of which he speaks, magnifies 130 diameters, very nearly indeed. It is the loss of light inseparable from the repeated reflection of the rays that makes this form of telescope less suitable for the observation of nebulæ and comets. Tulley, a celebrated optician of Territ's-court, Upper-street, Islington, flourished during the first quarter of the present century. I have no doubt that the achromatic of his make in Mr. Wake's possession is a fine and valuable one. The considerable focal length of course makes the instrument less handy; but the advantage of having the magnifying power done by the object-glass instead of by the eyepieces is considerable. Moreover, both spherical and chromatic aberration are more easily dealt with in a long-focussed lens than in one of short focus. By all means have two or three more ordinary Huyghenian eyepieces fitted to such a telescope. Leave the relative foci of their component lenses to the maker. It is not a vital point: the condition indispensable to achromatism merely being that they shall be separated by half the sum of their focal lengths. Mind and go to an actual maker of telescopes, and not to a mere seller of them.

As I do not possess "Lockyer's Lessons," I must refer "H. A." (query 75246, p 46) to the gentleman whom he addresses in conjunction with me, Mr. Denning, for a categorical answer, and can only say that the "hour-glass" marking on Mars is formed by the "Dawes Ocean" and the "Kaiser Sea."

I hope that the query (75254) of "Har." on p. 46 will not reopen a discussion on the vagaries of the pangeometers, as the space of four dimensions question was threshed out in these columns some time ago. I fancy that it was a Russian mathematician, Lobatschewsky, who first started the idea of a fourth dimension of space, apparently from a total inability to distinguish between an algebraic multiple and a spacial magnitude. As far as I can follow Lobatschewsky, Beltrami, Riemann and Company, the lines of their space are *curves* without radii, tangents, normals, or chords; all parallax must be positive, and if a man, were projected vertically upwards, say, from the earth, and went on long enough, his head would ultimately arrive at the place previously occupied by his feet! Does "Har." want any more?

In the number of *Ciel et Terre* for the 1st inst., M. Schleusner, of Antwerp, gives an interesting description of some recent experiments of his on the optical duplication of lines, experiments undertaken with a view of arriving at quantitative results in connection with this curious illusion. Having noticed that the apparent interval between a real line and its ghost varied with its difference of distance from the observer's eye, he set himself to determine, as approximately as might be, the extent of such variation numerically. In the outset he found that the distance between the actual line and its image increased in proportion as that between the line and the observer's eye diminished. At the distance of absolutely sharp and distinct vision (in M. Schleusner's own case, 11in.) no trace of gemination was visible. When the line approached the eye with a distance of 8·7in., the line and its ghost were apparently ·019in. apart; at 6·3in. from the eye they were ·039in. (a millimètre) apart. The way in which these measures were made was rather ingenious. The card upon which the lines to be experimented on was drawn, was fixed on a slide moving along a rule graduated in millimètres. On this card was drawn two black lines exactly 1 millimètre apart. One end of this rule was placed against the observer's cheek, and the card moved very gradually towards his eye within the distance of absolutely distinct vision (which, as I have said above, was, in M. Schleusner's case, 11in.) Thus the two lines became four. At 8·7in. from the eye the four lines became equidistant; at 6·3in. *three* lines only, instead of four, became visible, in which case, of course, the separation amounted to one millimètre, as in the former it would be equivalent to half a one.

I hear that the attempt to form an Ulster Astronomical Society has been so far successful that it is proposed to hold the first meeting during the current month, at which the presidential address is to be delivered. This certainly says a great deal at once for the courage of its promoters, and for the enthusiasm which has recruited its ranks, for I take it for granted that its members are sufficiently numerous to warrant them in forming themselves into a separate association, since a society composed of 20 or 30 people only would be daring indeed in thus launching itself. By the way, can anyone tell me what has become of the quondam powerful Liverpool Astronomical Society? Because after coming most prominently before the scientific public, and doing really admirable work, it has almost suddenly ceased to be in evidence at all. I am informed by a member that no number of the *Journal* of the L.A.S. has appeared since November, 1890. I do earnestly hope that Dickens's description of theatrical stars may not become applicable to a society which at one time formed really a power in the astronomical state. I mean where he says that "they come out—and they go in again."

I cannot help thinking that if Mr. Peal would only study the minutely-detailed descriptions of the intricacies of lunar formations given in these columns, in the *Observatory*, and elsewhere by him who is *facile princeps* among living English selenographers—I mean, of course, Mr. Gwyn Elger—he would be led to modify his notions about the cliffs, ravines, valleys, and intruding craters being composed of snow, pure and simple. Very oddly, I have never seen *Knowledge* for October, 1889; but, of course, the appearance so well delineated by Mr. Elger in the *Journal* of the L.A.S. is very familiar to me. I rather fail to see why snow should not lie on a very steep slope (*vide* paragraph six in your "Scientific News" on p. 60).

In connection with Mr. Stanley Williams's letter (32688) on p. 66, I would first and foremost say that I am personally wholly unable to identify Signor

Schiaparelli's map of Mars with that of Mr. Green. Let any one attempt to superpose them, and he will see what I mean. In the next place, I would humbly venture to remark that it was not *I* who gave the names of "canals" and "lakes" to certain features of Areographical detail, nor have I ever hinted (like more than one Areomaniac) that the former were actually constructed as aqueducts by sentient beings! These gentry did succeed in convincing the old lady to whose death and amazing legacy reference is made in your article "Talking with the Stars" on page 56; but, so far, they have failed to make a convert of me. If the "lakes" are lakes, I can scarcely regard my description of them as a solecism. Furthermore, when your very able correspondent alleges that "'F.R.A.S.' himself confesses that he is unable to account for the observed facts in connection with the duplication of the 'canals' of Mars by the hypothesis emitted by Messrs. de Boë and Schleusner," he is presumably referring to my words (in letter 32659) on p. 39. "I do not profess to account for "'Nilokeras' (whatever that may be) geminating, while 'Jamuna' so obstinately remained in a state of single blessedness." Now if this be so, I do not admit that what I wrote bears the interpretation put upon it by Mr. Williams. I should require much more information than I possess before definitely pledging myself to the opinion that the hypothesis of MM. de Boë and Schleusner had broken down. At present it certainly seems to me to hold the field.

In reply to query 75268 (p. 73), I may suggest to "C. R." that, when a train stops at all suddenly, what I may call the fixed part of his person has its motion arrested before that of the upper part of his body, which is free to move. In connection with the second part of his query, I am ignorant of any *astronomers* who doubt the theory of gravitation.

I cannot give "Tyro" (query 25272, p. 73) any formulæ by the aid of which the change in the illuminating power incident on the addition of two lenses to the eyepiece of a telescope is calculated. "Illuminating power" is rather vaguely used in such a connection as this, because what is properly so-called remains constant with the same object-glass, the effect of increase in magnifying power being simply to spread the same amount of light over a larger area. The power of a Huyghenian eyepiece (by which is meant the focal length of an equivalent single lens) is found by dividing twice the product of the foci of its components by their sum. Thus in the case of his 1in. and 2in. lenses we should have $\frac{1 \times 2 \times 2}{1 + 2} = {}_3$ or 1⅓, so that it would be equal to a single lens having a focal length of 1⅓; giving a power of 22½ with his 30in. objective. The question about the "multiplying power" of such an eyepiece with a microscope objective is meaningless, unless the focus of the latter is given. The advantage of the 1 : 3 ratio is that aberration is then at its minimum. Finally, Jupiter's Ist, IInd, and IVth satellites shine approximately as stars of the 7th magnitude, and satellite III. as one of the 6th. A 2in. object-glass, if good, will show their occultations very well.

What in the world does "A. B. C." (query 75280, p. 74) want a table of the earth's longitude for? It differs precisely 180° from that of the sun. He will find the logarithm of the earth's radius vector given for every day in the year on p. III. of each month in the *Nautical Almanac*. *q*, in the elements of a comet's orbit, is its perihelion distance expressed in terms of the earth's mean distance from the sun, calling the latter 1.

"X. Y." (query ,75281, p. 74) must draw back towards the eyepiece that part of the periphery of his object-glass—in his case the left—towards which the distortion of the stellar image apparently points.

A Fellow of the Royal Astronomical Society.

TRANSIT OF JUPITER'S THIRD SATELLITE.

[32707.]—On September 10th I witnessed an interesting transit of Jupiter's third satellite and its shadow. The transits of the satellite and shadow were timed to commence respectively at 7.31 and 7.59 p.m., but owing to Jupiter's proximity to the horizon, I could not see the commencement of either, the air being very unsteady at the time. At about 8.15 I was able to see the shadow, which by this time had advanced some way on to the planet's disc, and appeared as a small, perfectly black spot. As Jupiter rose higher above the horizon, and the air became steadier, I could distinctly see the satellite itself, a little south, preceding its shadow as a *dark spot* on the planet. It appeared to be slightly darker than the equatorial dark belts, but not nearly so dark as its shadow. It was best seen when about the centre of Jupiter's disc. I made a note at the time of the observation that the satellite looked smaller than its shadow, not knowing that this was usually the case. (See Herschel's "Outlines," par. 540.) As the satellite neared the west limb of the planet, it became invisible, only the shadow being seen; but at 10.45 it appeared as a small projection on the limb, and at 10.50 looked like a small bead on the planet's edge. The telescope used used was a 3¼in. achromatic by Wray, powers 45 and 100.

Newcastle-on-Tyne. **J. Hume.**

[We regret it is impossible to reproduce the pencil sketch sent.—Ed.]

[32708.]—On the 10th inst., about 9 p.m., I observed what I take to be the transit of Jupiter's third moon and shadow. The shadow was like a spot of ink, and the moon itself of a rather ruddy hue, as it appeared to me. Both moon and shadow continued visible all the time I was observing (about an hour).

I have never seen either moon or shadow in transit with my telescope before (2¼in.). Would those who happened to see the same kindly give their observations, as I think the phenomenon was exceptional?

Mexboro. **G. W. Middleton.**

STAR MAGNITUDES.

[32709.]—Perhaps the inclosed table may be worth insertion. The logarithms are given, as well as their natural equivalents, to show the simplicity of the method, which would not be so evident if in natural equivalents only.

Table for Star Magnitudes and Distances—(Logarithmic Ratio of Magnitudes = ·4).

Mag.	Diminution of Light.		Distances Removed.		Aperture dia. inches required.		Remarks.
	Log. =	Value.	Log. =	Value.	Log. =	Value.	
1	0	Unity.	0	Unity.	Naked eye.		—
2	·4	2·512	·2	1·58	Do.		—
3	·8	6·31	·4	2·51	Do.		—
4	1·2	15·8	·6	3·98	Do.		—
5	1·6	39·8	·8	6·31	Do.		—
6	2·0	100·0	1·0	10·0	Min. visible.		For naked eye ¼in. pupil.
7	2·4	251·2	1·2	15·8	—		Telescopic.
8	2·8	631	1·4	25·12	—		Do.
9	3·2	1,580	1·6	39·8	0	1in.	Do.
10	3·6	3,980	1·8	63·1	·2	1·57	Do.
11	4·0	10,000	2·0	100	·4	2·5	Do.
12	4·4	25,000	2·2	158	·6	4·0	Do.
13	4·8	63,000	2·4	250	·8	6·3	Do.
14	5·2	158,000	2·6	400	1·0	10·0	Do.
15	5·6	400,000	2·8	630	1·2	16·0	Do.
16	6·0	1,000,000	3·0	1,000	1·4	25·0	—
17	6·4	2,500,000	3·2	1,580	1·6	40·0	Lick refractor – 36in.
18	6·8	6,300,000	3·4	2,500	1·8	63·0	—
19	7·2	15,800,000	3·6	4,000	2.0	100·0	—
20	7·6	40,000,000	3·8	6,300	2·2	160	—
	$2{\cdot}512^{\text{mag.}-1}$		$\sqrt{\text{Diminution.}}$		$\sqrt{\frac{2{\cdot}512^{\text{mag.}-6}}{16}}$		For mag. visible by aperture $\frac{\text{Log. (aperture}^2 \times 16)}{0{\cdot}4} + 6$

If Sun = + 28 mag.
Then Light = 11·2 log. = 160,000,000,000 that of 1st mag. star.
Distance = 5·6 log. = 400,000 removes to = 1st mag. star.

The estimate of sunlight values is rather conflicting; perhaps + 28 may be a mean.

Liverpool, Sept. 12. **W. S.**

METEOR RADIANTS.

[32710.]—As many of your correspondents evidently take an interest in the subject of meteor radiants, I venture to state the principal points which I have raised in relation to them, and which are still *sub judice*.

Until the publication of Mr. Denning's great catalogue last year, I entertained doubts as to the existence of the stationary or long-enduring radiants which he had been advocating for several years. Of course he had observed meteors coming from nearly the same points at different periods of the year, but the question was whether these meteors were too numerous, and the agreement in their radiants too close to exclude chance. Theory seemed to imply that they could not have any physical connection, and this theory appeared to be abundantly confirmed by the connection which had been traced (by computations based on it) between certain meteor showers and certain comets.

But a careful examination of Mr. Denning's catalogue led me to conclude (and I think will lead any of your readers who study if to conclude) that the agreements in the radiant-points of meteors at different periods of the year are altogether too numerous to be accounted for by chance, and that, in fact, this repetition of radiant-points is not the exception, but the rule. An examination of some other catalogues of radiants confirmed the result. Meteors from stationary or long-enduring radiants not only existed, but constituted the ordinary rule. They must, therefore, be physically connected, and the theory which denies this connection must be defective or erroneous. I have not as yet found any satisfactory mode of supplementing the current theory, but Dr. Kleiber's orbits for Mr. Denning's radiants (computed on the current theory) present anomalies which confirm my belief in its insufficiency.

The general prevalence of stationary or long-enduring radiants led me to inquire whether there were any others. I therefore examined the cases in which Mr. Denning believed that he had observed a shifting of the radiant. I came to the conclusion that the evidence that the meteors in question belonged to the same shower, and exclusively constituted it, was unsatisfactory—that in the case of the Perseids the shifting asserted by Mr. Denning did not seem to be reconcilable with the current cometary theory—and that other observers had noticed a shifting in the opposite direction to Mr. Denning's in the case of the Andromedes. But of course my conclusion as to the insufficiency of the current theory led me also to doubt the alleged cometary connections, and as Mr. Denning's observations appeared to show the existence of a stationary or long-enduring radiant at 44° + 56° (other observations also confirming it), I doubted both the cometary and the shifting theory of the Perseids. At all events, we seemed to have a concurrence of three things—viz., a stationary radiant, a cometary radiant, and the richest point of a shifting radiant, which had not been theoretically connected with the comet at 44° + 56° on the 10th of August.

I have adopted this egotistical way of stating the questions in order to show that I have given no cause of offence to any observer. The late Mr. Proctor offered an explanation of stationary radiants, which supposed that Mr. Denning had made mistakes of several degrees in his radiants. I accept them all; but my inferences from them do not agree with Mr. Denning's.

The chief points to be investigated, then, are as follows:—1. Do stationary or long-enduring radiants exist? 2. Are they the rule or the exception?—and if the former, is the rule universal? 3. How are they to be explained? 4. Is the supposed connection between comets and meteor showers real? 5. Do shifting radiants exist?—and if so, what are their limits in space and time? 6. And if they exist, how are they to be explained? To these questions are to be added those as to the existence of areas of radiation rather than points, and of distinct simultaneous centres of radiation embraced within limited areas.

W. H. S. Monck.

THE METEOR DISPLAY OF AUGUST 10.

[32711.]—It is interesting to read of the general success that has attended both British and Continental observers of the meteoric display of Aug. 10 last, and the redundancy of meteors reported to have been seen. In London, however, the display was very poor, and the meteors small. From 10.30 p.m. to 11.30 p.m. I watched diligently without perceiving a meteor. Five minutes after, this monotony was broken by a small flash, and at 11.45 p.m. a gorgeous fireball darted with great swiftness in a horizontal direction, coursing between δ and ε Ursæ Majoris, and leaving a grand streak of unusual brilliance and persistence. The fireball was considerably brighter than Jupiter, brilliantly white and large, and lasted but a second, while its track was visible at least 30 seconds or more. (This meteor is evidently the one whose streak was seen by Mr. Holmes, letter 32641.) During the next 15 minutes, only six meteors were seen, and these were small; then occurred a very quiet period till 12.40 p.m., when, in less than 55 seconds, no less than seven were seen. At 13.10 p.m. five meteors in 12 seconds were counted, while at all other times, till 13.45 p.m., the meteors were remarkably few, scarcely averaging one in five minutes. At 13.45 p.m. clouds precipitated themselves over the sky, rendering further observation impossible. The shower was the finest I have ever witnessed.

D. E. Packer.

A SEARCH FOR TEMPEL-SWIFT'S COMET.

[32712.]—In the *Bulletin Astronomique* for May, 1891, M. Bossert has issued an ephemeris of Comet Tempel-Swift from corrected elements deduced from observations made during its apparitions in 1869 and 1880. At the suggestion of my friend, Mr. H. Ingall, I undertook to sweep for this object on the night of Sept. 1, 1891, and found near the calculated place a diffuse nebulous object of the brightness of Herschel's IInd. class of nebulæ. As no known nebula was situated in this region, I was led to the belief that the object seen was Tempel's comet. Its position at that date was approximately R.A. XXIh. 41·1m. and Dec. − 3° 1′, which differed from the calculated place by + 4min. in R.A. and + 19′ in S. Declination. I again observed this region on Sept. 3rd and again on the 8th (the only clear nights favourable for such work). On the latter date the calculated position was only + 1½m. in R.A., and 18·15′ S. of the centre N.G.C. 7082 (2 M.). After much careful examination of this region I glimpsed an excessively faint, round nebulosity nearly in the calculated position; also a doubtful object in R.A. XXIh. 26m. 45s. − 2° 25′ Dec. ±. If the first of these two objects was really the comet, it must have passed close to the cluster 2 M. on the night of the 9th. On the 10th I again perceived at intervals of good seeing a very faint object near the star D.M. − 1·4172°, and slightly preceding it, the position of the comet's calculated place being near that star. These are all the observations I have been able to make, as, being in the heart of the Metropolis, it is only possible to find such objects when on or near the meridian. Mr. Ingall also kindly undertook to observe the region on Sept. 9, but saw nothing of a decided character. My eyepiece was simply a single convex lens of 2in. focal length, and giving a field of 1½°, which I have found on a dark sky very effective in picking up faint nebulæ, &c. Mr. Ingall employed a sweeping power giving a field of 35′ ± on his excellent 10in. dialyte refractor. As my dialyte is of only 4in. aperture, the probability is that the comet, if it has been seen at all, may be one of those diffuse faint objects which D'Arrest found from experience are only visible in small telescopes with very large fields, which would agree with its appearance as noted during its last apparition in 1880. As many of your readers may like to sweep for this object, I inclose a copy of Bossert's ephemeris for every four days from Sept. 16 to Oct. 30.

Day of Month, 1891.	At Paris Mean Midnight.				
	Right Ascension.			Declination.	
	h.	m.	s.	°	′
Sept. 16	21	17	58	− 0	30·0
„ 20		13	52	+ 0	10·4
„ 24		10	25	+ 0	53·6
„ 28		7	55	+ 1	40·0
Oct. 2		6	24	+ 2	30·1
„ 6		6	2	+ 3	24·8
„ 10		6	55	+ 4	24·7
„ 14		9	9	+ 5	30·8
„ 18		12	49	+ 6	43·9
„ 22		18	0	+ 8	4·8
„ 26		24	50	+ 9	34·0
„ 20	21	33	30	+ 11	12·8

Owing to a halo of uncertainty which accompany my own observations, due to unfavourable atmosphere for observing, and the inability to follow the object beyond the meridian, due to neighbouring houses (a common drawback to town observers), I was loth to publish these notes until advised by an astronomical friend, who thought it might stimulate other amateurs to search for this object, to whom I wish better success.

London, Sept. 14. D. E. Packer.

THE TELESCOPE.

[32713.]—In a recent reply to a question, "F.R.A.S." said that to see the companion to Polaris with a 2⅜in. telescope a power of 200 would be necessary. Now, I have a 2in., 2½in. and a 4in. refractor, all of first-rate quality, and I find the very reverse to be the case. I see the companion best with a power of about 50. With the 4in. glass a power of 40 shows it best. I use for this power a B micro. eyepiece by the late Andrew Ross. It gives a large field, and the low power seems to intensify the brightness of the small companion, while a high power makes it indistinct. Take another example, viz., η Lyræ, which Admiral Smyth termed a superb physical object. This is, in my view, best seen with a low power. To test the keenness of my sight, I can see the sharp black division between the widest pair of the double double 3·5″ with a power of 40 on my 4in., when the air is in the best state for observation.

Again, "F.R.A.S." recently stated that for a finder you must have a positive eyepiece. Now, the one I use is a negative one. I divided the diaphragm into six, bored six minute holes, and having stretched across three pieces of very fine wire, I soldered the ends into the holes. Where the wires met in the middle I pushed through a fine needle to open them out slightly, and I thus have a minute aperture in the centre, which seems to be far better than bringing the star against the spot where two lines only cross each other.

To ascertain the powers of my eyepieces I found it very difficult with the dynamometer, as it is almost impossible to hold it steady. I therefore made a tube to screw on to the eyepiece in place of the dark glass. This tube is about 4½in. long, and has at the other end a smaller one sliding on a jacket to carry a micrometer eyepiece. I place a micrometer on the stage of a microscope, and turning aside the ordinary tube, I place the above arrangement on the top of the micrometer, and using a Wray 2in. micro. objective, I find the value of each division in the eyepiece micrometer. It becomes then a very easy matter to measure the diminished image of the object-glass in each eyepiece, when the apparatus is again screwed on the eyepieces, and the telescope adjusted for parallel light. The instrument is, of course, quite steady, and one can, therefore, measure with great accuracy. With the ordinary dynamometer held in the hand this cannot be so well done.

Some time ago I asked any of your readers who have special skill in the matter if the statement by Webb in his first edition, that there was a different focus required for stars and the moon, was correct. The few replies which you published were not quite satisfactory; but they seemed to lead to the conclusion that the difference, if any, was a physiological and not an optical one. Since I wrote that letter I have met with the following statement, which seems to set the matter in its true light, and I may be permitted to quote it.

It is reported in the *Observatory* of June, 1890, No. 163, as having been stated at the meeting of the R.A.S. on May 9 previous:—"Mr. Ranyard: Everybody is familiar with the fact that the moon and stars do not require the same focus with the telescope. Of course, that cannot be due to the difference of distance, for in each case the rays are practically parallel. There must be some physiological cause, and might it be this: that owing to the great light of the moon, the pupil of the eye is very much contracted, and only the central parts of the lens are used? With the fainter light of a star we use a much larger aperture, and the other parts of the lens have not the same focus as the central region, and if you focussed on a star the limb of the moon would appear slightly out of focus . . . . I cannot agree with Mr. Davidson that it can have anything to do with the condition of the air, because we are very familiar with these irradiation appearances round the bright objects close to us, such as the spiral threads of the electric light; everyone sees it very much thicker when it is incandescent than when it is dark."

Personally, I have never been able to detect with my 4in. telescope the slightest difference of focus between a star and the moon. On a recent very fine evening, when I saw the dark line between the 3·5″ double double with a power of 40, on turning the instrument to the moon, I found not the slightest difference whatever. It may be different with larger instruments, however, of which as yet I have had little experience.

Wega.

TELESCOPES AND TROOPSHIPS—AN INTERESTING VOYAGE—HEAT AND COLD—ASTRONOMY IN THE TROPICS—MERCURY AND SATURN—SUN—GROWTH OF VEGETATION—A SUICIDAL FISH—HURRICANE—JUPITER.

[32714.]—Last January I asked some questions in the "E.M." as to the chances of carrying a 3½in. refractor safely to Barbados in a troopship. For the benefit of future travellers, I may say that I was successful, although the want of care in shipping and unshipping the baggage, and the terrible weather encountered on the voyage, effectually demolished most of my belongings, even damaging a pair of gun-barrels packed amongst soft clothes! My method of packing was, in the case of the telescope, to have a box made an inch larger in all its dimensions than the telescope case, and then to fill in the space between the two with woollen articles pretty tightly compressed. I did not withdraw the object-glass, and was glad I had not done so, as in one heavy gale, when the ship was rolling 40°, all the cabin baggage took to describing eccentric orbits, with which it was impossible to interfere except at the risk of a broken leg, and the result was disastrous.

The only damage done to the telescope was the shaking out of the eye-lens of a high-power eyepiece. Unfortunately, the lens was lost; but as the telescope was almost the only piece of my belongings to arrive safely, I have no reason to complain.

Our voyage took us over much of the North Atlantic, as we touched at Bermuda, Halifax, and Jamaica, and the opportunity offered of studying the Gulf stream, and the varied climates of different latitudes was very welcome. Most remarkable of all was the change from cold to warmth when steaming due south from Halifax and entering the Gulf stream.

I can assure the disciples of the late Mr. Hampden that I kept a careful watch upon the Pole star, and that its altitude did not vary at all as we steamed east or west, whilst the moment we turned our prow southward it began to sink towards the horizon, and is here, in Barbados, only some 12° above the horizon. I should like to know how this fact is explained on the supposition of a flat earth.

We met an earthquake wave which did great damage on board; but I do not propose to treat of our voyage here. I will just say that the coldest temperature we encountered was about 12° Fahr., and the hottest 84°. Pretty well for the powers of the human frame to live in varying climates, and even in sharp alternations of the same, such as the very problematical inhabitants of Mercury would have to put up with.

In these skies I find astronomy a real pleasure. It is now the wet season, and yet there is not one night in ten on which observations are impossible, and the air is as clear as crystal. The first observation I got of Saturn, in April last, with the planet almost directly overhead, showed me, once and for all, what difficulties the observing astronomer has to wrestle with in England. Jupiter is now becoming a splendid object, and I must confess that I experience a feeling of self-congratulation when I think how home observers must be wrestling with his unlucky S. declination.

The only thing that mars my enjoyment of the heavens is the painful attitude in which it is necessary to sit when examining objects in the zenith with a refractor. I wish I had brought out with me a star diagonal; but it is too late now, as I cannot waste time in sending home the eye-tube of the telescope to be fitted; and, as to getting anything done here, I regret to say that in Barbados nothing is made, not even refined sugar, which latter fact will perhaps be a surprise to some persons. Every article of food, clothing, and general utility is imported from England or the United States, and charged an 8 per cent. *ad valorem* duty. The island produces nothing but raw sugar (of most unpleasant smell), and an unglazed pottery ware, made by hand, which is probably a survival of the prehistoric industries of the children of Ham.

On the night of the 15th August I looked out for Mercury after sunset, with a view to comparing his brightness with that of Saturn, as the planets were almost in conjunction, and therefore—in this latitude—the line joining them nearly parallel to the horizon. I soon found Mercury in the clear evening sky; but Saturn was so much fainter that, in spite of the rapid darkening of the tropical twilight, I did not sight him till nine minutes later. Turning the telescope on him, I got a good view, though so close to the horizon. The ring is now very narrow, but with a power of 100 the plane surface is still readily visible.

As another example of the clearness of the air here, I may add that ε Lyræ is very evidently separated to the naked eye when in the zenith. I find, also, that the mottling and other delicate features of the sun's disc are remarkably well defined in the image projected on a paper screen. Direct vision with dark glasses is out of the question, of course.

Unfortunately, I find that the object-glass of my telescope is developing spots of some fungoid growth—the result, no doubt, of the warm, damp heat of the present season, which rusts and mildews everything. The fungus looks like stars of a semi-transparent blue, when the glass is darkened and looked at from the front. It grows between the lenses, which are uncemented. I have tried damping with spirits of wine, without effect.

After heavy rain, I cut a banana stem across to see what the rapidity of growth would be. In four hours a green shoot $\frac{3}{10}$in. in length had grown from the centre of the cut. This is pretty rapid!

Last month a soldier bathing was attacked by a garfish, which drove its sharp jaw into the man's face, behind his eye, and broke the jaw off there, leaving a piece just 2½in. long, with teeth complete, wholly imbedded in the orbit! It was extracted with difficulty, and the man is doing well, though, of course, he will scarcely recover the sight of his eye, as the optic nerve must have had a bad time. The wonder of the case is where those 2¼in. of hard bone could have been packed away behind the eyeball, without reaching the brain.

By the time this letter is in print full details will, no doubt, have reached England of the hurricane which visited Martinique on the 18th inst. Only a meagre telegram has as yet reached Barbados; but it seems to have been a severe storm. Here, on that day, heavy rain fell till about 5 p.m., and then the sky suddenly cleared, and a strong breeze from S.S.W. to S.S.E. set in. The weather looked to me so threatening that I consulted my barometer, which I found only $\frac{1}{10}$in. below its usual reading, which latter, with the exception of a small diurnal variation, is quite constant here. Undoubtedly the wind we experienced was the very outermost fringe of the cyclone; but how limited in area must the latter have been to wreck Martinique, and yet only to cause so slight a fall of the mercury at Barbados! I wait with interest to learn the barometrical readings observed at Martinique, and to trace the course of the storm.

Whilst observing on the evening of the 21st the transits of Jupiter's Satellites I. and II. and their shadows, which phenomena occurred here at a reasonable hour of the evening, and not, as in England, in the early morning of the 22nd, I noticed a remarkable fact. Definition was so good that the shadow of I. could be seen, with a power of 100, cutting a neat notch in the disc of Jupiter as it entered. Some light clouds were crossing the heavens (terrestrial), and whenever one of these clouds approached within 2° or so of the planet the latter "boiled," as if looked at through the hot air of a chimney, losing all shape and definition. I have never seen this occur in England, nor heard of it in the Tropics; but no doubt it may be a frequent occurrence in the latter, and I suppose, shows that the clouds are formed by the contact of currents of air of very different temperatures and densities.

When I. entered on the disc, it distinctly appeared again outside it one minute later. But I lay no stress on the observation after what I have remarked of the tricks the air was playing. The shadow of II. was much greyer and fainter than that of I., but both visible in the telescope, even to a friend who looked through a telescope for the first time in his life, and, being shortsighted, had to focus for himself. Anyone who has endeavoured to show such phenomena to the inexperienced will realise how much such a fact says for the definition.

This is a long letter, and I will not now trespass further upon the Editor's patience. With his permission, I hope to send notes on the geology and natural history of this island as I find time.

T. Preston Battersby, Capt.R.A., F.R.A.S.
Barbados, August 24, 1891.

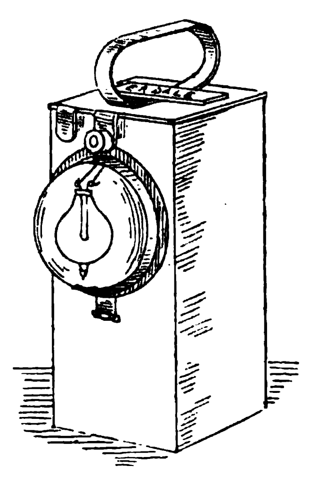
HINTS FOR EXPERIMENTALISTS.

[32715.]—Inflated bicycle tires appear to give a good deal of trouble, being so often cut and broken by sharp stones. But considering the frail character of indiarubber, this seems to me to be just what should be expected. All irregularities of the road are met by deformation in the tire, which, owing to the great elasticity of air, is of a purely local character, and is at the same time very much greater in extent than would be the case in a tire of solid rubber. It seems to me that by reducing the volume of air under compression at any given time, the strain on the rubber would be considerably reduced. This would be effected by employing rubber diaphragms at intervals to divide the cavity of the tire into a number of airtight compartments to be separately inflated. Yet another way in which local strains could be distributed over the tire would be by filling it with water in place of air, but as in this case the fluid itself is incompressible, we may doubt whether, on the whole, any advantage would be gained. For equal diameters, a tire filled with water and a solid rubber tire would be of about the same weight. Of course the main tire of a bicycle must necessarily be rigid, but I cannot see why some degree of elasticity in the spokes should be objectionable. It may be that not even the slightest sideways motion of the tire would be tolerable; but I think that at least it would be interesting to put elastic spokes to the test of practical experiment. I would prefer to use a much larger number of spokes than is commonly employed, but as it would not be easy to attach these to a small central hub, I would adopt two or three sets of spokes arranged as follows: The fine steel wire spokes each being coiled through a part of its length into a spiral spring, are attached to the tire in the usual manner. There may be, say, four times the usual number of these little spokes, and they are taken in pairs, of which the free ends are brought together and attached to a set of one half the number of intermediate spokes. The free ends of these intermediate spokes are joined in their turn by pairs to the central spokes, which radiate from the hub of the machine. Thus there are three sets of spokes, each spoke of the intermediate set having one half, and each of the outer set one quarter of the sectional area of those constituting the inner ring of spokes. The sets of spokes would be joined to one another by simple hooks, and the whole arrangement would cost very little more than a wheel of the existing type. If desired, the spiral springs might be replaced by springs of indiarubber, in tension or in compression. Of course, I do not know whether these suggestions are entirely novel, but I should be glad to hear anything on the subject; and I hope that if any of them are practically tested the result will be communicated to the English Mechanic.

Referring to the suggestions in my last letter as to the development of current electricity, I think that the system proposed would be applicable to the production of currents by means of varied temperatures only. For I imagine that there are reversible batteries, other than gas batteries, which generate a current of intensity proportional to their temperatures; and one such battery at a high temperature, with one at a lower temperature, gives a combination which should be workable in the manner I have already indicated. **A. D.**

PORTABLE ELECTRIC LAMP.

[32716.]—I send you particulars of a portable lamp made for me in various sizes, and which I have found very useful for many purposes. The small size weighs about 1lb 12oz., and stands 4in. high, and has been used over the steering-wheel of a tricycle, bracket of a piano, &c., with great success. They can be charged with a small Bottone dynamo, driven by a water-motor, or even a turning lathe at the same time as work is being turned, or with the improved primary batteries. The lamp is fitted with a sliding switch for turning the light on and off. When a light is required, the switch shown under the lamp should be pushed up; when it is pulled down, the top unlocked, and three plugs pulled up, it is ready for charging, the positive wire being inserted into the hole marked + under the cover shown in the left-hand corner, and the negative into the hole in the switch. The direction of the charging current may be found by attaching a lead wire to each of the two terminal wires, holding them slightly apart while immersed in diluted acid in a vessel. Presently one lead wire will turn a dark-brown colour; but I much prefer using the P.F.P. test-paper.



E. R. Dale, C.E.,
Associate of the Institution of Electrical Engineers, Inventor of Electric Blinds, &c.

THE ELECTRIC FLUID.

[32717.]—Mr. Gurney is perfectly correct in negativing the employment of the term "fluid" as applied to electricity. The word is now only used in this connection by newspaper reporters. Objections may also be raised against the use of electromotive "force," "pressure," &c.; but everyone understands what is meant, and they will continue to be employed until someone invents better terms. **Sm.**

DIALLING.

[32718.]—"C. H. T." (letter 32696) will not find any account of dialling in Ferguson's "Astronomy," but will find a considerable portion of Vol. II. of Ferguson's "Lectures" devoted to it. There is also a pretty exhaustive article on the subject in Vol. VII. of "Encyclopædia Britannica," by J. Godfray. **T. R. Clapham.**

SPACE OF FOUR DIMENSIONS.

[32719.]—In letter 33704, page 70, our talented electrical correspondent, "Sigma," in reply to a query relating to the subject expresses very strong opinions concerning space of four dimensions and all the persons who believe therein. With all respect to "Sigma," I still do not think it quite certain that four-dimensioned space is the absolute absurdity which he seems to consider it. We have never had any experience of such a kind of space, and we probably never will have any experience thereof; but that does not quite prove the non-existence of such space. Space of a higher kind than any we know practically is distinctly shadowed forth by mathematical equations. An equation of the first degree represents extension in one direction, that is space of one dimension which is a straight line; an equation of the second degree represents extension in two directions, that is space of two dimensions, which is a surface; an equation of the third degree represents extension in three directions, that is ordinary space. It is true that we have no experience of the kind of space corresponding to equations of the fourth (or higher) degrees; but such space may very well exist for all that, and I do not see why "Sigma" should try to throw cold water on the attempts of men who are trying to make out the properties of this kind of space.

Perhaps the best way in which we can form a conception of space of four dimensions is to commence by studying the difference between space of two dimensions and our ordinary space. A creature living in two-dimensioned space, and such creatures are conceivable, would be as incapable of understanding the third as we are of grasping the fourth dimension. If two such creatures met each other they would have to get past by going over and under, not as we do, by going right or left. They would deem a triangle a closed box, and would have no experience of what we call lateral movement. If they were transferred to our ordinary space we could do all sorts of things which would seem miraculous to them. We could disappear mysteriously and reappear as mysteriously, and it would be impossible for them to fasten anything up in such a manner that we could not get it. Reasoning from analogy, we may infer at least two things concerning four-dimensioned space: The beings in it could appear and disappear to us in our three-dimensioned space without our being able to tell from whence they came or whither they went; and they could remove anything from a locked box without opening it or disarranging it in any way. If our earth ever gets into four-dimensioned space, we will be quite at the mercy of any creatures inhabiting that space.

"Sigma" may reply that all this does not prove the existence of the anomalous kind of space. I never said it did. I am not certain that the existence of such space can be proved in the strict sense of the term. All we can do is to endeavour to form a conception as to the meaning of certain equations. There may not exist the space corresponding to these equations; but it may exist, and unless "Sigma" has been all over the universe he cannot be certain that there does not exist space of higher dimensions than we know on earth. There is at least much more evidence in favour of transcendental space than there is of the existence of a principle of life apart from matter. And yet "Sigma," unless he has changed recently, believes in such a principle.

Wm. John Grey, F.C.S., Analytical Chemist.
Newcastle-on-Tyne.

ATMOSPHERIC PRESSURE AND GASEOUS EXPANSION.

[32720.]—Perhaps the following simple experiment illustrative of atmospheric pressure and gaseous expansion might interest some of the readers of your valuable paper:—

Take an ordinary 2oz. or 4oz. flask (such as used in chemistry for boiling), fit with sound cork, through which passes a piece of ¼in. glass tube about 12in. long. When fitted the glass tube must not pass more than a ¼in. into the flask, beyond the cork.

Having now prepared our apparatus, about one-third fill the flask with water, replace cork and glass tube, and boil water over spirit-lamp or Bunsen flame for some minutes, or until the atmospheric air previously contained within the flask has become expelled, steam from the boiling water having taken its place.

Now turn the flask quickly over, tube downwards, taking care to protect the hand from the hot glass with a duster. It will be found that the water does not run out from the flask, as might at first be expected; but instead of that a large quantity of air will bubble up through the tube into the flask. This at first goes on very vigorously, gradually quieting down until the space in the flask above the water has become filled with air of the same density as that on the outside.

As soon as this state has been attained we find a few drops of water to run from the tube, thus lowering the level of the water left in the flask, and consequently the pressure on the inclosed air is lessened, allowing it to expand by its own elasticity to fill the increased space, the immediate result of this lessened density of the inclosed air being another inrush of water up the tube, until both have again become of the same density. A few more drops of water will now run out, the level in the flask is lowered, the air again expands, and another inrush of air, and so on, for 10 or 15 minutes, or until nearly all the water has been emptied drop by drop.

As the action becomes a little slow after the first few intervals, a slight shake of the tube will bring down a few extra drops of water, and thus cause an increased inrush of air.

Todmorden. **Dan. B. Garside.**

ELECTRICAL.

[32721.]—I did not ask "Sm." for any explanation about the current at all. When I used the word it was to signify the flow or passage of electricity along a conductor. There was no need for "Sm." saying there is no such thing as a current, since it is understood by all in what sense the word is used. All this, however, has nothing at all to do with the argument, which is, whether the current (or, to satisfy "Sm.," the current of electricity) spreads out in its passage through the liquid or not. Does he still maintain that it does not? By what he writes, it seems that he thinks there is no electricity in the liquid, but simply that it is the transference of atoms he speaks of. Would he write what he really does mean in a direct manner, and not confuse his ideas in the way he has done? It is all tomfoolery about the textbooks, and he might have saved the ink for another time.

Mr. Goodchild is quite right when he says capacity also depends upon the shape, although it does not alter the fact that capacity and conductivity are not the same. When I said lessening the resistance did not cause an increase in the accumulation of electricity, I was correct, for it is not the lessening of resistance that causes more electricity to accumulate, although it is true the decreased capacity which causes it is dependent upon the lessened resistance.

A. Benjamin.

THEOSOPHY.

[32722.]—Writing at extra speed last week, I may have been somewhat illegible; but it is a printer's mystery that I can have been made to say "Some of our noblest intellects are being *washed over resembles* about what would happen in space of four dimensions." I certainly meant to write "are wasted over discussions."

Time is the great avenger. Years ago I came under condemnation and ridicule because I stated things which I knew to be true, as to those mental and nervous phenomena known under the names of mesmerism, electro-biology, and hypnotism. Those very things are now being proclaimed as scientific novelties, and studied by the medical profession in the French hospitals, though those medical men are only attaining a very partial and misleading knowledge, because they are chiefly trying to explain them on merely material principles. At that time, or one of those times, I stated that thought, sensation, and perception can be transferred from one mind to another, quite independently of the usual organs of the senses, and I was pretty strongly denounced by "Kappa," who denied that my habits of close experiment and induction in material science gave any weight to my experiments and induction in these more occult branches of science and physiology.

Now "Kappa" (presumably the same) appeals to me (in query 75302, Theosophy.—To "Sigma") for my thoughts on what is really the same subject, and says he has noted that I have had actual experience of, and insight into, these matters. I have; and as this subject is now so prominently before the public mind, I will try to answer "Kappa's" question.

But, first, let me say that his two alternatives do not cover the ground. He asks, "Is occultism merely another vulgar imposture?" and also asks whether the "claims for the conquest over matter by spirit, or call it what you will, are founded on even the slenderest fact?" The first question is far too narrow. Which among the mightiest mental powers or religious impulses has not been tainted with imposture of the kind known as pious fraud? Does that make the thing itself a mere vulgar imposture? The debatable region outside the seen, the relation of life to matter, all the field of metaphysics, is illusive. The order of mind which gives us the poet and the prophet is under the influence of enthusiasm, and nothing is more powerful or more delusive than enthusiasm: it can create objects which then become realities; but the prophet who proclaims is not an impostor, though he is very likely indeed to get disciples who will aid him with imposture.

As to the second question, the claims have a basis of fact—the two bases just mentioned, self-created facts, and invented facts. The self-created facts are just the phenomena of mesmerism, the suspension of those faculties of the mind by which thoughts are converted into visible realities, as unknow occurs commonly in the less complete state of dreaming. The other "facts" are similar to those supplied by so many distinguished mediums who have been found out.

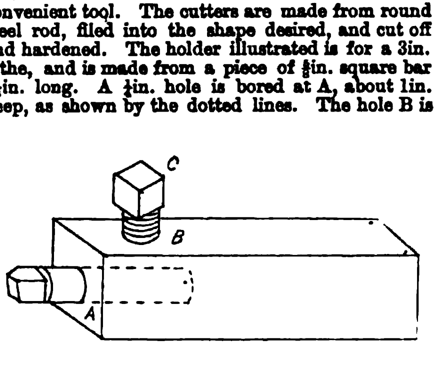
Theosophy is a hotch-potch of Buddhism and spiritualism—a late revival of notions which have floated down the ages in the mind of many a noble dreamer, and is blended with much of the pseudo-science that is fashionable nowadays. As to my own knowledge and experience, I have no hesitation in saying that the direct action of mind upon mind, apart from the ordinary modes of communication, is a certain fact. But in no single case have I ever found any evidence of any action whatever of mind upon matter, except through the agency of organised matter, as in the motions which living matter is capable of producing. Nor have I ever succeeded in finding any evidence that the occult powers confer upon the mind any means of gaining knowledge not attainable or already possessed in the usual course.

I have not time now, but I will try to trace out, next week, how these ideas are working out, and why they are acceptable to many who ought to know better. Of course the momentary impulse is due to their acceptance by Mrs. Besant. It is only reasonable to ask why any reasonable being should follow the lead of a woman who, with abundant ability, has shown no evidence of stability, but drifts from one set of ideas to their opposites, while enthusiastically maintaining the truth of all. I really think that Paul would be a safer guide into the regions of the unknown than Mrs. Besant.

Sigma.

THE SCOTIA TOOL-HOLDER.

[32723.]—I inclose a sketch of a tool-holder I made some time ago for use in my own workshop, and which has turned out a most excellent and convenient tool. The cutters are made from round steel rod, filed into the shape desired, and cut off and hardened. The holder illustrated is for a 3in. lathe, and is made from a piece of ⅝in. square bar 3½in. long. A ¼in. hole is bored at A, about 1in. deep, as shown by the dotted lines. The hole B is tapped with a thread for the bolt C, which holds the cutter firm. The performance of this tool is exceedingly good, and it is so simple that anyone can make it for himself.



Lintmill, Portgordon. **James Thompson.**

MAGIC SQUARES.

[32724.]—Errata.—In my letter 32703, it should have been mentioned that in the last paragraph, R stands for the root of the square, whether it be odd or even, and that it has not the double signification of the preceding paragraph. And in the paragraph under the skeleton square of 9, the number 1,623,201,856 is too little. It is easily proved that the number cannot be less than 8^{11}, or 8,589,934,592. Lastly, in the last paragraph but one, last line, "number of figures," strike out the words "of figures." **T. S. Barrett.**

A WEIGHT-POWER TO DRIVE FANS, &c.

[32725.]—In your issue of Aug. 14 I noticed the above power, which consists of a series of weights with pulleys fixed to them; these are hung on a rope running through a series of pulleys fixed to the ceiling; one end of the rope passes round a drum which is connected to cogs, &c. At the end of the explanation of this motive power I read the following:—"By using an additional set of weights with proper connections, this power may be made to operate without interruption, one set of weights being wound up as the other runs down." Would some kind reader of the "E.M." explain this more fully, giving diagram of the extra set of weights and the suitable connections? It seems to me that it would take a much heavier set of weights to pull the other set, and at the same time do some work, and that there would come a time when the mechanical power would stop, and a little manual labour become necessary.

N. W. Howard-McLean.

PATENT FEES: TAXATION OF INVENTORS.

[32726.]—Referring to a paper recently read by Mr. L. Edmunds before the British Association respecting the desirability of abolishing the annual taxes on patents at and after the fourth year, I may be allowed to say that, from practical experience, I am unable to agree either with abolishing these fees altogether or with retaining them altogether. It is a question of public convenience on the one hand, and of justice to the inventor on the other. The former demands the extinction of such patents which are not worked for the benefit of the public (and the inventor); the latter demands that the inventor should not be heavily burdened or hampered in his strenuous exertions, with the world's lethargy and conservatism against him, as against every innovator. But, at all events, to pay the surplus into the Treasury for the purpose of lightening the taxation of all non-inventors is both unjust and foolish. A comparison with the Post Office surplus will put the patent-fee surplus in a proper light by contrast. The Post Office surplus is made up of postage-stamps, paid by everybody almost, and the more you avail yourself of the post, the more you pay towards the surplus. This, then, is a just and convenient tax; but the inventors form a very small and mostly poor body of the community, and there is no reason why they should lighten the taxation to the tune of £100,000 a year for all the other taxpayers in the land. To meet the exigencies of the case, I propose to reduce the annual patent taxes by £5 throughout, so that none would be less than £5, and none more than £15. And secondly, I propose that the large yearly surplus even then created should be spent for the inventor and for that part of the public which is more especially interested in patents. Let the Patent Office Library in London receive more consideration from the Board of Trade, and let other towns besides London feel the benefit also by aids to their technical libraries, and let a fund be created for annuities of £50 to £100 a year for aged, poor, deserving inventors, by devoting to it, say, £5,000 a year out of the surplus. This fund, once created and well managed, will then also receive help from rich inventors and others.

P. Jensen,
Fel. Inst. Patent Agents.

[32727.]—Before going into other matters, it may be as well to point out that the reason it is not worth while to criticise Sir F. Bramwell's remarks about the type and the drawings of the printed specifications (see p. 69) is simply that the type is only one size smaller than has always been found sufficiently large for the law courts, and that the drawings are reproduced by photolithography. As a matter of fact, specifications are so rarely required that it would not be worth while to print them any larger, as it would then be next to impossible to store them in any quantity. I do not know who it is that determines the number of copies of specifications to be printed; but I believe 200 is about the average. Some run "out of print" (Werner Siemens's dynamo, Bell's telephone, Edison's electric light, for instance); but others remain as dead stock on the Patent Office Store shelves. Here let me point out something else: Provisional protection is now really an "application"; there is no provisional specification published except when on receipt of a complete specification a patent is granted; but, to save space, the blue wrappers formerly used to cover the printed specifications (which sometimes were as bulky as the specifications themselves) have been abolished, and that is a consideration when the applications amount to something like 20,000 a year, and a large proportion go to the "seal." The cost of the stamp on an application form is £1, that on the complete specification £3, making £4 in all, which, plus a few pence, is the total cost of obtaining a patent lasting four years. Now see what the Patent Office is bound to do for that money. So long as any so-called "invention" is not *contra bonos mores* it is compelled to grant a patent, and no matter how long the specification may be, it is bound to print it, and recoup the cost by selling it at so much a "sheet." Now, if I were a crank and liked to write a whole volume describing my invention of perpetual motion, the Patent Office must print it, and probably would not sell a single copy beyond those I purchased to present to my friends. As a matter of fact, I saw a specification some two or three years ago which was priced 11s. or 11s. 2d. (I am not sure, and it does not matter), and it was all about an "invention" which could not by any possibility be of use to any body. You will understand that a specification for which the Patent Office at its fixed rates has to charge 11s., costs a good deal of money to print, and you may take my word for it there was no profit out of that £4. Say it is an exceptional case, as I hope it is; but I mention it to show what may be done, and also to impress the fact that something must be charged for patents, although, personally, I should be glad to see them granted for nothing at all, except mere office expenses in the shape of what we may call "stationery." It is objected that the patentee has to pay (by instalments it should be remembered) £150 in all, which does look like a tax on the face of it, but it is really paid by those who use the invention, and money must be obtained somehow to support the Patent Office. The real question of a fair charge turns upon how long it takes to introduce an invention. Four years was considered sufficient by Mr. Chamberlain and those who drafted the Act of 1883; but perhaps it would be wiser to make the first term longer, and grant a patent for seven years on payment of £4. Surely in that time, if an invention is worth patenting, it would begin to be profitable, and then the patentee could pay, thus helping to support the Patent Office Library—an institution which is of the first importance to all would-be patentees. Mr. Leng said in his speech (I quote from his authorised report) that the accommodation at the Patent Office is "at present miserable," and that "the library is a limbo where inventors soon lose themselves, and give up searches in despair." It is quite true that new buildings are much needed; but the searcher of average intelligence, with the assistance which he can always obtain for the asking from the courteous librarian and his subordinates, should find no difficulty in making any "search" he needs—at least, that is my experience, and I know it is not singular.

Mr. Leng says that the "American system of examination should be adopted to prevent duplicating and triplicating patents for the same invention." Why? It is the intending patentee's business to see that he has not been anticipated; and he would not be pleased if some examiner reported that his invention was not new, and so procured a refusal of a patent. So far as my experience teaches, the American system of examination is an utter failure. Many things have been patented in the United States which were not merely old, but quite antiquated, at the date of patenting—and that in spite of the examiners. The examination here is little more than a farce, though it is useful when it tells a would-be patentee that a similar specification has been lodged in the office, which specification cannot be seen until some months after the second inventor has gone through all the formalities. The staff of "examiners" in our office would be much better employed in compiling "abridgments," for every facility should be given to inventors or their agents to discover whether there is any "anticipation"; but it is risky work to refuse a patent because an examiner thinks there is something like the invention already in the office. Warn as much as you please, but don't refuse! The average inventor has so great a faith in his own child that he will take the risk, and nothing but absolute demonstration will satisfy him that he has been anticipated or forestalled.

Now as to fees. It is obvious that there is no occasion to make the Patent Office a revenue-earning institution; so long as it pays its way that is all that is required, and it simplifies matters; but the Patent Office must have a good library, and the printed specifications must be so located that they can be easily examined, while besides the "subject-matter" indices and the "name" indices there should be, as Mr. Leng suggests, the "abridgments" brought up to date. Sir M. Hicks-Beach has, it appears, gone over the Patent Office, and is convinced that new buildings are required—"simply a matter of reconstruction" were his words—so there is a possibility that a new building will be provided, especially as the "savings" of the present office are amply sufficient to pay for it.

As the object of the patent laws is to "encourage invention," make the obtaining of a patent as easy as possible, and risk those long and expensive-to-print specifications referred to above; but make the fees after seven years sufficient to cover all deficiencies, for if an invention cannot be made to pay in seven years, say, it is not worth much. As a matter of fact, half the patents taken out in this country are, on their merits, not worth the paper on which the specifications are printed. There, I have done it now! **Saml. Ray.**

PYROMETERS.

[32728.]—Very much depends on the class of work "B. M." (letter 32705) wishes to use his pyrometer for. Most, if not all, of the pyrometers in use have serious defects, and their indications are of little value. In my own experiments I never found any so-called pyrometer of any practical service whatever, and I discarded all for the rule of thumb of the so-called "practical" man, as I required only definite indications of certain temperatures which produced the required results. For moderate temperatures up to a clear yellow heat, I used strips of pure metals, lead, tin, copper, silver, platinum, &c., of a uniform thickness, width, and length, supporting the ends on two edges of fireclay at one uniform distance apart. The softening and dropping of these gave one definite series; the fusion of the fusible ones into a ball gave another. For temperatures over a yellow and up to a bluish-white, at which platinum fuses, I used one or more thicknesses of green glass, estimating the heat by the number of thicknesses required to make the outlines of the furnace contents barely visible. This is, of course, an unscientific makeshift, totally worthless for obtaining any figures; but it is a simple and reliable workshop standard, by which the daily working of processes may be rendered uniform and certain.

If the work is steady repetition of the same processes on the same material, and the temperatures are sufficiently high, the appearance of certain known lines in the spectroscope, in succession, may be usually depended on; but after repeated trials I discarded this for the different layers of coloured glass, and green proved to be the most reliable and pleasant to the eyes. **Thos. Fletcher.**

WASTED FOOD.

[32729.]—I am a vegetarian, and have wished for some years that I knew the edible fungi from the poisonous; but on making inquiries for books, &c., on the question, have always been told they were very expensive, and with them even it was difficult to detect or distinguish the edible from the poisonous (?) sorts. Will Mr. S. Ray (letter 32697), or any of our authorities, kindly say if this is so? I am living in the centre of the New Forest, and there are many poor families who depend on their crops of potatoes to pay their rent and enable them to live, and now this source has failed, would, no doubt, welcome any addition to their table. We have not far to go in the inclosures here to see any amount of fungi if we could tell which we could eat. Is there any cheap book on the edible fungi (with cuts, if possible), their time of appearance, and how to cook them? Is Dr. Badham's book on "Esculent Fungi" an expensive book? Has it plates, and does it give hints as to cooking? Any information will be thankfully received by

Lyndhurst. **James Jerrard.**

OHM'S FORMULA.

[32730.]—At p. 364 of the "E. M.," June 19th last (letter 74055), Mr. Benjamin offers the following as a proof that this law in relation to resistances is not clear. He says: "Suppose the E.M.F. of a battery is 4 volts, and the external and internal resistances together half an ohm; then the current's strength is $\frac{4}{\frac{1}{2}} = 8$, thus the strength of the current is greater than the E.M.F., because we introduce some resistance."

I have been waiting to see if anyone would object to this calculation, but though other portions of his letter have been criticised, this appears to have passed unquestioned.

Is not, however, the resulting current 4, and not 8 ampères—seeing that the divisor is a half, and the dividend has to be halved to correspond: and the formula right, after all? **B. Harcourt.**

THE NEW OPTICAL GLASS.

[32731.]—Referring to "Orderic Vital's" query about o.g.'s with the new Jena glass, I would like to say that since this query appeared I have come into possession of a telescope with a 2in. o.g., which was evidently made of Shott's, or somebody else's, new glass. Now, I think, the condition this o.g. has assumed so soon after it has seen the light of day, deserves to be known, were it only to damp a little the ardour of the hunter after novelty. The flint concave is speckled all over, and that to various depths, since it shows all the colours of the rainbow. This appearance gives one the idea that the mass of its glass was not a homogeneous chemical compound, but an uncombined mixture of different ingredients.

The crown lens has on the inside the appearance of a heavily dewed or slightly-ground glass. As far as the optician's part of the work is concerned, it is well made throughout, and the telescope must have been a very good one when it left its makers. The glass must prove a warning to maker and user. The strange part of the matter to me is that both outside and exposed faces of the lenses appear perfect. Could the polishing material have brought about that undesirable appearance, or the want of air, or dampness? The old kinds of flint and crowns do not exhibit such peculiarities. All Dollond's crowns turn green with age, and I was told by an eminent chemist that all crowns will do so. Now, can this be due to a condensation of the glass, or to some other molecular change, and to what degree will it affect the quality of a telescope?

A. Caplatzi.

DIATOMACEÆ.

[32732.]—I have lately had the opportunity of inspecting a unique collection of *Typen Platten*, by Herr Moeller, of Wedel, whose *ordinary type* slides, I believe, are well known all over the world. The present collection of some forty slides is not to be compared with the ordinary slides, as it embraces all the types of Diatomaceæ hitherto known, and has cost over five years of steady labour and exhaustive patience, which will never be repeated again. The individual diatoms are arranged according to their classification, and according to the localities where found, all parts of the globe having been put under contribution; the ones in straight parallel rows, and the others in concentric circles,—and so beautifully has this been done, that every individual appears quite distinct, and with all its characteristics plainly visible. The principal slide of the collection is really a wonderful work of art. On it you can *plainly* and *easily* count 4,026 atoms, representing all the known types, not thrown down promiscuously, but geometrically arranged, having the appearance somewhat similar to that of a fly's eye under high magnifying powers. It has, as yet, only been shown to a few privileged friends on the Continent, and may, later on, possibly be publicly exhibited to microscopical societies in this country. I was told by Herr Moeller that it was not for sale at present, and that he would never divide it, and if that decision is adhered to, it will, undoubtedly, always be looked upon as a *chef d'œuvre* fit for any museum. **A. Caplatzi.**

REFRACTION OF SOUND-WAVES.

[32733.]—To impute an error to Tyndall's assertions in matters of sound, by an ordinary individual who thinks he has discovered such, will, as a rule, result in himself falling in error. The instance of Mr. A. T. Wheeley is no exception (letter 32699, p. 68), as his analogy shows, of a glass sphere and rigid bells, to an almost flaccid balloon of CO_2 is no comparison. They take up sound-waves and form nodes and ventral segments peculiar to their structure, which is no case of refraction. While such a balloon referred to produces none of these, but transmits sound refracted in the same way as light through a lens, only not in the same degree.

Walton-road, Liverpool. **G. Whittle.**

Erratum.—Sir R. Ball on the Ice Ages.—In the 3rd column of p. 66, line 4, "lune" is misprinted "time."—G.

USEFUL AND SCIENTIFIC NOTES.

Indiarubber Cement.—In order to fasten glass letters, figures, &c., on glass, so that even when submerged in water for several days they will not become detached, use an indiarubber cement. The best for this purpose consists of one part indiarubber, three parts of mastic, and 50 parts chloroform. Let stand for several days at a low temperature to dissolve the cement. It must be applied rapidly, as it becomes thick soon.

The entire production of the Ural platinum mines for the last ten years has been sold to a foreign syndicate which originally had the idea of speculating upon a progressive demand for the metal for electrical purposes. Since work on the Trans-Siberian railway was initiated, a scarcity of labour at the mines has been experienced, causing a diminution in the production from 1,249 kilos. in 1888 to 1,113 kilos. in 1889. The total output of the rough mineral in Russia in 1881 was 2,986 kilos.; 1882, 4,081; 1883, 3,327; 1884, 2,137; 1885, 2,591; and 1886, 4,319 kilos. All the mineral extracted comes from the Goroblagodz and Nigi-Taguitsk mines in the Government of Peru.

In reference to the subject of "bogus coffee beans," it is worth noting that an Imperial decree has been issued in Germany forbidding the manufacture and sale of machines for producing artificial coffee beans, as contravening the food law. These beans are not intended to supply by themselves a beverage which, from similarity of taste or effect, might form a substitute for coffee, but to be used in trade for mixing with the genuine article. So vast is the extent to which spurious coffee is permitted in the United States to masquerade under the names of "Java," "Mocha," or "Rio," that it is calculated that the American people pay annually 25 millions of dollars, or more than five millions sterling, for ingredients of this sort that can be manufactured for one-fifth of that sum.

Borax Solution of Rubber.—Indiarubber not only may be kept emulsified by a borax solution, but actually may be dissolved in the same from the raw solid gum. If simply an emulsion be desired, a solution of the rubber in benzine or other hydrocarbon, to which a small portion of alcohol has been added, is mixed by vigorous agitation with a two-fifths saturated solution of borax, previously heated to from 120° to 140° Fahr., the agitation being continued until the mixture has cooled down to the temperature of the air, or nearly so. It is found that not more than about 3·5 to 4·5 per cent. of rubber should be present in the fluid when finished, as any higher strength, if attempted, quickly separates, and in such cases sometimes the entire quantity coagulates when the separation begins. It would also seem, as an important fact, that the Ceara or Madagascar rubbers have proved the best for use with borax solutions, possessing advantages in this respect even over the Pará. Dr. B. W. Richardson has found that guttapercha, softened in hot water, or in hot water and glycerine, may be made to absorb almost any desired styptic and antiseptic substances. The mass can then be drawn out or moulded into any required shape, and as a surgical dressing will serve the purpose both of adhesive plaster and splint.

REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75060.]—**American Organ.**—The querist will find it far better to purchase a set of suitable springs, which can be purchased from any of the dealers who advertise fittings in the English Mechanic. The cost will not exceed 1s. per set of 61 springs. It is foolishness to make, or try to make, springs, when they can be bought so cheap.

Practical Organ Builder.

[75051.]—**French Engines.**—The mark "75 Caltes" seen on French locomotives probably means 75 "of that pattern," or, as we should say, it is engine 75 of its "class." T. L.

[75056.]—**Essences.**—The querist should get Bailey's "Chemists' Pocket-book," E. and F. N. Spon, or the Pharmacopœia. Essence of spruce is simply a decoction of the young tops of the black spruce fir (Abies nigra) evaporated down to a black syrup. Perhaps the querist means something else.

R.

[75057.]—**Soap.**—There are many recipes for making soap in back volumes; but a good "toilet" is made by dissolving yellow soap, scenting to taste, and drying in tablets. M. L.

[75058.]—**Ferns.**—When the spores are ripe, dry the leaves or bracts, and the spores will easily rub off. L. M.

[75060.]—**Steam Tramway Engines.**—The steam-condensing arrangements are mainly pipes exposing a large surface to air, and the smoke-consuming is the usual arrangement of firebox; but as to the result there are differences of opinion. They were fully described some time ago. M.

[75061.]—**Air-Gun.**—"An Old Subscriber" should look in his back volumes—say Vols. XL. to XLV., as a guess. Video.

[75184].—**Electrical Testing.**—To George Clayton.—I can put you right. Your apparatus is admirable for insulation measurements, and you will find, when you get into the way of using your resistance-box for shunting the galvanometer, that you will get a greater range of sensibility, as well as greater accuracy. Let me preface my further remarks with a suggestion. If you want to do accurate work, it will be necessary to take into account the effects of temperature on all your resistances. Your galvanometer resistance being known at 60°F, I should make a table of the calculated resistances, extending, say, from 30°F to 90°F. Galvanometer coils being of copper, vary to a very considerable extent. The value of resistance coils should also be calculated for the temperature at which you work; but the co-efficient being very much smaller than that of copper, there is not much harm in neglecting this, and taking them at their face value. Another suggestion: If you are not familiar with logarithms, I strongly advise you to master them; they are exceedingly simple, and will simplify your calculations greatly. The multiplying power of the shunt is found by adding together the resistances of galvanometer and shunt, and dividing by that of the shunt. Taking your figures, and supposing your tests were taken at 60°F, you commence by calculating the constant of your apparatus, which is done by multiplying together the sum of resistances, the deflection, and the multiplying power of the shunt, thus:—

$$100{,}000\omega + \text{battery res. (say 1,000)} = 101{,}000 \times 55 \times \left(\frac{5500 + 1}{1}\right) = 35{,}558{,}055{,}000$$

The above represents the deflection your battery would give, provided the sum of the resistances could be reduced to 1ω, and you had a scale capable of giving so large a deflection; or, to go to the other extreme, the resistance through which your cells would give a deflection of 1°. If, therefore, you follow the above reasoning, you will see that any deflection you obtain, with the same apparatus, divided into the above constant, will give you the resistance through which it was obtained—i.e., the insulation of the insulating covering, plus the resistance of your apparatus, battery, and shunted galvanometer, thus:—

$$\frac{35{,}558{,}055{,}000}{200^\circ \times \left(\frac{5500 + 850}{850}\right)} = 23{,}815{,}300.$$

From the above result, substract the resistance of your apparatus, and you have the required insulation resistance. The joint resistance of galvanometer and shunt is found by dividing the product of the two resistances by their sum, thus:—

$$\frac{\text{Galv.} \times \text{Shunt}}{\text{Galv.} + \text{Shunt}} = \text{joint resistance; or, if you are}$$

content to express your results in Megohms, thus:—[illegible] Ω, you may ignore the resistances of battery and galvanometer. I have not gone into the temperature corrections in the above, but will give them if desired, and, in doing so, would much prefer to use logarithms. T. J. W.

[75152].—**Gas-Engine.**—The compression space in the cylinder undoubtedly contains part of the products of combustion, which at the next out-stroke follows up the piston, and may form a cushion at the time of ignition between the piston and the perfect mixture of gas and air at the next in-stroke. I don't think it is of much importance; perhaps it may be of advantage to the life of the hot igniting tube. For mixture of gas and air (which is about 1 part gas to 9 of air) I would have reference to the work, "Gas and Petroleum Engines," advertised in this paper, page 9, May 15, 1891; or "The Gas Engine," by D. Clark (Longmans, Green and Co.) Jock.

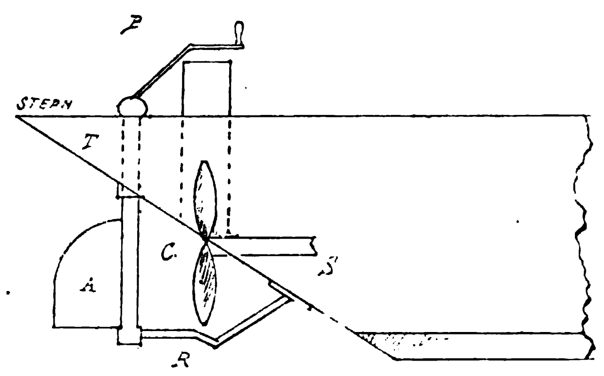
[75227.]—**Gas Fires.**—In reply to "Gloster" (No. 1380, Sept. 4), I have had very satisfactory experience of the convenience and healthiness of one particular form of gas-fires, made by Chas. Wilson and Son, of Leeds, having used them for some years in drawing-room, dining-room, bed, bath, and dressing-rooms with the greatest comfort. These fires are constructed of a deeply-corrugated back, composed of some compound of fireclay and asbestos, I believe, and have ornamental bars of some compound of iron, with from three to six Bunsen burners at bottom. When lit, the back and bars of the stove become incandescent after about 10 to 15 minutes, and the heat is radiated therefrom well across the room. These gas-fires must be fixed in front of the ordinary fireplace, with their flues to carry off the products of combustion well into the chimneys, and though not absolutely necessary, I find it preferable to have the opening into the chimney closed by a sheet of iron, through a suitable hole in which the flue is made to pass. This gives better ventilation than when the space around the flue is left open, and there is less waste of heat. No gas fire without a ventilating flue is fit to be used for bed or sitting-rooms. These of Wilson's are made in numerous forms to suit the different kinds of rooms to be warmed. For the small room you specify I can strongly recommend the form I have in my dressing-room—a "three-burner Parisian" stove with duplex arrangement for the burners—to enable the room to be kept warm with but one burner in action after the temperature has been raised to a comfortable heat, say 60° or 65°, rapidly, but the use of the three burners at first. During the whole of last winter I never had my dressing-room otherwise than quite comfortable immediately after getting out of bed, after lighting it about fifteen minutes before quitting same.

Gamma Sigma.

[75234.]—**L. and N.W. Locomotives.**—No. 3092, to which I suppose "Draughtsman" refers, is not a new engine, but one of the old outside-cylinder, Metropolitan tanks, rebuilt, and converted into a ten-wheeled engine. She is, I believe, at present the only one of her class.

North-Western.

[75256.]—**River Punt.**—A nice width for your punt would be 4ft. to 4½ft., and depth of side plank 2½ft. or 2ft. Punt runs down in a slope both ends, and I should think, with care and proper structure, you could put in a launch engine. You did not state in your query the width of the launch engine, and if very large would not suit the width I stated. A small "Kingdon" engine would suit you admirably. My sketch shows the sort of thing I should imitate if I were building one. B is a cutting away or box for your screw to revolve in, C is the screw, and S the shaft; T is the stern of the punt, and is the same both ends, A rudder, R rudder holder. Of course, you would have to be careful into what depth of water you went. I believe a few numbers back there was an explanation of an electric punt in the "E.M.," but I do not remember which one. I should put your boiler as near the middle as you can, or right in the centre of the punt. C. G. M. Bennett.



[75257.]—**Electrical.**—I should remove the brass rods from top of frame, and make a separate conductor. This may be a brass tube 3½in. diameter, 14in. long, and closed at the ends with hemispherical caps. It should be mounted on a cylindrical glass pillar 1in. in diameter, and furnished with a wooden foot. When this conductor is well charged, the terminal ball should give a 3in. spark, or thereabouts. To make the amalgam melt together one part of tin, two parts zinc, and add six parts of mercury. Stannic sulphide or mosaic gold is, in my opinion, a better dressing for the rubber. The bottles containing brass turnings are primitive Leyden jars. J. T. M.

[75264.]—**Yeast.**—There is no line of demarcation sufficiently well marked to enable us to say definitely whether amongst the lower kinds of organisms this or that belongs to the animal or vegetable kingdom; but in spite of what "Vita" says, yeast will be considered as a vegetable until something better than his mere "ipse dixit" is forthcoming. To call the yeast cell an animalcule is simply to play with terms, and to assume an amount of knowledge which is certainly not possessed by even the most distinguished biologists. "Vita" may know more than Cohn or Huxley, or any other of the students (real "students," it should be noted), but I think it will puzzle him to prove the yeast plant to be an animal.

Mag. est Ver.

[75265.]—**Piano Pedals.**—As you wish to slide these underneath piano, you could not do better than get one of Nuttall's patent pedal actions. By a very simple and ingenious arrangement they are made to fold up when not in use underneath the keyboard. The seat is also attached to pedal-board, and can be raised or lowered at will; also can be detached from piano without any trouble whatever. I believe there is also a pedal arrangement with independent notes; but if your instrument is seven octave, I don't see the necessity of this.

Stubbins, near Manchester. Schofield.

[75265.]—**Piano Pedals.**—If the Editor is willing, I will send a most successful plan of doing what is required by the querist. The lowest cost for a proper pedal action for pianofortes would be £2 10s. This would comprise first-class birch pedal-board and necessary attachments to keys. If the piano is too harsh, get a practical pianoforte tuner to tone it down for you. The hammers may require to be re-covered with new felt. After this is done, any practical man would be willing to tone it down for you at a reasonable cost.

Practical Organ Builder.

[75265.]—**Piano Pedals.**—The querist, if he cannot refer to back numbers, should procure Rushton's specification of his patent, or, better still, see pedals actually applied to a piano. What he means by "their tone being different to the piano" I do not know, and cannot guess, as pedals would presumably act on the same strings as the piano keys themselves, and if the bass notes are a little "harsh" in the piano the mere application of pedals would not soften them. What does "Pedals" mean by saying he should like the pedals to "speak independent of the piano"? Such a query is a query that takes the form of a puzzle. P. F.

[75268.]—**Inertia.**—This same question was discussed in these columns some years ago; but, to my mind, a complete reply was not given. One correspondent maintained that recoil was the cause of the opposite motion. Recoil there is, it is true, but it will be found on careful experiment, to be only a small factor in this case, resulting from the springs and the structure of the carriage as a whole. But the chief cause is the inclination from the vertical that a person takes, when standing at the time of stopping of a train, so as to maintain his equilibrium in opposition to the retarding effect the brakes have on his motion of translation, together with the train. To make it clear, suppose a train moving quickly, but uniformly, along, a person standing feels no inconvenience, but stands upright, but when the brakes are gradually applied, he unconsciously takes a position inclined to the vertical, some 10 or 20 degrees to his former and upright position, and retains this, more or less, according to the effectiveness of the brakes, which generally is greatest just before the actual stop, and, of course, when this does occur, he immediately falls in the direction of his inclination, and instinctively puts out his hand to guard himself, the translational motion being at this instant entirely absorbed by the brakes.

Walton-road, Liverpool. G. Whittle.

[75269.]—**Harmonium.**—If the harmonium is "too heavy" in the bass, the Sourdine stop must be used, or the bass half must be muffled by means of a board covered with swansdown, placed just above the pallets of the bass. Organon.

[75269.]—**Harmonium.**—This defect can be remedied by reducing the amount of wind admitted into the bass register, similar to the plan adopted in the construction of the Sourdine stop, or otherwise to voice the reeds to suit the person who requires the softening of the bass register. Another plan would be to place a piece of thick felt over the bass pallets, and "smother the baby," as it is sometimes termed. Practical Organ Builder.

[75269.]—**Harmonium.**—It would have been easier to reply to your query if you had given specification. I suppose it is a two-row 16ft. and 8ft. You can replace the bass reeds with American harmonium reeds, which are much lighter. Perhaps the treble reeds are too much smothered with cotton wad, or something similar. An octave-coupler would be a great improvement, and could be actuated by knee-lever or stops.

Stubbins, near Manchester. Schofield.

[75270.]—**Dynamo.**—To Mr. Bottone.—A Simplex type dynamo, with armature 5in. dia. by 2in. deep, wound with 3lb. No. 20, would need on the field-magnet core, to balance the armature and properly excite the field, 8lb. of No. 22 if shunt connected, or 5lb. No. 15 if series connected. The E.M.F., if driven at about 2,000 revs. per minute, would in either case be about 50 volts, and it would probably feed four or five lamps of 48 volts, 16c.p., each taking about 1 ampère. S. Bottone.

[75273.]—**American Organ.**—Probably caused by some defect in the tubeboard, but could not pass a correct opinion without examination of the organ. Sorry I cannot help you in this case. If the fault is not in the reeds, it stands to reason that it must be the fault of the tubeboard.

Practical Organ Builder.

[75273.]—**American Organ.**—See that the dumb reeds fit well in the tubes. There should be no leakage in the tube or underneath the front between the felt and reeds. If this fails to make the dumb speak, examine the tongues, and if too thick (which is probably the case), file them down, and also see that tongue is clear of slot in block.

Stubbins, near Manchester. Schofield.

[75273.]—**American Organ.**—This query is quite incomprehensible as stated. Some reeds won't speak when in their proper places, and yet reeds an octave lower speak right enough when placed in the others' cavities, and the speechless reeds speak also when placed in another row. No wonder "Spring" is puzzled: he must get an expert to examine the instrument. Perhaps the Mahatmas are "having a lark" with it.

Organon.

[75275.]—**Output of Dynamo.**—To Mr. S. Bottone.—If circle-made, probably about 50 volts, 4 or 5 ampères, at 1,800 to 2,000 revs. per minute. See also reply 75270, which refers to a very similar dynamo. S. Bottone.

[75276.]—**Carbonising Wool.**—I am sorry I cannot answer with any definiteness the inquiries of "Fibre"; but I think there is a book on "Wool and Wool-Stapling," by Mr. McLaren, published in Cassell's series of Technological Handbooks, which might be of use to him. As to the chloride of aluminium, no doubt Mr. Blackwell, of Liverpool, who advertises in this paper, could supply it in quantity, as could, I suppose, the various chemical works in Lancashire. There was a very good form of drying-closet illustrated not long ago in connection with some notes on laundry work; but any chamber through which warm, dry air can be passed will do.

Nun. Dor.

[75277.]—**Iodine.**—(1) It is very questionable if iodine can exist, under the circumstances described, in the free state. You might be able to liberate it by the careful addition of chlorine water, and remove by agitation with ether. (2) Get Winter Blythe's "Poisons." Sm.

[75281.]—**Object-Glass.**—The rule is in every case, that side of the object glass at which most flare is seen is "too far" from the eyepiece.

T. R. Clapham.

[75282.]—**Oars.**—Hand band-saws are made by the Britannia Co., and by Hindley. The latter maker's are more portable, as they can be fixed to the bench when wanted, and moved away when out of use. Made in two sizes, £6 and £7 10s., exclusive of fly-wheel and handle. Amateur.

[75283.]—**Case-Hardening.**—A simple and expeditious method of case-hardening small articles is as follows:—The article to be case-hardened should be first polished. Raise it to a red heat, and sprinkle it with finely-powdered prussiate of potash, which will be decomposed with the heat. When the potash has all disappeared, the article should be plunged into cold water and quenched.

Stud.Inst.C.E.

[75283.]—**Case-Hardening.**—I gave full directions for this process, suitable for small articles, as described by "Back Centre" some months ago in these columns. I may add bone-dust may be purchased at any manufacturers of buttons or any bone articles. The sawings are best, and be particular not to use all new dust, but half and half, as directed.

R. G. Mason, Manufacturing Optician.

69, Park-road, Clapham, S.W.

[75284.]—**Shunt.**—If the accumulator cells are in good working order, and the E.M.F. of the dynamo not much greater than 10 per cent. over that of the accumulators to be charged, there is no necessity to use a resistance; but if the cells are much run down, or if the E.M.F. of dynamo is greatly in excess of the above limit, it will be well to place a resistance-board in circuit, with some lead from the dynamo; the resistance must be reduced as the cells charge. If you don't cut the series well out of circuit when charging, the accumulator, when charged to a certain point, drives its current round the series coils, and thus reverses the polarity of the dynamo. This cannot occur when the shunt coils alone are in circuit.

S. Bottone.

[75285.]—**Glass Painting.**—It does not pay to prepare the colours for this on a small scale. They can be bought for experimental or amateur work from any of the dealers in artists' materials, or in larger quantities from Hancocks, of Worcester, who supply the trade with colours for both china and glass painting. 999.

[75286.]—**Heliograph.**—Full description of this instrument, and method of working, will be found in a little book on "Army Signalling," procurable from any army bookseller, and costing 1s.

T. R. Clapham.

[75287.]—**Unfermented Wine.**—Some time ago I examined several specimens of so-called unfermented wine. They all contained alcohol, and were simply mixtures, coloured and flavoured. I would strongly advise you not to imbibe solutions of antiseptics. Sm.

[75287.]—**Unfermented Wine.**—The powder mentioned by "Colonist" was probably either salicylic acid, or boracic acid, or boric acid, as he puts it, with "glycose" also for glucose. Unfermented "wine" is a misnomer; it may be a fruit juice, or a fruit syrup, but "wine" is a term which implies fermentation. Walker says "preparations of vegetables by fermentation, called by the general name of wines." I should think "Colonist" could preserve his "unfermented wines" in much the same way as the confectioner makes jam or jelly, and could then dilute with water, as required. I have reasons, however, for thinking that it is salicylic acid that is used for preserving fruit juice, or whatever it is that is called "unfermented wine." Nemo.

[75288.]—**Dry Battery.**—To Mr. Bottone.—Make your zinc outer case of the size and shape you desire. Procure a carbon block a little longer than the case, and of such a size to leave a good ¼in. space all round between zinc and carbon. Now make a pretty thick cream of plaster of Paris, to which add about $\frac{1}{10}$th of a mixture of finely-powdered salammoniac and sulphate of zinc, in equal quantities. Coat the inside and bottom of the zinc cell, to the depth of about ¼in., with this paste. When nearly set, place the carbon rod in the centre, and pack round with a mixture of coarsely-powdered black oxide of manganese 5 parts, graphite 90 parts, salammoniac 10 parts, and enough water to render the whole as pasty as fresh mortar. Do not allow either the plaster of Paris or this mixture to come quite to the top of the cell; leave about ¼in. all round, wipe the zinc dry, and close the cell by pouring in melted pitch right up to the top. Attach terminals to both zinc and carbon. S. Bottone.

[75289.]—**Electrical.**—There is no sense in the question, as the conductor would carry off the charge from the drop of water. Sm.

[75291.]—**Dissolving Elements.**—You cannot dissolve anything by the application of heat. The melting points of the metals may be found in most textbooks on chemistry. Sm.

[75291.]—**Dissolving Elements, &c.**—The querist can find all the information asked for in any elementary work on chemistry, or, say, in Miller's "Inorganic" volume. What he means by the "degree of heat," or "electric force," passes the comprehension of ordinary mortals. However, he will find what he appears to want in most of the textbooks. What does he mean by "other chemicals"? Few people call gold and silver "chemicals," and nobody wants to render them "gaseous," which "Ra-Osiris" will find it very difficult to do. Will he elucidate? Nun. Dor.

[75294.]—**Red Colour for Oil.**—Soluble red colours as a rule are not very permanent. Your query can only be answered by experiment, as I am not acquainted with the solvent power of oil on such matters. If rosin be soluble in oil, it would be a good one to try first. Sm.

[75294.]—**Red Colour for Oil.**—An extremely beautiful and fairly durable colour can be given to oil by the addition of a small quantity of the "oil-soluble" variety of the aniline dye known as eosine.

P. W. Stanley, Analytical Chemist.

5, Billson-street, Poplar, London.

[75297.]—**Dynamo.**—To Mr. Bottone or Mr. Askew.—Presuming that the machine is properly wound, no false coils in armature, and the brushes at the right position (this makes a vast difference), the probabilities are that the magnetic field is not sufficiently intense; not from a want of ampère turns in the field-magnet coils, but from a peculiarity in small machines, that a large current of few turns seems to excite them better than a smaller current of many turns. Compound wind the field-magnet with about 1lb. of No. 16 and see what that does. You do not state the length of your armature. With a Siemens H armature 2in. diameter, 6in. long, wound with ½lb. No. 18, equal to about 22½ yards, I can get easily 30 volts at 3,000revs. So with 50 yards on a 2¼ armature you should certainly get 30 volts at a lower speed.

S. Bottone.

[75301.]—**Gilding Steel.**—First coat with copper and then with gold, by electro-deposition.

Sm.

[75301.]—**Gilding Steel.**—This is not a job worth troubling yourself about doing while there are so many places where you can get it done at a much less cost than you could make up a solution for. The cost for brassing would be very little, and if lacquered after, would look very well for a time; if gilt it would cost considerably more, but would look very much better. There are gold (?) paints which would look very much like brass if painted on, and, when thoroughly dry, burnished.

S. Robert Bonney, Electro-plater, &c.

[75303.]—**Small Electro-Motor.**—You will find full directions, with sketch, for making such a motor in the series of articles I supplied to the "E. M." some time back, p. 472, Vol. XLVIII.; also at p. 468, Vol. LI. If you cannot refer to these, you will find the description and cuts of a similar machine in my book on "Electro-Motors." See my advertisement in Sale Column.

S. Bottone.

[75304.]—**Locomotive Query.**—The pressure of steam on the G.N. "singles" is 140lb. per square inch. Worsdell's "compounds" are built to work at 200lb., but in actual practice 175lb. is never exceeded. On the West Coast, F. W. Webb's "compounds" work at 175lb. per square inch, and the Caledonian engines at 150lb.

Battersea. H. W. Armstrong.

[75304.]—**Locomotive.**—On the L. and N.W. Scotch expresses the engines carry 175lb. per sq.in.; on the G.N. the engines carry 140lb. per sq.in.; north of Carlisle, on the West Coast route, the pressure varies between 140 and 150lb. per sq.in., according to the class of engine used. For the same reason the pressure carried by the engines on the East Coast route north of York, and as far as Edinburgh, varies between 170 and 175lb. per sq.in.—mostly the latter pressure.

North-Western.

[75305.]—**Electric Bell to Clock.**—Place a metallic arm on the arbor of the hour-hand, which makes contact at the desired time by rubbing against a bit of watch-spring attached to the wooden case; join wires to spring and to framework of clock.

Sm.

[75305.]—**Electric Bell to Clock.**—You have connected-up your clock all right; but I infer, from your query, you have wound the alarum as well as the going train, which causes the hammer to vibrate. Do not wind the alarum. Get a small spiral spring, connect one end to the hammer, and the other to a small screw fixed in back of the clock, which will pull the hammer in contact with the bell, and so complete the circuit. Scrape the parts bright where the hammer and bell make contact; or better, solder a piece of platinum or silver on each. You can easily make the alarum to ring at any given time by setting the brass disc which is on the face of the clock. Waterloo.

[75305.]—**Electric Bell to Clock.**—Take away the gong, and in its place put an ordinary contact pillar. Then fix a very thin strip of brass so that the weight of the hammer will make contact with the contact-pillar. You will perhaps find that both spring and contact-pillar want to be quite close to the hammer, but must be far enough away to make and break the contact. Next join your two wires, one to each contact-pillar and spring. Now if your contact-pillar and spring is platinum-tipped at the point they engage, there is no reason why you should not succeed. The main point is you must not wind up the alarm, for you will find it will work by itself. Now set your alarm to go off as if you had done nothing to it.

R. Claridge.

[75305.]—**Electric Bell to Clock.**—I have a bell of my own working from a wooden-case alarm clock (not a continuous ringing bell), connected as follows:—I have joined one wire to one of the small screws which holds the clockwork to the wooden case; then I thrusted a brass screw through the back of the clock (the wooden case), which, when the alarm is at rest, and the spring full open, makes a good contact with the alarm spring. The other wire is fastened to this screw. I have also placed in a convenient place in the circuit a one-way switch. When I go to bed at night, I adjust the alarm dial to go off at the time I want to get up in the morning; I then put on the switch. The bell rings until I have wound up the alarm, so that the contact is broken between the screw and the spring of the alarm. I then let it stand. I do not wind the alarm to the top, only until the bell stops ringing. In the morning, the alarm goes off at the adjusted time, and directly the spring comes in contact with the brass screw the bell rings continually until I come down and move the switch. The bell, a 2½in. gong, worked by two Leclanché cells, is fixed close to the bed, and the clock in the bottom floor kitchen. This is very simple and efficient.

A Colliery Electrician.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

7613. Microscope Objective, p. 438.
7614. Loco. Spring Buffers, 438.
7615. Mining Engineering, 438.
[illegible] Cotton Weft, 438.
7652. Galvanometer.—To "M. H. W. L.," 439.
7655. Thames Steamboats, 439.

[illegible] Turning Eccentrics, p. 534.
[illegible] Dynamo, 534.

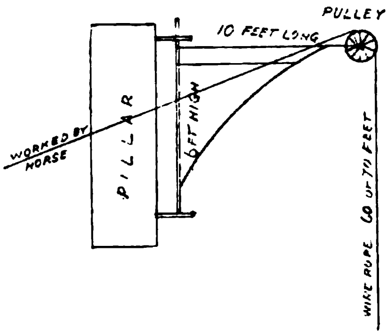
At a recent meeting of the Paris Academy of Sciences, M. Pasquelin exhibited a new blowpipe of a single tube, connected by an indiarubber tube with a carburator. A cylinder of wire gauze prevents the flame from reaching the carburator. The air of a bellows, regulated by stop-cocks, feeds the flame, part of it going through the carburator, which contains a mineral essence. The maximum heat of the flame is obtained when it is of an indigo blue colour, showing a complete combustion of the carbon, and its temperature is then sufficient to fuse platinum, that is to say, 1,800° Centigrade.

Buried Alive.—A Paris correspondent of the *Lancet* writes:—A very remarkable story is related from Saint Crépin, near Rodez. At the funeral of an old man of seventy, who died the day before, the four men who carried the coffin from the church to the cemetery hard by became conscious of what they believed to be movements inside the coffin. Nothing was said at the time; but when the ceremony was terminated they compared notes, and each one was astonished to learn that his companions felt similar sensations. They communicated their fears to the clergyman, who immediately went to the graveyard and hal the coffin broken open. They were greatly taken aback when they saw the hands of the departed, which had been crossed on the chest, raised towards the eyes; but it occurred to them that this might very well have happened by accident. They, however, removed the body out of the coffin, and although they spoke to it, it did not reply, yet it swallowed some cordial which was administered. The swallowing also might have been more apparent than real, but the strangest part of this strange story is that the body was taken back to the house, and it is said that the measures adopted to restore animation and life were successful, for the next day the lately deceased was undoubtedly living once more, for he spoke and drank fluid nourishment, and is now said, although extremely feeble, to be slowly recovering. The foregoing story, which is going the round of the lay and medical press, is about as extraordinary as it is unreasonable.

QUERIES.

[75306.]—**Musical-Box.**—I have a musical-box of the old-fashioned sort—i.e., with pins on a cylinder, and playing eight tunes. Several of the pins have broken off by rust or otherwise, and I should be glad of instruction as to how to proceed to fit a new tune or tunes to it. The barrel advances ⅜in. lengthwise during its eight revolutions, and then slips back to original position. Help as to how to insert new pins, and the usual way to find the exact position of each, will much oblige.—W. A. B.

[75307.]—**Size of Bars for a Crane.**—What size of iron bars are necessary for a crane to lift from 5cwt. to 7cwt. of stone or gravel, &c.? Is wire rope or chain the best and cheapest? Also is a stone or concrete pillar the best? I want to erect one on the top of a cliff 60ft. or 70ft. high. I would use no windlass, but a horse, for lifting loads. Would I get crane cheaper in a foundry than by having it made to order?—Sea-side Farmer.



[75308.]—**Wood Vats.**—I have bought several large ones, old, but sound, and well bolted together; bottom boards are very open at joints, which are not tongued. Can I cement between joins whilst dry to make water-tight? Bottoms appear simply nailed on with long nails; but perhaps some kind of waterproof glue or cement was used in addition. Shall have to put new bottom to one. Any hints thankfully received.—S. J. B.

[75309.]—**Sparking Dynamo.**—To Mr. Bottone.—I have a shunt-wound Manchester dynamo, having a normal output of 50 volts 10 ampères at 1,800 revs. per minute. The armature is 7in. diameter, 4in. deep, built up of cog-rings wound with 6½lb. No. 16 in sixteen coils; wrought-iron field-magnet cores 7⅛in. high, 3⅛in. diam., wound with 24lb. No. 20; massive cast-iron pole-pieces; commutator sixteen sections hard copper, well insulated. I have nine or ten 3.-volt 10c.p. lamps arranged in parallel. The brushes spark a great deal, and wear down the commutator very badly. Can you kindly suggest a remedy? I may mention that I have tried both copper gauze and stencil-plate copper brushes, and have arranged them so as to short-circuit two segments of commutator; also have altered the angle of lead to every point, but without avail. The dynamo in every other respect is perfect, and lights the lamps splendidly.—Tyro.

[75310.]—**E.P.S. Storage Cells.**—Will any fellow-reader please help me in the following? I have charge of several sets of L. 15 type cells—1888 type—and though they have been in use only about two years, they seem to have lost their capacity; they will not give out more than half the current put into them. Is this due to sulphating? What is the remedy?—Perplexed.

[75311.]—**Arc Lamps**—To Mr. Allsop or Others.—Having to fix two arc lamps lately for temporary use—distance from dynamo about 500 yards—and not having sufficient insulating material at hand, we ran nearly all iron wire (No. 12 galvanised) on insulators, but could not get sufficient current to burn lamps properly, and ammeter would not register a single point, although engine was racing as though it had nothing to do. I may say the ammeter registered and lamps burned well when connected up close to dynamo; also that it was very damp and wet nearly the whole time we were running to distant lamps. The capacity of dynamo is 65 volts 15 ampères, and of the Crompton type. If you will kindly state probable cause of failure I should be obliged.—Perplexed.

[75312.]—**Screw-cutting.**—Will some of our readers kindly inform me how to get the proper depth of a V-thread? I have got a spindle ⅞in. in diameter, with a pitch of 20 threads per inch to fit a plate to. What would be the proper size to bore the hole before cutting the inside thread? Can it be got by decimal fractions?—Novice.

[75313.]—**Dynamo.**—In calculating the length of wire for Siemens drum armature, do we reckon one volt per yard? Mr. Bottone's answer to my former query gives 4lb. No. 14 for 60 volts; this is nearly the whole length of wire. As it is a split current, does it not require twice the length of wire—viz., 8lb. on armature, and should like to learn proper way to calculate wire for any output.—Magneto.

[75314.]—**Stretching Old Parchment.**—Will someone put me in the way of stretching and mounting (for framing and glazing) 100-year-old parchments, which are stiff, dirty, and creased by being folded? I should prefer not to stick them down to a stiff back board or card, but only pin them (drawing pins). I should be glad to know how they may be cleaned without damage to the writing.—Old Parchment.

[75315.]—**Small Self-Starting Electro-Motor.**—Will Mr. Bottone be kind enough to give sketch of small self-starting electro-motor to go with one Leclanché cell or bichromatic cell, and say size of wire required.—A Scotch Reader.

[75316.]—**S.E.R. Loco. "Onward."**—Will some of your readers kindly oblige me with dimensions and sketch (engine and tender) of this fine locomotive which was exhibited some time back at the Paris Exhibition.—H. O.

[75317.]—**Harvest Moon.**—May I ask some of our astronomical friends to explain, by means of diagram, the position to each other of the sun, earth, and moon at the time of harvest moon. What I should like is a diagram showing the position of the moon's orbit around the earth as compared with the Ecliptic, and the position of the moon in its orbit as compared with the position of the sun in the Ecliptic at the time of harvest moon.—Dan B. Garside.

[75318.]—**Raising Water.**—I am desirous of supplying a farmyard with water from a pond situate at a distance of 100 yards from, and 40ft. below, the farmyard level. Is it possible to do so by using a water-wheel on the shaft of which is an eccentric to work a force-pump about 1½in. ram? I have sufficient fall from the pond to work wheel, but don't know what kind nor size to use. Would one something like the paddle-wheel of a steamer do? Perhaps "Vulcan" or "Nun. Dor." or some other kind correspondent will assist.—Waterloo.

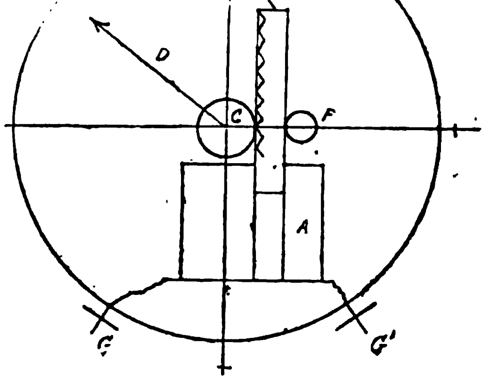
[75319.]—**Motion.**—Given a plane; a cannon shoots a ball along the plane at any speed horizontally, say at 6ft. from ground. At same instant a ball of equal weight is released and falls to earth (6ft.) Will both balls reach the earth at same instant?—A. Ashworth.

[75320.]—**Geographical Tables.**—I want a table showing the actual distances in geographical miles from the Equator (on a meridian) to each degree of latitude, as per normals to the ellipsoid figure of the meridian; or, and if possible also, the normal angle (latitude) for each 60 miles from equator, the latter preferred. Will any of your talented correspondents inform me where I can find same, or otherwise assist me? No doubt our esteemed friend, "F.R.A.S.," will oblige, if it is not troubling him too much.—Geo. Collins.

[75321.]—**Turbine.**—I have a Blackman air propeller 48in. diameter, and want to erect a small turbine to drive same. I have a fair supply of water with 12ft. fall. Will any reader kindly inform me (from experience) what class of turbine I could gain the greatest amount of effect from a given amount of power employed? Also the probable cost and size I will require. Please say if a de-description and drawings and comparative usefulness of the "Hercules" turbine have been published in "Ours."—Aqua.

[75322.]—**Electrical.**—Will some correspondent kindly inform me what would be the current in a 5H.P. shunt-wound motor, with a resistance in the armature from brush to brush of 0·18 ohm, and the resistance in the shunt coils 7 ohms? I require the current running with load, and without load; also current in the shunt coils. The motor will receive energy from 50 E.P.S. cells, and will run at 800 revs. What would be the current in motor when it is standing still?—D. Lowdon.

[75323.]—**To Mr. Bottone.**—I want to make a voltmeter to indicate to 80 volts, also an ampère-meter to indicate to 20 ampères. Will you please say if the accompanying sketch is suitable? A is a sucking solenoid; B is a soft iron core, having a rack face; this rack engages into a pinion C; this pinion carries a pointer, D, which moves round the dial according as the iron core B is drawn in or out; E is a light spiral spring of sufficient strength to suspend B and return it to its normal position when current is shut off from A; F is a friction roller to keep B in its place. If you think it suitable for both meters, will you kindly give the following?—Diameter and length of A, amount and size of German-silver s.c.c. wire in the one instance, and c.c. copper in the other; length and diameter of B, and approximate travel of B in either case. I should prefer to use multiple fine wire in the ampère-meter, if possible, instead of one heavy wire. G and G' are terminals.—Metres.



[75324.]—**Camera.**—Can any of ours give me a simple and efficient way of making a dark slide for small detective camera? Dimensions are length: 5⅞in. by 3⅝in.; depth, 2⅛in. I want to expose half-a-dozen plates of as large size as possible, if not too small.—Detective.

[75325.]—**Magnetic Polarity.**—Thanks to Mr. Bottone. May I trouble him a little more? I have experienced the value of electricity (using an induction coil) in dyspepsia, sluggishness of the liver, and severe congestion caused by cold. I have an opinion that a stream of electricity so mild that one could scarcely feel it, continued for six or eight hours a day, would be likely to do much good in debility, loss of vitality, or sluggishness of any organ of the body, which I think is a state of partial paralysis. If a voltaic pile, say 1ft. long, was placed across the back with wires for each end element, ending in metal terminals 2in. or so in diameter, these terminals lying on each side the abdomen, and about 7in. or 8in. from each other. If the pile is powerful enough to generate a current that would just overcome the resistance of the skin, and pass under it on its way to the other terminal, I think the system would absorb as much of the current as it had need of and receive great benefit from it. Will Mr. Bottone kindly inform me what the diameter of the zincs and coppers should be to generate a current of such strength, and I shall be glad to have the opinion of any gentleman on the therapeutical properties of such an appliance. The method is analogous to that of electroplating (which only requires a current of low intensity continued for a sufficient length of time) applied to the body, and less troublesome than the battery and coil, and, owing to the low intensity, could be used for a much longer time.—EVIL.

[75326.]—**Battery.**—I have a chloride of zinc battery consisting of six stoneware cells of 3-pint capacity. Could you please inform me how much it would cost to charge the same six cells? How long would it last, and what power lamp could I use, and should the zincs be removed when the battery is not in use? Also the proportions of chromic-acid, hydrochloric acid, and water, to be used in the outer cell. I understand for the porous pots chloride of zinc must be used with water. Any advice would be gladly welcomed by—AN AMATEUR.

[75327.]—**Metal Patterns.** — Will some of our readers kindly tell me what metals and what quantities to melt together to make small patterns that could be bent after being cast? I have a pattern to make triangle shape, about 12in. and ½in. thick, one side tapered gradually to one point to quite an edge. I want it to bend without cracking about ½in. or ¾in. out of level. I have been making out with lead patterns, but find after I have got them the right bevel they will ram out of shape in sand. Have heard block-tin and lead will do.—PATTERN, Norfolk.

[75328.]—**Midland Locos.** — Will Mr. Stretton kindly say whether the loco. No. 1870, which is said to be the largest single inside driver on the narrow gauge, has been put into regular work, and if so, on what link?—H.

[75329.]—**Dental Composition.**—Can any of "ours" oblige by giving the formula for making the composition used by dentists for taking impressions? It softens on being steeped in hot water, and sets almost immediately in cold. I believe it is called "stents" or "stentz."—F. B.

[75330.]—**Electrical.**—Will any reader please say what gauge wire, iron and copper, will safely carry 20 ampères of current?—also what length will each require to be to have a resistance of one-tenth of an ohm? In graduating the dial of a 50-volt voltmeter by means of chromic-acid cells, which would be best to do—short-circuit the cells, or place a resistance (equal to the internal resistance of the cells) in the circuit, the voltmeter being coupled in shunt with the cells? What is about the inter. resis of a half-pint single-fluid chromic-acid cell?—WIRE.

[75331.]—**Wall Diagrams.**—Can any reader oblige with recipes for making inks suitable for stencilling the above in black, red, and blue? I have tried rubbing up lampblack with glue size for black, but it makes an ugly mess.—J. F.

[75332.] — **Dyeing Grass.** — Would some experienced dyer kindly say how to prepare an alkali as a mordant, or to attract the dye for grass dyeing to obtain a bright scarlet and other bright colours?—A DEALER IN GRASS BOUQUETS.

[75333.]—**Fishing Nets.**—Will some one kindly inform me what material is used to prevent the injurious action of sea water upon cotton fishing nets?—J. TURNER.

[75334.]—**To Mr. Bottone or Mr. Askew.**—I have a permanent magnet 8in. by 1in. by 1in. and 4oz. of silk-covered copper wire, B.W.G. 36. and I wish to make a shocking machine. Will you kindly give me following dimensions? Length and diam. of cores, thickness and diam. of the discs of iron of the revolving armature, and would an ordinary 2-split commutator do in order to give shocks.—S. M. O. B.

[75335.]—**Polishing Bosses of Wood Rollers**—Having tried various kinds of shellac varnish and polishes for polishing the bosses of wood rollers, and failed to get that gloss and body required, I should be glad if some of your readers would kindly inform me through your paper the best varnish or polish for that purpose—how to make and apply the same for the purpose mentioned.—ENQUIRER.

[75336.]—**Engine.**—I have a horizontal engine with two double-actioned oscillating cylinders (1in. bore, 2in. stroke), but which has no flywheel. Will anyone tell me what sized wheel to put on, and also what sized boiler would work it (with paraffin oil if possible)?—F. T. C.

[75337.]—**To Mr. Bottone.**—I have recently constructed a Siemens H dynamo laminated armature, 3½in. long by 1⅝in diam., wound with 5oz. of No. 20 d.s.c. wire, worked in field-magnets 6in. high, 4in. wide, and ⅛in. thick, wound with 5lb. of No. 20 c.c. in shunt, with the brushes driven by hand-wheel, 15in. diam., on a small pulley at about 2,500 revs. per minute. I have carefully insulated every part, and magnetised with six chromic-acid cells, but I cannot get but very little current. Will you kindly tell me if this should magnetise steel instead of battery, and why I do not get a strong current? The brushes are properly adjusted, and the commutator runs perfectly true. The armature runs 1-32in. clear of the channel. I have taken the above dynamo, amounts of wire, &c., from an answer for "Class Demonstration" in Vol. XLVIII. No. 1227, and one of your books. If you can show me the fault I shall be much obliged.—E. J. W.

[75338.] — **Astronomical.** — Will "F.R.A.S.," or any other astronomical reader of the "E. M." be so kind as to give me the exact place of heliocentric long. and lat. of the planets at perihelion, also their greatest and least distance from the sun, the earth's mean distance taken as 10,000. For example, Venus ·03870981 at mean distance, that is, to seven places of decimals. I should like them to as many decimals, or more if it is necessary. I have not seen them in any work on astronomy to exceed three places of decimals.—T. MOOR.

[75339.]—**Four-leaved Clover.**—I have hitherto been under the impression that a clover-leaf with four lobes was such a rarity (if not actually a myth), that an old superstition connected luck with the finder thereof, and I have often for the sake of curiosity, searched for, but never found it. Last week, however, out of a quantity of white clover in flower, I picked two or three leaves with four lobes each, and one with five. Will any of "ours" say if these are curiosities?—B. H.

[75340.]—**Chemical.**—What volume or quantity measured in pints of carbonic-acid gas can be evolved from 1oz. avoirdupois of bicarbonate of soda when the bar. stands at 30° and ther. 60° Fah., and what amount of tartaric acid and water is necessary to liberate all the carbonic-acid gas?—NOVICE.

[75341.]—**Battery for Incandescing Wire.**—Thanks to those kind correspondents who answered this query. Will Mr. Bottone kindly inform me if the way described is the best way of doing it electrically? Would a dynamo be better? If so, could he refer me to any back number in which such a one is described, or oblige by describing one? I have searched the back numbers to the commencement, and they are now becoming a pretty big pile, but have not found anything I thought suitable. —CRUCIBLE.

[75342.]—**Phosphor Bronze.**—Would some practical brassfounder kindly give instructions for the production of phosphor bronze? The difficulty to me appears to be chiefly owing to the highly-inflammable nature of the phosphorus.—D. W. B.

[75343.]—**Induction Coil.**—I am about to construct an induction coil, using as secondary 2lb. of No. 38. Now would one of "ours" be kind enough to let me know what should be the length and diameter of core, number of wire for primary, and in how many layers, and what would be the best kind of battery to use to get the full effects, or how many No. 3 Leclanché cells should I require, and what should be the best size for condenser?—B. W. B.

[75344.] — **Electrical.** —Is four layers of No. 16 cotton-covered wire too much for primary? Secondary only 6oz. s.c. Would Mr. Bottone be kind enough to answer?—W. B.

[75345.]—**Hydraulics.**—Will some reader of "Ours" well versed in hydraulics give me some assistance? I want to know what power would be obtained with a supply of one thousand miner's inches of water with a fall of 415ft., and what fall would be necessary, with the same amount of water, to obtain 1,000H.P.? Also what diameter pipe would be required to convey this power? What quantity of water per twenty-four hours is represented by a miner's inch? I believe it is that quantity which will flow through an opening 1in. square under a pressure of 6in. I should like to know if this is correct, and should also like to know the quantity, as I read that a certain channel is carrying 127,000 miner's inches, and a certain piece of machinery was pumping out 2,000in. I should also like to have a description, and, if possible, a sketch, of the hydraulic elevator used in the United States in hydraulic mining.—X.

[75346.]—**Engine for Lift.**—What power steam-engine shall I require to pull up 3cwt. in a lift through 45ft. in twenty seconds? The lift is geared down 1 to 5, the cog-wheels are 18 to 90; so that it requires to pull 5ft. to move the lift 1ft. Please state size of pulley on lift and engine, also size of the cylinder; the boiler-pressure will be 60lb. per square inch.—LIFTMAN.

[75347.]—**Patent Resonating Gongs.**—I am thinking of arranging a clock to chime (Cambridge chimes) on these gongs. Would any of your readers inform me whether they would be suitable for the purpose, how far they are dependent on the size, shape, and material of the gong itself, and of the resonator for the pitch and quality of their sound) Would there be room in a space 14in. by 5in. and 10in. high for four gongs to chime the quarters?—K. G.

[75348.]—**Coil.**—To MR. BOTTONE.—Would you kindly tell me size and quantity of wire I should have to wind shocking coil with? Paper tube is 1¼in. diameter, 5½in. long. Also, how should I connect it up so as to get different strengths from it?—R. N. E.

[75349.]—**Astronomy.**—Will "F.R.A.S.," or any other competent reader, kindly advise me how to begin the study of astronomy? I am not blessed with much mathematical knowledge (about up to London Matric.), nor yet with a long purse, nor do I quite know what I want. I could afford a few books and a cheap telescope, and I think I should like to verify the ephemeris of a planet as given in the "E. M.," to learn to recognise the constellations, and to watch the courses and changes of the planets. I am in an out-of-the-way part of India (N.W.P.), and can get no local assistance. A few hints as to what books to read and the kind of instrument to get, how to start work, and what course to follow will be very thankfully received by—DUFFER.

[75350.]—**Section of Iron.**—Information is desired as to the method of preparing thin sections of iron or steel for microscopic examination, or reference to any publication in which the process is described.—FERRUM.

[75351.]—**To "The Lydney Dispenser."**—Will this able correspondent kindly reply to the following, viz:—A female friend, presumably suffering from cancer, has had one breast removed by an eminent surgeon, also the glands of the left arm. The left arm has swollen up to three times its natural size, and the patient's suffering is almost intolerable from the intense heat of her body; her general health, too, is affected by sleeplessness. The doctor has prescribed boracic acid and cocaine ointment applied to open wound. In an old treatise on ailments, I find that hemlock is recommended for cancer patients Is this worthy of a trial? The right breast is now quite hard, and under the armpits a similar hardness appears.—LANCET.

[75352.] — **First Aid to the Injured.** — I am employed in an oil refinery, using a good deal of caustic soda liquor at 70°, and some of the men occasionally get burned; but as rather a severe accident has happened with us (a couple of gallons of this liquor being splashed all over a man's eyes, face, arms, and legs), I should like some medical gentlemen to give a few hints what would be best to do in a like accident to the eyes. What oil is best to use, and what would be best to neutralise this soda and be at the same time safe to use in a similar accident? I have an ambulance book by Dr. A. Wilson, F.R.S.E. (Common Accidents"), but it does not say anything regarding caustic soda in the eyes.—C. F. R.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, September 16, and unacknowledged elsewhere:—

J. C. FRANK.—W. Munro.—Omelo.—Golconda.—S. R. H. —J. M. K.—E. R.—Blakeley.—W. J. Parker.—Volt.—P. Shanks.—M.R.C.S., &c.—Disc.—A. G.—Abington. —C. P.—Rifle.—W. L. R.—T. Westlake.—F. Simpkin. —Lamp Man.—Mrs. Chambers.—J. McG. Dollar.—Constant Subscriber.—A. Villager.—Fal.—Rab.—A. D. —Wm. Laughton.—Fred A.—Battery.—C. Gandibert. —T. Haques.

WM. C. WRIGHT. (We regret our space forbids pursuing the subject on the line you indicate. We agree with you—indeed, we go further. We would tax the whole revenue of the State, and leave the land free. If you have not got it, get "Freeland: a Social Anticipation," by Dr. Hertzka, of Vienna, translated by Arthur Ransom, and just published by Chatto and Windus, Piccadilly. It is as interesting as Bellamy's "Looking Backward," and, we fancy, much more practical.)—H. W. (Most probably not; but you might consult Mr. Wetherfield, the legal editor of the *Weekly Times and Echo*, sending him full particulars. All depends on the conditions of the policy, and we are scarcely competent to advise on questions of insurance law.)—F. (The famous Laxey wheel in the Isle of Man is employed for driving pumps to drain the mines at that village. The wheel is 72ft. 6in. in diam., and has a breadth of 6ft. It is an "overshot," and the water for driving it is brought from a reservoir on a neighbouring hill, and conveyed by pipes to the top of a masonry tower forming part of the support of the wheel)—PHONO. (You must give more particulars. There is a loud-speaking telephone, and the phonograph can be made to speak loudly; but we have not heard of a combined instrument capable of speaking loudly, "printing the sound characters on paper, and reproducing the same."—NIPPER. (You can probably succeed in turning the "tan"-coloured boots black by brushing over with a solution of acetate of iron, or with currier's black liquor. The ordinary blacking used for polishing will not do; but if you like it Nubian blacking will, and convert the boots into something like patent leather. Any tanner or leather-dresser could supply you with a little of the iron liquor, or black liquor, that he uses.)—MANCHESTER. (See the illustrations of penny-in-the-slot machines illustrated on p. 220 last volume. Some are older than the patent laws by a good many years, but you must not make any machine which is protected by a valid patent. There is, however, ample scope for the exercise of ingenuity. There is no patent in the idea, but many of the machines are still protected in the case of the actual mechanism used.)—TYRO. (See the articles on model making. The size of the boiler depends on the pressure at which you wish to work. Look to the references given in the index last week.)—FRUIT. (Apples and pears should be picked before they are ripe, and stored on shelves in a cool room; but peaches cannot be easily kept for any length of time in their natural state.)—RUPTURE. (Better put the question to Dr. Allinson through the *Weekly Times and Echo*; but really, no surgeon can give a definite answer unless he has an opportunity of examining the case)—PHILALETHES. (The advertised "enamels" are of no use for such work. The enamelled tablets you mention are stoved, and without proper plant and some experience you cannot do them. Good oil paint on zinc plates is the best substitute. Some of our black and white *Weekly Times* tablets which you notice over the newsmen's shops are done this way, and they outlast all the "enamelled tablets," although we use both. Only the very best white lead and other colours must be used, and the varnish and dryers must be the best obtainable.)—Z. Y. X. (For incubators see Nos. 935, 1057, 1069, 1075, 1195, 1211.)—NEMO. (Probably the use of paraffin oil will prevent the "green scum," and clean the clothes at the same time.)—L. V. (A mixture of white and red lead, or even putty, might do; but it is better to use solder.)—LEARNER. (It is doubtful if there is any special work on the subject; but the matter is treated in nearly all works on boilers and furnaces.)—W. (Perhaps "Glass Manufacture," published by Bell, may suit.)—DUGUID. (Will attend to it.)—AUTOLYCUS. (Thanks; but we see little use in publishing sketches of sunspots.)—J. H. TRUSCOTT, CANOPUS, S. E. PEAL. (In type.)

"**A New Man.**"—A long letter has been received from Mr. J. Dickinson, in which he says "Harness' Electropathic Belt has made a new man of me, my health being now wonderfully good." This gentleman, who lives at Horatio House, Leeds, suffered severely from nervous exhaustion, and has been completely cured by wearing one of these genuine Electric Belts. Those of our readers whose constitutions are debilitated, or who feel "out of sorts," should call or write at once for particulars. Pamphlet free on application to the Medical Battery Company, Limited, 52, Oxford-street, London, W.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, SEPTEMBER 25, 1891.

LATHEWORK FOR AMATEURS.*—VII.

(Continued from page 538, Vol. LIII.)

Construction with Fly-wheel above.

FIG. 49 represents the fly-wheel placed above adapted to the construction of the false poppet. This figure is the lathe built up from the parts shown on a larger scale in the details. The column itself serves for the false poppet, and the same construction can be adopted when using the horizontal quartering (Fig. 70).

In Fig. 49 the general arrangements of the lathe can be seen. A is the treadle connected by a cord to the pin B (shown enlarged at Fig. 79). This pin is fitted to the disc C (Fig. 78), which is fitted on one end of the spindle (Fig. 76); the other end carries the fly-wheel D (Fig. 59). The cord round this fly-wheel drives the pulley E, which is fixed on one end of the mandrel (Fig. 84), and the other end carries the driving chuck F (Fig. 57). The cord may be made to fit the smaller groove in the pulley E by raising the fly-wheel D, which is done by pulling down the handle G, after loosening the winged-nut H (Fig. 55). The cord attached to this handle draws up the box (Fig. 56) contained in the column, and when the fly-wheel is to the desired height this box is fixed by tightening the winged nut H. The cone point of the back poppet is marked I; the poppet itself is marked K, and is shown enlarged on p. 419, Vol. LIII. The T rest is marked L, and the details of this will be found illustrated later.

The Octagonal Upright Column.

The octagonal column to support the driving wheel is hollowed out squarely from the top to a depth of 3ft. This is easily done by making this top of two pieces, well jointed (see Figs. 50 and 51). On two of the interior faces grooves are made ½in. deep, marked B B, Fig. 50. Through the opposite sides an open mortise is made 1in. wide and 1ft. high, reaching to within 6in. of the top of the column. This mortise, intended to allow the spindle, Fig. 76, to pass, is marked A A in Figs. 50 and 51. The part of the column Fig. 51 may be fastened to Fig. 50 by means of wood-screws, but the pressure of the fixing bolt, Fig. 52, is ordinarily sufficient. The piece of wood in which the driving wheel bearings are inclosed, called the box, and shown at Fig. 56, will next require attention. It should be 1ft. high, made of elm, beech, walnut, or wild pear, and be provided on each side with a tenon marked F F, designed to slide in the grooves which have been already spoken of. From the opposite side near the bottom the box should be pierced with a square hole, marked B, intended to receive the bolt shown at Fig. 52, which should effect the clamping.

This box should exactly fill the cavity in the column. In a transverse direction relative to the tenons a deep notch is made. Near the front and the back of this notch small vertical grooves should be made, intended to receive the tenons of the bearings or brasses marked A, which will rest in them. The construction of this box is so well shown by Fig. 56 that further description seems unnecessary. In the notch of this box will be placed the bearings of brass or of bronze, cut V-shaped, or rounded after the form shown in Fig. 56. The upper part is filled with pieces of the same metal; these are shown in Fig. 58.

After this, attention is given to the cap or cover of the box. It is made of a piece of the same kind of wood, fastened by six wood-screws, the holes for which are shown in Fig. 57. Near each end, and centrally above the bearings, set-screws marked S S are fitted, to press down the pieces A A, Fig. 58, and so make the bearings fit tightly. In the middle of the top of the cap an eye-bolt E is screwed, and to this the cord is tied, which ends in a handle, G, Fig. 49.

Constructing the Spindle and Flywheel.

These arrangements made, a piece of 1in. square iron is put upon the lathe to make the spindle for the flywheel. It is shown at Fig. 76 turned exactly round at the necks A A, which should rest in the bearings. At B B collars are left the full size of the square iron. These are intended to form shoulders, against which the flywheel (Fig. 59) and the crank (Fig. 77), or the disc (Fig. 78), will be bedded. C C are squares to receive these. The screwed portions D D are fitted with hexagon nuts, which fix these firmly on the spindle. Fig. 80 shows an iron washer to go in the centre of the disc, as seen in Fig. 78; Fig. 79 is the crank-pin, which fits the groove A in Fig. 78.

Constructing the flywheel next requires attention. Assuming we speak to an amateur who has already given proof of his capacity, and who has perhaps already a wheel in his workshop, long details, which would be entailed by describing each piece, will not be entered upon. Fig. 59, representing edge and side views, give sufficient idea of the construction. The square hole in the centre fits the spindle (Fig. 76). The dotted circle represents an iron disc. A similar one is used on the opposite side, and the two are held together by rivets put through the four small holes shown, and firmly clamp the arms of the wheel between them. The rim of the wheel is made in four segments, joined together by halving. The arms are dovetailed into the rim. At A a groove is shown which is intended to take a crank-pin, like that shown at Fig. 79, in the event of this flywheel being used under the bench. The treadle then connects directly to it, and the mechanism above the bench is dispensed with.

Putting Together.

When the flywheel is made, it remains but to put it in place. This is the way in which the whole mechanism is put together. First the box, Fig. 56, is placed in the cavity of the column, the piece Fig. 51 is placed in position, and the two parts are brought together and fixed with countersunk screws. The flywheel spindle, Fig. 76, will be put in near the top of the column, passing it through the mortise A A, which pierces the column from side to side; it is laid in its bearings, and the cap of the box is put on and fixed by screws. Next, the square bolt, Fig. 52, is passed through the mortise in the column and through the hole B in the box. The iron washer, Fig. 53, is first placed under the head of the bolt, and another washer, Fig. 54, is put on the screwed end of the bolt under the winged nut, Fig. 55. This bolt serves to fix the box at any required height in the column by tightening the winged nut.

This done, a grooved brass pulley, mounted on a staple, Fig. 60, is fixed on the top of the column by driving the staple into it at one of the points marked B in Fig. 50. A cord is passed over this pulley, one end is tied to the eye E, Fig. 57, screwed into the middle of the cap of the box, and falling lengthways of the column the cord ends in a ring or handle marked G, Fig. 49, within reach of the turner's left hand. When he wishes to slacken the driving band, he has only to unscrew the winged nut Fig. 55, and slacken the cord, termed a bell-rope. When he wishes to tighten the band, he pulls the bell-rope, and when the flywheel is lifted to the right height he fixes it by tightening the winged nut.

As will be seen, this contrivance is a little more complicated than the other; but once established, it will never alter, and its movement will be ever so much smoother than that obtained by the old practice. It should be stated that a slight twist must be given to the column, so as to guard against the driving-band rubbing at the point where it crosses. Such rubbing wears the band rapidly, and causes an unpleasant noise, which may occasion trouble by hindering the detection of other rubbing which should not occur. A well-mounted lathe should not occasion the slightest noise except that made by the tool.

Another Mortised Column.

There is another method of constructing the mortise in the column, much more simple, and giving the same results. Fig. 61 shows this. A mortise 2in. wide, 18in. long, and reaching to within 4in. of the top of the column, is made through the entire thickness. On both sides of the mortise a rebate or groove is made, so as to hollow the interior as shown by the dotted lines in Fig. 61. These rebates enlarge the mortise to the full width of the octagonal face of the column.

Two strips of the same kind of wood as that used in making the column are next prepared, to make a frame for the bearings in place of the box (Fig. 56) previously described; this frame is shown complete at Fig. 62. The two strips are smoothed with the planes so that they exactly fill the rebates, and enter to a depth of 1in. the whole of their length. They are joined near the bottom by putting between them a crossbar of wood, 2in. square (marked B, Fig. 62), and fixing them with a bolt through the hole C. So arranged, this frame will fit in the rebate in Fig. 61, and freely slide up and down a certain distance. In the middle of each strip, the holes A A will be made to take a strong iron bolt fitted with a winged nut, which draws the two strips together, in the same way that Fig. 52 acts.

Midway on the top of each strip a brass or bearing marked E E will be fitted in a similar way to that adopted in the previous method. These bearings will have notches and covers pressed down by screws, as shown in Fig. 63. In Fig. 62 D is the inner face of the farther strip.

Fig. 64 shows the top ends of similar strips made in a simpler and easier way. In this D is the strip to the left when in its place, provided with an iron catch which prevents end motion by engaging in a groove turned in the spindle. The making of caps may even be dispensed with as shown at Fig. 64; the weight of the flywheel and the pull of the band sufficiently confine the spindle; but as it would necessarily lean forward, the catch is put over the back bearing. This catch, which should be made of iron, is shown on a larger scale at Fig. 65, with its clamp-bolt and winged nut.

The spindle for the flywheel is made like the one illustrated at Fig. 76, but the lengths will not be the same, and the neck will have a groove turned in it by a point tool to receive the iron catch, which should serve as the top bearing.

This contrivance is very simple. To facilitate its movement up and down a bell-pull may be added, as to the former one, but this is not indispensable in this case.

Hand-Driven Flywheel.

The V-shaped bearings spoken of lead naturally to the following explanations. Though one has little power to resist the inclination always drawing us into grooves which custom has made it easy to follow, attentive reflection will reveal that all objections and suppositions are in favour of V-shaped bearings. These are doubtless the reasonings that caused the idea of anti-friction rollers to be conceived and invented to facilitate the motion of large hand-driven flywheels.

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* "Lathework for Amateurs" is mainly adapted from "L'Art du Tourneur," by Desormeaux; but deletions and additions are numerous and extensive. The illustrations are new, and the treatise entirely remodelled.

The drawing of this contrivance is given at Fig. 66; but readers are cautioned that its employment should be limited. Daily use quickly deteriorates it. The three anti-friction rollers are marked A A A; B is the neck of the wheel spindle; C is the movable crosspiece which carries the upper roller; D is the clamping-screw, serving to fix the upper roller at the required distance; E is the groove in which slides the clamping-screw of the crosspiece; W is the iron plate, ½in. thick, serving as a foundation for the whole, and fixed to the wooden upright by countersunk screws.

If the mechanism is attentively considered, it will be seen that the three rollers marked A, turning on axles, demand great attention to keep them constantly moist with oil. Because if one of these rollers ceases to rotate, the circumference becomes notched by the action of the neck B. If the central holes in the rollers become enlarged out of centre or oval, the effect of the contrivance is also destroyed.

The V-bearings, so simple, so convenient, so cheap, will offer the same advantages; and though at first sight the anti-friction rollers appear to offer less resistance, it will be understood on mature reflection that all things are equal.

It is therefore advised that two brass bearings with V-notches should be placed on the tops of the uprights of the frame which supports the hand-driven flywheel. The construction of this wheel belongs rather to the joiner's art than to that of the turner, so details of it will not be discussed. The drawing Fig. 67 should usually suffice. The two winch handles are marked H H. Such is the second manner of placing the driving-wheel, which is less used than the three others, because, as has been already said, it necessitates employing a journeyman.

Flywheel under the Bench.

The third manner, which is, perhaps, the most used, is to place the driving-wheel under the bench or behind it, away from the feet. There is much cause for regret that the simple and convenient method which has been lately thought of could not be used. The facility which it offered caused it to be warmly adopted. This simple method consisted in making a brass nave for the centre of the driving-wheel, making a hole in the centre of this nave, and fitting to it an iron axle—this rising and lowering in a groove made in the middle of the back leg of the bench and being fixed as wished by a set-screw with a strong, winged nut.

Nothing was more seductive than this method; but the axle quickly wore away the nave, the hole enlarged and allowed a rocking which increased daily. It was painfully apparent that it was absolutely necessary that the arbor should turn with the wheel, and not merely the wheel on a fixed arbor. Thus it was necessary to return to the process used formerly, but even this was not without inconveniences. The chief resulted from the spindle turning in two brass sockets which wore them more or less quickly according to their width, and then the wheel rocked and caused a disagreeable noise. Thus recourse was had to split bearings, the only method to employ to attain perfection.

With this object two oak planks 1in. thick were cut to the form shown by Fig. 69. These two planks were jointed to the back left leg of the bench, one inside, the other outside, by wooden pins marked A. These planks were made long enough to inclose the two legs and to project 6in. beyond the front one. They were united at this place by a transverse piece of wood (B), or of iron tapped in the middle, and receiving an adjusting screw (A, Fig. 68), also of wood, or of iron, according to the material used to make the nut. This screw, having its head shaped so that it may be readily held by the hand, has its point bearing on a shoulder placed on the front leg at the left end of the bench. Figs. 68 and 69 show this arrangement.

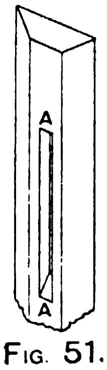


Fig. 51.

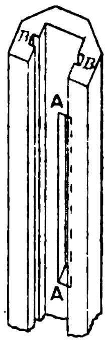


Fig. 50.

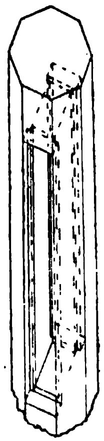
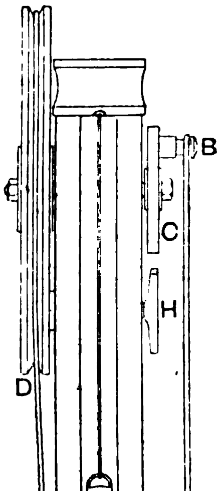


Fig. 61.



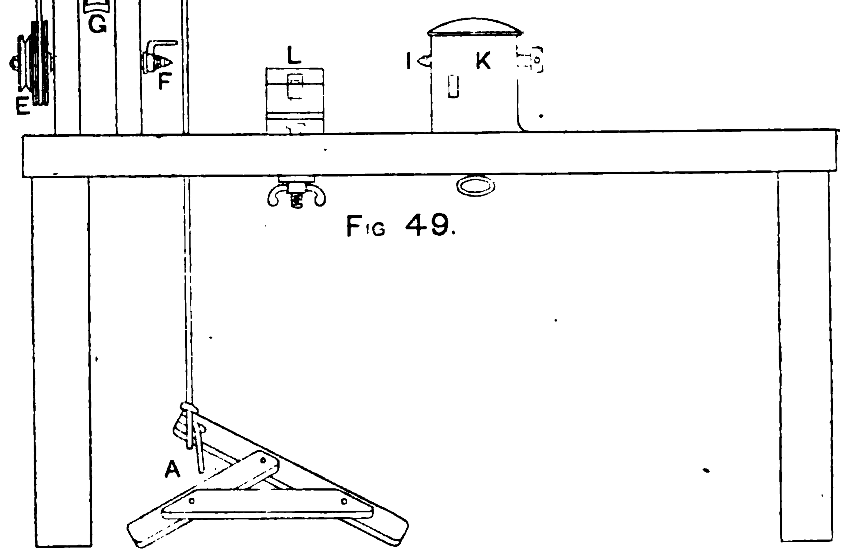


Fig 49.

The two planks thus arranged have deep notches cut in their upper edges near the middle to receive the brass bearings with V notches. Over each of these bearings is fixed, by the aid of four screws, a bar of iron, carrying in its middle a binding screw, marked S, in Figs. 68 and 69, which bears on the traverse, also of brass, which serves as the top bearing; see Fig. 69.

The Wheel in Front of the Bench.

The fourth manner of placing the fly-wheel in front of the bench now only remains to be spoken of. We proceed in almost the same manner as when placing the fly-wheel above the lathe, but as there are nevertheless essential differences to be noted, new explanations should be given. The column will be made rectangular, instead of octagonal; it is placed upon the lathe-bed, and fixed there with two strong bolts, shown in Fig. 70. It may be notched, as shown at A, so as to sit more firmly on the bed. That part of this column which projects from the bench, which it cuts at right angles, should be 1ft. longer than the radius of the wheel. It will be mortised right through, a length of about 9in., commencing at 3in. from the end of the column (see Fig. 70). On each side of the mortise wide grooves will be made, leaving only ½in. of wood on each side as a shoulder. Two strips of wood will be fitted after the style described above in speaking of the perpendicular column, and on the edges of these strips are placed two bearings with inclined V's.

Figs. 71 to 75 illustrate this frame and the bearings, &c., belonging to it. Fig. 71 is the bolt which fixes the frame in the mortis of the column (Fig. 70) at the required position. This bolt is shown in Fig. 75, with it winged nut marked N. Fig. 72 shows the inner side of one of the strips, the incline V-notch is the brass bearing, the square hol is to receive the ball, Fig. 71. Fig. 73 show the reverse side of the other strip. Fig. 7 is the iron catch which confines the en motion of the flywheel spindle, and a bette notion of which is given by Fig. 65. Fig. 7 is a top view of the two strips fixed together N being the winged nut of the bolt, Fig. 71

The driving-wheel spindle should nex be turned to the pattern shown by Fig. 76 The iron catch will be made and fixed on th back strip by a countersunk screw, and hel by the same bolt which clamps the two strip to the column, and fastens the bearin against the pull of the band.

Inclined V's are recommended—that is t say, with one side vertical, which will b turned to the direction from which the pul is exerted—that is to say, towards the bench On the crank side, the vertical side of th second bearing is placed in the opposit direction—that is to say, the inclined sid will be turned towards the bench. In thi manner it will be impossible for the flywhe spindle to leave the right angle, because will be maintained by two perpendicula faces. This explanation will be easily under stood by attentively examining the illustra tions of these bearings.

The iron catch, Fig. 74, prevents th spindle leaning towards the wheel side, th weight giving it this tendency. This cat further serves to give a twist to the whee and by this means to guard against the ban rubbing at the place where it crosses, th rubbing heats it and wears it quickl This last described method of placing th wheel is used only for putting in motio lathes of small and medium size.

In all these details it has been omitte

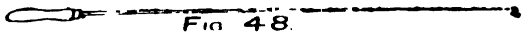


FIG. 48.

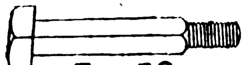


FIG 52

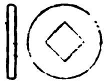


FIG. 53.

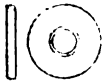


FIG. 54.

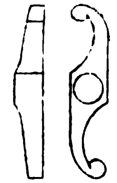


FIG. 55.

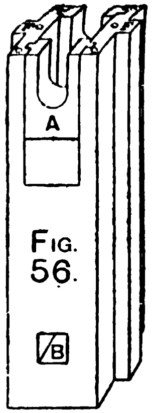


FIG. 56.

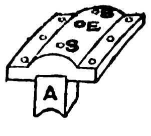


FIG. 57.

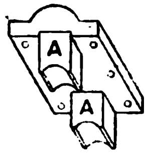


FIG. 58.

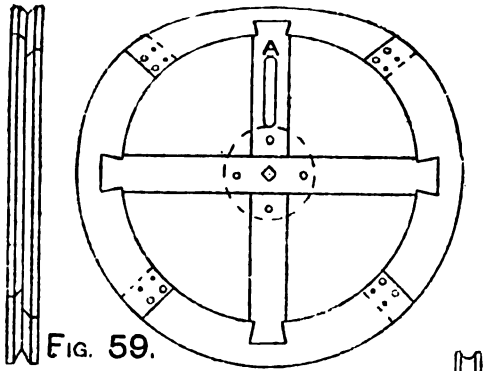


FIG. 59.

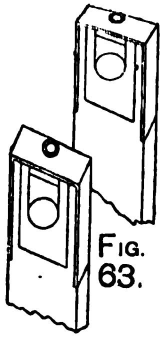


FIG. 63.

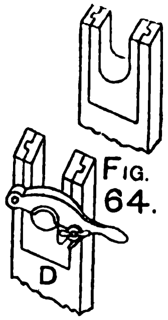


FIG. 64.

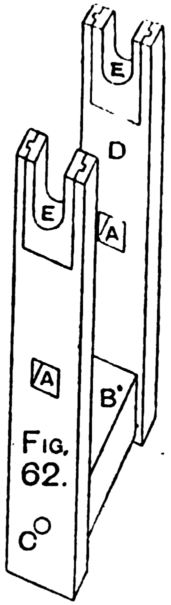


FIG. 62.

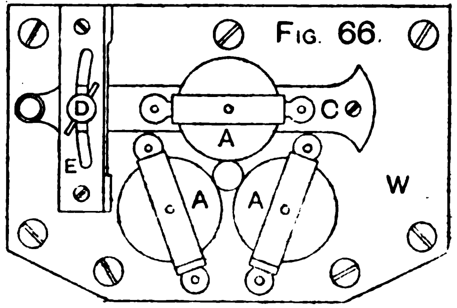


FIG. 66.

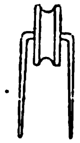


FIG. 60.

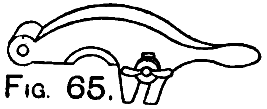
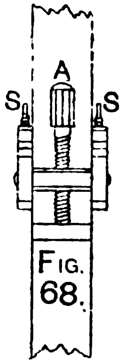


FIG. 65.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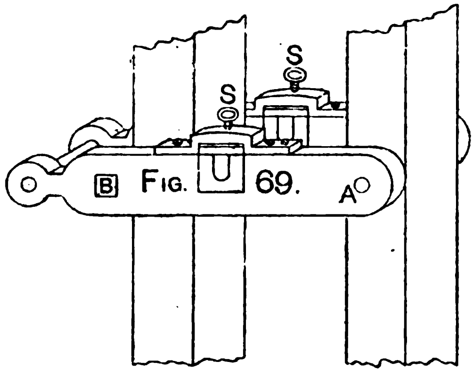
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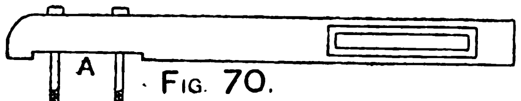
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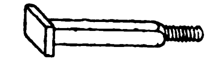
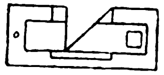


FIG. 71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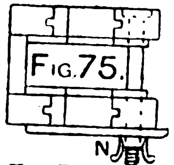
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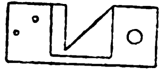
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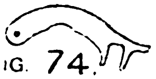
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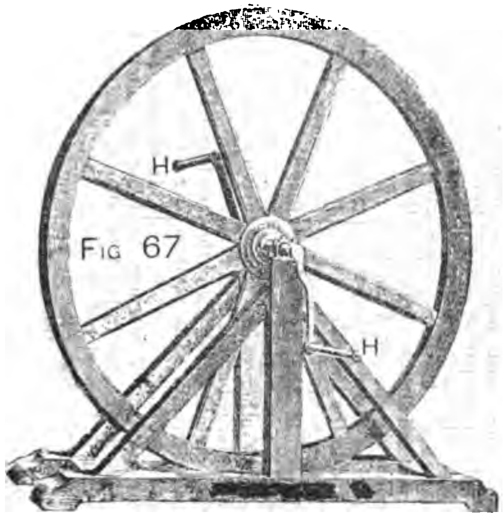
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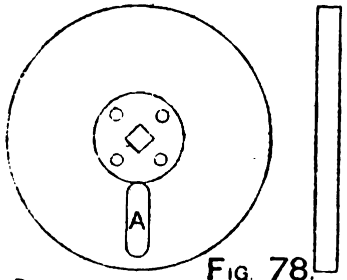
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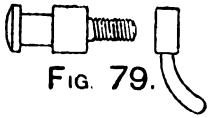
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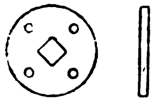
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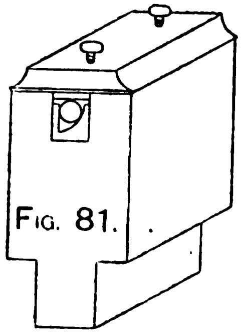
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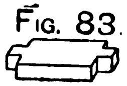
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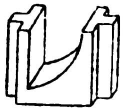
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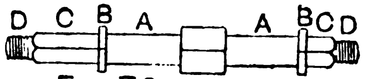
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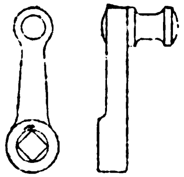
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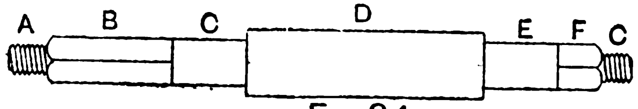


FIG. 84.

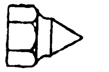


FIG. 85.

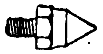


FIG. 86.

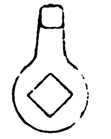


FIG. 87

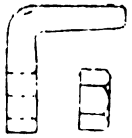


FIG. 88.

to speak of the construction of driving-wheels, of placing the treadles, of the radius at which the crank-pin should be placed where the core is attached, which connects with the treadle, of the crank arm, and of the different shapes it may be made. It has been thought that all these accessories were already known to the amateur; the illustrations will make up for what is wanting in the description. Beginners, buying their tools complete, or having their contrivances made, do not need to know them. It is sufficient in this last case to compare the object they wish to buy, or which they have made, with the illustrations, to assure themselves that these have the required degree of perfection. Neither have the holes and funnels made in the bearings, or placed outside of them to give passage to the oil, been spoken of. All these things explain themselves; the necessity of always putting oil will be sufficiently apparent not to need recommendation. There is an old proverb which says oil is the best workman. Some will bore through the clamping screws, and also through the bearing, and introduce oil by this method. Others will solder to the inside of the upper bearing a little oil sink communicating with a small crooked hole intended for the same purpose. Others establish conducting tubes. A larger number simply put oil to the joints. No rule is laid down here in this respect; let each one do what he considers appropriate; as long as oil penetrates to all the bearings, all will go well.

There is still a rather important observation to be made: it is that the caps of lathes, &c., which have clamping screws through them, are as good in wood as in iron; and in spite of the makers' objections, I accord these the preference. A well-threaded binding screw, tapped into knotty, cross-grained wood, is better in effect than when the nut is of iron; the wood has an elasticity which the iron has not. The best proof that can be had of this is that a lock-nut is wanted for screws in iron, and binding screws working in wood have lasted for 30 years without at all loosening.

Universal Poppet.

When the driving-wheel is placed in one of the four ways which have just been explained, the next thing is to render the lathe universal. There is a very simple method of accomplishing it. A short demonstration will suffice to enable this to be done speedily.

A piece of elm, or of any other wood not subject to twisting, such as walnut, beech, and wild pear, very dry, is made, about 4in. square, and of a length equal to that of the poppets of the running mandrel lathe. At the lower end of this piece a tenon is made, intended to go in the space between the bearers of the lathe, and to be fixed there either by the aid of an ordinary bolt or by two lateral screws. This false poppet is shown at Fig. 81; its upper part is shaped to the usual form of the back poppets of running mandrel lathes. To this poppet must be fitted, by a method already explained, two brass bearings having straight V notches if the driving-wheel is above or below, or having inclined V's in the two other cases. Next, the upper bearings must be made in the following shape: If the flywheel is above, an inverted V; or a plain straight crosspiece in the three other cases. These bearings are shown enlarged at Figs. 82 and 83, which show the straight-sided V and the plain crosspiece respectively. The position of these is shown in Fig. 81.

It is understood that the V bearings, in those cases where the flywheel is in front of or behind the lathe, will be placed in the following manner: In the first case, if the flywheel is placed on the left of the column (it must be remembered, from what has been said above, that the driving-wheel can be placed on either side of the column, and here it is supposed to be placed on the left) the vertical side of the V in the back bearing of the mandrel will be turned towards the flywheel, so as to oppose its perpendicular face to the pull of the driving-band, and the front bearing will be reversed. These positions will be reversed if the driving-wheel be placed according to the second supposition—that is to say, on the right of the column.

It is observed that in this position of the driving-wheel, trouble is saved if the false poppet is made in part of the horizontal column itself, in such a way that all the apparatus may be taken off at once, and is fixed to the bench only by means of two bolts, as shown in Fig. 70, or by some similar method. When everything is thus placed, the cap for the false poppet is made from a piece of the same wood cut with the grain; it is fixed on the poppet by four good screws, and two screws with wings or flat heads are made to pass through it just above the bearings, and to press on them.

The Mandrel for False Poppet.

The mandrel should now be turned. After having previously taken its dimensions with the calipers, this mandrel will be made to the shape shown in Fig. 84. A is the tail-end, screwed to take the hexagon nut, which secures the pulley E, Fig. 49. B is the square on which this pulley is placed. C is the back neck. D is the central part of the mandrel left the full diameter of the round rod from which it is made. E is the front neck. F is the square on which is mounted the driver, Fig. 87. G is the threaded nose end, on which may be screwed the cone point, Fig. 85, or the hexagon nut, Fig. 88. The nose is drilled up and tapped internally to receive such cone points as that shown at Fig. 86.

The movable cone points, Figs. 85 and 86, may be screwed upon or in the mandrel, or may be fitted conically. One may even be turned on the end of the mandrel itself, but this is less convenient. For this purpose care must have been taken to weld a piece of steel to the end intended for the front. This mandrel, either in boring and threading the inside, or to give the final finish to the steel cone point, should be finished with the graver when turning in its own bearings. The cone point, if this is welded to the end, is afterwards hardened and tempered to blue colour.

The square part B should be filed straight with sharp corners. A plank of hard wood is placed on this square, and next to this plank a ring of iron or brass, then the binding nut. It is also well to put a similar ring on the square before putting the plank upon it; it will serve as a foundation to screw against. The square part F is intended to take the driver, Fig. 87.

The whole poppet being thus prepared, the spindle is placed on the lathe-bed so that the plank which has just been spoken of is towards the right, and the rest being placed near it, it is turned in one, two, or three grooves of different sizes according to the thickness of the plank.

This apparatus may be used for all purposes; but to accelerate or diminish the rotary motion, care must be taken to make the pulleys of different sizes, but always so that the one most habitually used shall be five times smaller in diameter than the driving-wheel; the others larger or smaller according to circumstances. The speed of the flywheel can also be diminished by adding a ring smaller than the rim.

In shaping the pulley and the wheel care must be taken to make the grooves V-shaped, and not rounded at the bottom as certain authors advise. This last method exacts a much greater tension of the band, which slips in the half-round grooves, instead of wedging, as it does in the V first named.

(To be continued.)

THE OPTICAL LANTERN: ITS CONSTRUCTION AND USE.—IV.

By Chas. A. Parker.

The Front Fittings of the Lantern—The Stage-Plate—The Outer Plate of Slide-Stage—The Inner Spring Plate—Fitting Stages Together—Attaching Completed Fronts to Lantern Body.

THE lantern body will now be ready for the front fittings, including the stage-plate, slide-stages, and condenser cells. It may be said with regard to the stages that it will be absolutely necessary to employ professional aid to a certain extent, unless the amateur is well acquainted with the operations involved, and is likewise in possession of the requisite tools for their performance. For the benefit of those of our readers who may prefer to purchase the fronts ready made from a firm of repute, it may be stated that Messrs. T. S. and W. Taylor, Slate Works, Leicester, supply biunial brass fronts with adjustable slide stages, open at the top and sides to take any form of slide or tank, with fittings for 4in. or 4¼in. condensers at the following prices:—With single tubes, as above described, £1 18s.; with double draw-tubes, as above described, £2 8s.; with triple draw-tubes, £2 18s.; and a rolling curtain can be added to either of the above at an extra charge of 5s. Mr. Tyler, of 48, Waterloo-road, S.E., supplies tin stages with front o.g. tubes for a biunial, including four uprights, screws, and binding screws at 27s., or the same in brass, 75s. Of course, if the reader is able to turn and mill the work and make these fronts entirely himself, it will effect a considerable saving in the expense; but if the lathe-work and more difficult portions have to be placed in the hands of a professional, it will be found almost as economical to purchase them ready made.

The reader is strongly advised to employ brass in preference to iron or tin in the construction of the stages, as this metal is easier to work and capable of a higher degree of finish than either of the former, although it must be said that iron stages look very well if carefully finished and nicely japanned. Before entering into the work involved in making the brass fronts, it may be stated that suitable sheet-brass ready for use will cost from 8d. to 10d. per pound, according to thickness, and drawn brass tubing 2s. 6d. per pound, or ordinary 10d. per pound. When purchasing the metal it is simply necessary to give the dimensions of the sheet of brass or diameter and length of the tube required, which will be accordingly cut off and charged for by weight. The following metal warehouses stock plates, rods, and tubing in all sizes and thicknesses:—Messrs. Smith and Sons, 29-33, St. John's-square, Clerkenwell; Messrs. Stanton, 21, Shoe-lane, Fleet-street, E.C.; and Messrs. Cotton and Johnson, Grafton-street, Soho.

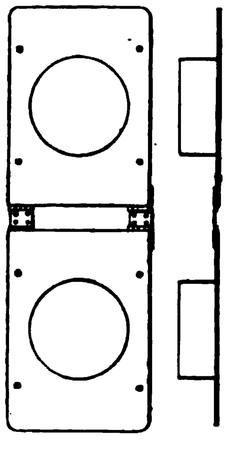
For the stage-plates, which are shown joined together by a pair of hinges in Fig. 20, a couple of flat brass plates, free from flaws or other imperfection, will be required. Each of these should measure 8½in. by 6in., and ⅛in. thick. Before working upon the metal, select the best side and proceed to polish this up to a certain extent by rubbing the way of the grain with No. 0 emery cloth—or, better still, pumice-stone, or bluestone and water—until a good dead surface has been obtained, the final polish being left until after it has been worked up. Thus prepared, see that the plate is quite square and true, then make a centre-punch mark at 4¼in. from one end, and by means of a pair of compasses strike out a circle 4⅛in. in diameter, afterwards cutting a circular aperture this size in a lathe having suitable accommodation for turning a plate of these dimensions, as it is absolutely necessary that these circles should be perfectly true and cleanly cut.

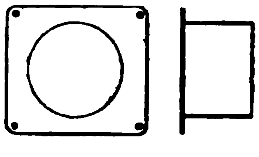
If the reader neither possesses nor has access to a suitable lathe, there should be no difficulty in finding an engineer willing to execute a job of this description cheap. When the aperture has been cut, the two corners of the plate should be roughly shaped out by means of a cold chisel, after which they may be carefully smoothed by a file, at the same time filing the edges of the plate on all sides. They may, of course, be rounded or left quite square, according to the taste of the maker. The stage-plate will now be ready for the collar or cell to hold the condensers. For this obtain a 1¼in. ring of stout brass tubing 4⅛in. in diameter, and then carefully true up both ends of this in a lathe, or, if preferred, this can be done by means of a file, care being taken not to file more off one part than another, as this would leave it lopsided. A mishap of this kind can, however, be obviated by frequently testing the tubing on a perfectly level surface. When the edges have been trued up, the collar must be made to fit accurately into the aperture in the stage-plate, with the edge of the tube flush with the outer surface of the plate, after which the two are brazed together in the following manner.

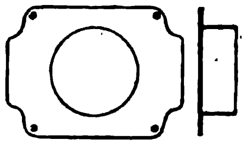
First rub up some lump borax with water on a piece of clean slate until it is as thick as cream; then file both edges of the proposed joint in order to expose a bright band of metal, and carefully fit them together in the position they are intended to occupy when finished, after which paint some of the borax and water round the joint by means of a feather, and sprinkle a small quantity of spelter round the junction of the tube and the plate. If the whole is now heated over a clear coke or charcoal fire which has been well blown, the borax will be seen to froth and swell up, presently sinking down again, and causing the solder to fuse into the joint, and thus effect a union of the two parts. The operation will now be completed, and after having been allowed to cool sufficiently, the joint may be filed and cleaned up, when it should present the appearance of a thin line of metal scarcely distinguishable from the surrounding surface. In brazing, it is necessary to have a much greater heat than would be required for soft-soldering; therefore it will be useless to attempt to get a good sound joint unless a powerful source of heat has first been obtained, and in getting up the fire it is of first importance that it should be blown perfectly clear, as a smoky fire will effectually mar any chance of a firm joint. A gas blowpipe may, of course, be used if more convenient; but it will require to be worked by a foot-blower in order to get sufficient blast. A great many amateurs experience a difficulty in brazing articles together by the aid of spelter, as this frequently refuses to run, or perhaps burns up if a blowpipe flame is used. Those who have experienced this difficulty should employ a solder composed of 11 parts pure silver and 13 parts copper, using borax as a flux as above directed. This will be found far superior to that usually sold as silver solder, and it is, moreover, easier for an amateur to work. Some workmen prefer to file up the solder and mix it with a paste of borax before applying it to the joint. If the reader is a fair hand at soft-soldering, and this is his first attempt at brazing, it will be found an economical plan to practise first upon a couple of spare pieces of brass, in order to gain that unwritten knowledge which falls to the lot of everyone who persevares.

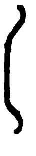
To return to the stage-plate. In actual work, it will be necessary to make this collar to fit the cell in which the condensers are mounted. The dimensions given are in accordance with the usual size of 4in. condenser mounts. If unable to get the tubing of the exact size required, it will be found advisable to get the next size larger, and cut a piece out of this and braze together again. When the collar has been fitted to the stage-plate, an L-shaped slot should be filed in the upper edge of it, and then the condensers should be pushed into the collar for the position of the short arm of the L to be marked on the condenser cell, which is then withdrawn for a hole to be drilled and tapped where marked, sufficient to take the head of a short brass screw, which is screwed into the cell, thus forming a bayonet catch for securing the condensers in the collar. This bayonet catch is a necessary precaution: otherwise, when the apparatus is folded into the case for transit, the condensers would be apt to fall out of the collar and get broken. To secure the condenser in position it is pushed into the collar with the screw head passing though the longitudinal slot, when a slight turn to the right causes the screw head to pass to the end of the shorter arm of the L-shaped slot, thus serving to fix them securely in the collar.

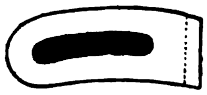
Having provided the stage-plate, the next proceeding will be to make the outer plate of the slide-stage, which carries the objective-tube. For this we shall require a flat plate of brass ⅛in. thick, measuring 6in. by 5½in. Previously to working on the plate, the surface should be brought up to a smooth and even semi-polish, by means of emery cloth; after which the edges are squared and the corners rounded off by the use of a cold chisel and file, as before directed. Thus











prepared, make a centre-punch mark in the middle, and with the compasses strike out a 4in. circle, then mount the plate in a lathe, with the head centre pushed forward until it touches the punch-mark in the plate, when the latter may be clamped up securely, and sufficient brass removed to form a circular aperture of the required size. Now procure a 3in. length of brass tubing, 4in. in diameter, and another piece of the same length, which will just fit and slide over this in telescope fashion. Drawn tubing should be obtained for this purpose, as it is necessary to have the interior quite smooth. If unable to procure a tube which will move stiffly over the other, it will be requisite to get the nearest size larger, and cut a piece out of this in order to bring it to the diameter needed, afterwards twisting a piece of iron binding-wire round each end for the purpose of holding the seam together while it is being brazed in the manner before described. Supposing that the tube is only a trifle too large, it may be put in a lathe and sufficient metal removed to bring it to a suitable size, to allow of its moving stiffly over the other tube. This tube, which may be called the draw-tube, can now be placed aside, as it will not be required again at present. Now take the other smaller tube, and after having turned up both ends quite true in a lathe, proceed to fit it into the opening previously cut in the metal plate, and when it has been accurately adjusted, carefully clean up the edges of the tube, and the aperture in the metal plate, then apply some solder and flux, and braze the two together, afterwards filing off any superfluous metal, in order to form a clean and neat joint. We shall now require four small 1½in. bolts and nuts similar to Fig. 22, also a 4in. length of tubing of sufficient diameter to easily take the stems of these bolts. On returning to the work, drill a hole through each corner of the brass plate in the position indicated in Fig. 21, and just large enough to take the heads of these bolts, then place this plate in position on the stage-plate, previously described, and mark and drill four holes of the same diameter, after which the tubing is cut into four 1in. lengths, and filed up true, the stages being afterwards clamped together by means of these four bolts, with a short length of tubing between each, in order to leave the stage 1in. wide on all sides. If preferred, these supporting rods may be formed of 1in. lengths of ⅜in. stout brass tube, to each end of which a small brass nut is hard-soldered, the screws belonging to the nut being screwed into the latter when the stages are clamped together. Of course anyone possessing suitable taps can cut up four lengths of brass rod, and drill and tap a hole longitudinally at each end for the reception of a suitable brass screw; but the average amateur will have to remain content with either of the above plans.

For the convenience of writing the work has been pushed on a little too quick, as it will be necessary to provide the stage with the spring plate, which retains the slides in position, this being slipped on to the stage before the plates are screwed together. For this we shall require a sheet of brass $\frac{3}{16}$in. thick, measuring 5¾in. by 7½in., the metal being hammered out perfectly flat, and then roughly shaped by a cold chisel to the form of Fig. 23, an outline having been previously drawn on the plate by means of a sharp point, a half-round and flat file being afterwards used to smooth the brass to the exact outline. When this has been done, make a centre-punch mark in the middle of the plate, and with the compasses strike out a circle 3¾in. in diameter, afterwards mounting the plate in a lathe, and cutting a circle this size as before described, after which a hole is drilled through each corner of sufficient size to allow of the plate being readily slid on to the supporting rods of the slide-stage. A 1½in. ring of brass tubing 3¾in. in diameter, should now be trued up carefully in a lathe, and then brazed or soldered into the opening in the spring plate just described. As this plate will neither be subjected to great heat nor rough usage, it will be found sufficient to soft-solder the brass ring to the metal. In doing this it will be necessary to file both surfaces of the metal until quite clean, after which they are separately tinned by moistening them with soldering spirit (chloride of zinc dissolved in unsweetened gin to saturation, or, if preferred, ordinary soldering fluid can be employed), and then running a line of soft solder round the parts to be tinned by means of a copper bit. Thus prepared, the tube is fitted into the circular aperture in the plate, and some spirit is run round the proposed joint by means of a feather, after which the whole is held firmly in a pair of pliers over the flame from a Bunsen burner, which will cause the solder to melt and run round the tube, thus forming a firm joint. When a dulling of the surface indicates that the solder has set, the plate may be plunged in cold water, and all traces of the spirit washed away, any superfluous solder being afterwards filed off in order to leave a neat joint. Before the plate is slipped on the stage, it will be requisite to provide it with springs for the purpose of forcing it against the stage-plate. A couple of strips of springy brass ¾in. wide, bent to the form of Fig. 24, and riveted one on either side of the central tube, will be found sufficient; or, if preferred, these springs may be formed of spiral coils of moderately-stout bird-cage wire bent round an ordinary cedar pencil, or something the same diameter as the rods of the stage-plate, in order to form four strong spiral springs. One of these coils of wire should be slipped on to each of the rods before the outer plate or front is screwed down. It will be readily seen that the spring-plate thus adjusted will be capable of holding any form of slide firmly in the stage.

A couple of pieces of $\frac{3}{16}$in. sheet brass should now be filed up, to form two slotted plates the same size and shape as Fig. 25, and, when ready, these are to be soldered one on either side of the stage-plate, as will be seen by reference to the cuts. Outline the position for each slotted arm on the back of the stage-plate, then scrape or file each surface to be soldered, and sprinkle with solder and spirits, afterwards heating over a Bunsen flame until the solder runs and covers the allotted space, guiding it, if needful, by means of a heated soldering iron. The parts are now rinsed in clean water, then brushed over with some fresh soldering spirit, and again held over the flame until it causes a union of the two parts, after which the plate is swilled in clean water, and the soldered portion trimmed up with a file. As the process of soldering will have annealed or softened the slotted plate, it will be an easy matter to bend it up to right angles in the position it is intended to occupy.

The stage plates should now be provided with a pair of hinges, by which they are joined together in the middle prior to being screwed to the woodwork of the lantern front. Suitable hinges for this purpose can be obtained from Mr. E. G. Platt, Birkbeck Works, Birkbeck-road, Kingsland, N.E. The hinges required will be No. 3 in his list, price 8d. per pair. These hinges will require to be drilled and countersunk in the middle to take the heads of four ½in. brass screws, after which they can be soldered to the under-side of the stage plates in the position shown in Fig. 20, soft solder being sufficiently strong for this purpose. The outer leaves of each hinge, also the under-sides of the stage plates, will require to be first cleaned with emery cloth, and then coated with soft solder by putting a few scraps of solder and some spirit on the metal, and then heating this over a Bunsen flame until the solder has covered the required space, after which the spirit is brushed away by means of an old tooth-brush and some cold water. Some fresh spirit is now applied to the tinned surfaces, and they are held in close contact over the flame by means of a pair of pliers, which will soon cause a union of the two metals, and squeeze out any superfluous solder from the joint, the soldered portions being afterwards rinsed in water, and any extraneous solder cleaned off by an old file. When the two stages have been joined together in the manner above described, they should be screwed on to the front of the lantern by means of four ½in. brass screws driven through each hinge.

A couple of milled screws and nuts, No. 61 in Mr. Platt's list, price 5d. each, will now be required. Shallow holes must be bored in the side of the lantern body, sufficient to take the bushes of the screws, which are screwed into the woodwork in a suitable position behind the slotted arm, in order that milled screws working in the slots will securely clamp the latter in any desired position.

If preferred, the ordinary regulating nuts and screws may be used for the stage plates, in place of the slotted arm above described. Perhaps the cheapest house from which to obtain these nuts and screws would be Messrs. D. Noakes and Son, Billingsgate-street, Greenwich, who undertake to supply amateurs with parts of lanterns, likewise castings of brasswork, which are charged at 2s. per lb. These regulating screws consist of an ordinary threaded screw, about 1¼in. long, which is riveted to a circular plate of brass of about an inch in diameter, the latter being provided with countersunk holes, through which screws may be driven for the purpose of attaching it to the lantern body, and a couple of loose milled nuts travel along the threaded screw with the stage-plate between them when in use. In affixing the threaded screw to the woodwork it will be necessary to first sink a hole in the wood by means of a centre-bit of a suitable size, sufficient to take the circular foot-plate attached to the screw, which may then be secured in position by three ⅜in. brass screws to each one. A ⅜in. hole will have to be drilled at each of the rounded corners of the stage-plates in order to take the stems of the threaded screws.

ASTRONOMICAL NOTES FOR OCTOBER, 1891.

The Sun.

Day of Month.	Souths.	At Greenwich Mean Noon.		
		Right Ascension.	Declination South.	Sidereal Time.
	h. m. s.	h. m. s.	° ′ ″	h. m. s.
1	11 49 42·10 A.M.	12 29 26	3 10 47	12 39 43·67
6	11 48 10·56 ,,	12 47 37	5 6 50	12 59 26·43
11	11 46 48·53 ,,	13 5 58	7 1 16	13 19 9·20
16	11 45 38·17 ,,	13 24 30	8 53 15	13 38 51·97
21	11 44 42·13 ,,	13 43 17	10 42 4	13 58 34·74
26	11 44 2·89 ,,	14 2 20	12 26 56	14 18 17·52
31	11 43 42·25 ,,	14 21 43	14 7 2	14 38 0·29

The method of find the sidereal time at mean noon, at any other station, will be found on p. 367 of Vol. LII.

Solar activity being now thoroughly re-established, the sun should be examined on every clear day for the interesting spots and faculæ now becoming more plentiful on his surface.

The Zodiacal Light may be looked for in the east, before sunrise.

Occultations of (and Near Approaches to) Fixed Stars by the Moon.

Day of Month.	Star's Name.	Magnitude.	Disappearance.	Moon's Limb.	Angle from Vertex.	Angle from N. Point.	Reappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.
			h. m.		°	°	h. m.		°	°
6	B A C 5109	6	6 27 p.m.	Dark	75	42	‡7 25 p.m.	Bright	317	280
15	30 Piscium	5	5 50 ,,	Dark	114	150	6 27 ,,	Bright	189	222
20	B A C 1242	6	†1 36 a.m.	S.S.E.	156	164				
20	99 Tauri	6	11 56 p.m.	Bright	8	48	12 28 a.m.	Dark	312	348
21	103 Tauri	6	4 54 a.m.	Bright	92	61	6 6 ,,	Dark	251	211
22	139 Tauri	5½	†12 4 ,,	N. by W.	347	30				
23	39 Geminorum	6½	12 9 ,,	Bright	60	104	1 10 ,,	Dark	288	331
23	40 Geminorum	6½	12 24 ,,	Bright	100	144	1 29 ,,	Dark	249	291
27	B A C 3579	6	†1 56 ,,	S.S.W.	197	237				
27	ι Leonis	6	3 48 ,,	Bright	193	232	3 57 ,,	Dark	208	247

† Near approaches. ‡ The Moon has set.
An illustrated explanation of the above table will be found on page 367 of Vol. LII.

Jupiter's Satellites.

Day of Month.	Satellite.	Phenomenon.	H.	M.	S.
1	*I*	*Sh I*	5	52	P.M.
1	I	Tr E	7	31	,,
1	I	Sh E	8	10	,,
1	II	Oc D	9	1	,,
2	II	Ec R	1	7	34 A.M.
3	II	Tr E	6	49	P.M.
3	II	Sh E	8	11	,,
5	III	Oc D	7	3	,,
6	III	Ec R	1	21	2 A.M.
6	IV	Tr I	11	44	P.M.
7	I	Tr I	12	33	A.M.
7	I	Sh I	1	18	,,
7	*I*	*Tr E*	2	51	,,
7	I	Oc D	9	50	P.M.
8	I	Ec R	12	53	23 A.M.
8	I	Tr I	6	59	P.M.
8	I	Sh I	7	47	,,
8	I	Tr E	9	17	,,
8	I	Sh E	10	5	,,
8	II	Oc D	11	19	,,
9	I	Ec R	7	22	12,,
10	II	Tr I	6	17	,,
10	II	Sh I	7	57	,,
10	II	Tr E	9	9	,,
10	II	Sh E	10	49	,,
12	III	Oc D	10	30	,,
13	*III*	*Oc R*	1	54	A.M.
13	*III*	*Ec D*	2	10	49 A.M.
14	*I*	*Tr I*	2	19	,,
14	I	Oc D	11	38	P.M.
15	IV	Ec R	5	58	52,,
15	I	Tr I	8	46	,,
15	I	Sh I	9	42	,,
15	I	Tr E	11	4	,,
15	I	Sh E	12	0	,,
16	*II*	*Oc D*	1	39	A.M.
16	I	Oc D	6	5	P.M.
16	III	Sh E	7	31	,,
16	I	Ec R	9	17	43,,
17	*I*	*Tr E*	5	31	,,
17	I	Sh E	6	29	,,
17	II	Tr I	8	39	,,
17	II	Sh I	10	35	,,
17	II	Tr E	11	32	,,
18	*II*	*Sh E*	1	27	A.M.
19	II	Ec R	7	37	49 P.M.
20	*III*	*Oc D*	2	0	A.M.
22	*I*	*Oc D*	1	26	,,
22	I	Tr I	10	34	P.M.
22	I	Sh I	11	38	,,
23	I	Tr E	12	53	A.M.
23	IV	Tr E	7	7	P.M.
23	III	Tr E	7	16	,,
23	I	Oc D	7	53	P.M.
23	III	Sh I	8	10	,,
23	I	Ec R	11	13	17,,
23	III	Sh E	11	31	,,
24	*IV*	*Sh I*	1	7	A.M.
24	*I*	*Tr I*	5	1	P.M.
24	I	Sh I	6	6	,,
24	I	Tr E	7	20	,,
24	I	Sh E	8	24	,,
24	II	Tr I	11	3	,,
25	*II*	*Sh I*	1	14	A.M.
25	I	Ec R	5	42	15 P.M.
26	*II*	*Oc D*	5	13	,,
26	II	Ec R	10	14	18,,
28	*II*	*Sh E*	5	24	,,
30	I	Tr I	12	23	A.M.
30	III	Tr I	7	27	P.M.
30	I	Oc D	9	43	,,
30	III	Tr E	10	54	,,
31	III	Sh I	12	13	A.M.
31	*I*	*Ec R*	1	8	55,,
31	I	Tr I	6	51	P.M.
31	I	Sh I	8	2	,,
31	I	Tr E	9	10	,,
31	IV	Oc D	9	20	,,
31	I	Sh E	10	20	,,

Ec, Eclipse; Oc, Occultation; Tr, Transit of Satellite; Sh, Transit of Shadow; D, Disappearance; R, Reappearance; I, Ingress; E, Egress. The printing of a phenomenon in *italics* indicates that its visibility is rendered doubtful, either by the brightness of the twilight, or by Jupiter's proximity to the horizon.

The Moon

Is New at 12h. 57·9m. in the very early morning of the 3rd, and enters her First Quarter at 10h. 56·8 p.m. on the 10th. She will be Full at 1h. 45·0 p.m. on the 17th, and enter her Last Quarter on the 24th at 1h. 56·2 p.m.

Day of Month.	Moon's Age at Noon.	Souths.
	Days.	h. m.
1	28·2	10 53·9 a.m.
6	3·5	2 19·3 p.m.
11	8·5	6 46·5 ,,
16	13·5	11 19·1 ,,
21	18·5	2 59·7 a.m.
26	23·5	7 27·2 ,,
31	28·5	10 52·3 ,,

The Moon will be in conjunction with Mercury (3° 30′ North of him) at 7h. a.m. on October 1st; with Saturn at noon on the same day (Saturn 2° 59′ S.); with Venus at 7h. a.m. on the 3rd (Venus 2° 36′ S.); with Jupiter at noon on the 14th (Jupiter 3° 57′ N.); with Saturn again at 1h. a.m. on the 29th (Saturn 2° 52′ S.); and with Mars at 7 o'clock the same evening (Mar 3° 20′ S.)

When our Notes begin the Moon is actually o the confines of Leo and Virgo, which last con stellation she immediately enters, and in whic she remains until 6h. a.m. on the 5th, when sh quits it for Libra. Having crossed Libra, sh arrives, at 5h. 30m. a.m. on the 7th, at th Western Edge of the Northern Spike of Scorpio By 6 o'clock the same evening she has travers this, and passed into Ophiuchus, where sh remains until 5h. a.m. on the 9th, at which hou she passes into Sagittarius. She quits Sagittarius for Capricornus at 8h. p.m. on the 11th and Capricornus, in turn, for Aquarius, a 1h. p.m. on the 13th. By 11h. 30m. a.m. on th 15th she has traversed Aquarius and entere Pisces. Journeying through Pisces she arrive at 2h. a.m. on the 16th at the boundary of th western outlier of Cetus, into which she the plunges, but emerges from it into Pisces agai at 10 o'clock the same night. This, however, i only to enter another outlier of Cetus at 9 p.m on the 17th, and having completed her pat through this, she comes out in Aries at 2 a.m. o the 18th. She is travelling through Aries unti 11 a.m. on the 19th, when she enters Taurus She finishes her journey across Taurus b 3h. a.m. on the 22nd, and then, of course, passe into Gemini. Her passage through Gemin terminates at 2h. a.m. on the 24th, when sh leaves it for Cancer. She only takes unti

3h. 30m. p.m. on the 25th to cross this, and enters Leo, which she does not quit until 6h. p.m. on the 28th to enter Virgo. She has not completed her journey through Virgo at midnight on the 31st.

Mercury

is a Morning Star throughout October, but comes into superior conjunction with the Sun at 3h. a.m. on the 28th. During the earlier part of the month he may be caught before sunrise at a small elevation above the horizon, to the South of East; but his angular diameter diminishes very steadily from 6·6″ on October 1st to 4·6″ by the last week of it.

Day of Month.	Right Ascension.	Declination.	Souths.
	h. m.	° ′	h. m.
1	11 27·5	5 11·6 N	10 47·9 a.m.
6	11 54·7	2 40·0 ,,	10 55·4 ,,
11	12 25·3	0 40·1 S	11 6·3 ,,
16	12 56·7	4 18·9 ,,	11 17·9 ,,
21	13 28·0	7 58·2 ,,	11 29·5 ,,
26	13 59·1	11 27·9 ,,	11 40·9 ,,
31	14 23·9	14 4·8 ,,	11 52·1 ,,

The path thus indicated commences on the confines of Leo and Virgo, extends through the whole length of the last-named constellation, and terminates in the western part of Libra. Mercury will not, however, approach very near to any conspicuous stars in describing it. He will be in conjunction with Saturn (Mercury only 12′ S.) at 7 a.m. on the 3rd; and with Uranus at 1h. p.m. on the 26th (Uranus 10′ N.)

Venus

Is an evening star in the sense of southing after noon; but she is but indifferently situated for the observer, and presents a very nearly circular disc, indeed, whose diameter increases absolutely insensibly from 9·6″ at the beginning of the month, to 10″ by the end of it. She is too much in the neighbourhood of the sun to be fairly seen at all.

Day of Month.	Right Ascension.	Declination	Souths.
	h. m.	° ′	h. m.
1	12 43·9	3 23·5 S.	0 4·2 p.m.
6	13 6·9	5 54·3 ,,	0 7·4 ,,
11	13 30·0	8 22·1 ,,	0 10·8 ,,
16	13 53·5	10 45·3 ,,	0 14·6 ,,
21	14 17·3	13 2·2 ,,	0 18·7 ,,
26	14 41·5	15 11·3 ,,	0 23·2 ,,
31	15 6·2	17 10·9 ,,	0 28·1 ,,

It will be seen from the above ephemeris that Venus travels across a considerable portion both of Virgo and Libra. She will approach no star simultaneously visible with her. She will be in conjunction with Uranus (0° 21′ N. of him) at 4h. a.m. on the 17th.

Jupiter,

but for his South Declination, would be tolerably well situated for the observer throughout October, being fairly visible during the major part of the ordinary amateur's working night. His angular equatorial diameter decreases from 48·0″ on October 1st to 44·5′ on the 31st.

Day of Month.	Right Ascension.	Declination South.	Souths.
	h. m.	° ′	h. m.
1	22 47·9	9 13·7	10 6·5 p.m.
6	22 46·1	9 23·8	9 45·1 ,,
11	22 44·6	9 32·3	9 23·9 ,,
16	22 43·3	9 39·0	9 3·0 ,,
21	22 42·3	9 43·9	8 42·3 ,,
26	22 41·7	9 46·9	8 22·0 ,,
31	22 41·3	9 48·0	8 2·0 ,,

It will be seen from the above Ephemeris that Jupiter will be travelling backward in Aquarius, a little to the south of the 4th magnitude star λ, in that Constellation.

Mars and Uranus

are, for the observer's purpose, invisible, the last named planet coming into conjunction with the sun at 11h. a.m. on the 25th.

Saturn

is most inconveniently situated too; but as his ring does not reappear until the 30th, should be looked at before sunrise during the latter half of the month by everyone interested in seeing him shorn of that familiar appendage.

Neptune,

in so far as his Meridian passage is concerned, is a morning star, but as he rises before 8 p.m. on the 1st, and more than two hours sooner at the end of October, he may well be seen for some time before midnight.

Day of month.	Right Ascension.	Declination North.	Souths.
	h. m.	° ′	h. m.
1	4 30·1	20 12·7	3 51·7 a.m.
6	4 29·9	20 12·1	3 31·8 ,,
11	4 29·6	20 10·9	3 11·9 ,,
16	4 29·2	20 10·1	2 51·9 ,,
21	4 28·8	20 9·1	2 31·8 ,,
26	4 28·4	20 8·0	2 11·8 ,,
31	4 27·9	20 6·8	1 51·6 ,,

The short retrograde arc thus indicated is described in a blank region in Taurus between 3° and 4° North of Aldebaran.

Minima of the Variable Star Algol

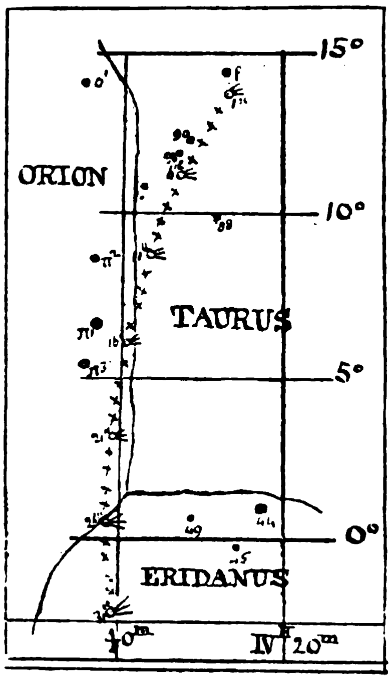
will occur on the 8th at 4h. 9m. a.m.; on the 11th, at 12h. 58m. a.m.; on the 13th, at 9h. 47m. p.m.; on the 16th, at 6h. 36m. p.m.; on the 28th, at 5h. 52m. a.m.; and on the 31st, at 2h. 40m. a.m.; as well as at other times, when daylight will render the phenomenon invisible.

Shooting Stars

May be looked for about the 2nd, 4th, 8th, 11th, and 14th, and the most notable shower in the month on the 18th. Indications of other showers exist on the 20th and 29th.

Wolf's Comet,

will attain its greatest brightness during the middle of October, emitting 12·1 times the amount of light that it did at the date of its discovery. Hence it will now be very fairly visible in comparatively small telescopes. Fortunately for the observer, its maximum of brightness will occur while it is yet North of the Equator. It rises about 8h. 22m. p.m. on the 1st, and some 10 minutes sooner only on the 31st, as it is travelling pretty rapidly in a southerly direction. As shown in our map, its path lies in a barren region of the sky.



Path of Wolf's Comet during October 1891.

Day of Month.	Right Ascension.	Declination.
	h. m.	° ′
1	4 27·1	13 47·7 N.
6	4 32·3	11 17·8 ,,
11	4 36·4	8 40·5 ,,
16	4 39·3	5 58·2 ,,
21	4 41·0	3 14·1 ,,
26	4 41·6	0 31·4 ,,
31	4 41·1	2 6·2 S.

Greenwich Mean Time of Southing of Thirteen of the Principal Fixed Stars on the Night of October 1st, 1891.

Star.	Souths. h. m. s.
δ Aquilæ	6 39 12·46 p.m.
Altair	7 4 36·14 ,,
α² Capricorni	7 31 4·68 ,,
α Cygni..	7 56 42·53 ,,
α Cephei	8 34 52·22 ,,
ε Pegasi..	8 57 40·12 ,,
α Aquarii	9 18 57·97 ,,
Fomalhaut	10 10 16·68 ,,
Markab..	10 17 57·10 ,,
ι Piscium	10 52 52·26 ,,
α Andromedæ	11 21 12·21 ,,
α Cassiopeiæ	11 52 41·76 ,,
Polaris..	*12 37 56·19 ,,

* Early morning of 2nd.

The method of ascertaining the Greenwich mean time of Southing of either of the stars in the above list on any other night in October, as also that of determining the local instant of its transit at any other station, will be found on p. 368 of Vol. LII. It must, however, be noted that the rules there given are not rigidly accurate when applied to Polaris, nor, in fact, to any close circumpolar star, although they will probably be found quite sufficiently so in actual practice.

FITTING.—V.

THERE are some elementary parts of machine structure that are of cardinal importance, the parts namely with which structures of all kinds are united. What nails and screws are to the carpenter, bolts and rivets, cottars, keys, and pins are to the fitter. They are all very simple in form, are in constant use, and are often apt to be overlooked or neglected. Yet on their design and method of fitting the stability and accurate working of an entire mechanism often hangs. It is of the first importance, therefore, that the fitter should have a good knowledge of the fitting of these elementary parts of machines. Though apparently so trivial, they are cardinal parts. It is the old tale: "For want of a nail the shoe was lost," &c. The giving way of a key or a screw, or bolt, or cottar, or pin may cause either parts to slacken, and become a fruitful source of ultimate trouble. Very often these elementary fittings are given to lads to do, and if the foreman does not happen to notice them, they are left slop fits, or otherwise faulty. I want, therefore, to show the functions of the elementary parts of union, and the way in which they should be put together.

The subject of screwing is of so much importance in workshop practice that it will be impossible to do it full justice in the length of one article. But I will try and condense as much as possible into this article, reserving the next for the subject of screwing tackle.

The forms in which screws are used are very multifarious. Quite a multiplicity of screw attachments in various forms are employed in the union of fitted parts. Some few have a very limited use, but the majority are employed very extensively in general work. It is not always easy to give a reason why a particular form of screw should be selected for a particular job, but in most cases the reason is that there is no alternative method really practicable.

The typical form in which the screw is used is that of the common bolt, Fig. 20, with Whitworth standard thread. This is almost invariably used when the form of the parts to be united will allow room for the bolt-head and nut.

Fig. 21 is not called a bolt, but a set-screw. It is not nearly so secure a fastening as Fig. 20.

The simplest illustration of the use of Fig. 20 is that of a couple of pipe flanges, Fig. 22. Common bolts are usually forged circular right down to the head A, like Fig. 20, and fit in round holes. Then the head has to be held with one spanner to prevent it turning round, while the nut B is screwed up with the other spanner. But where a large number of similar flanges have to be united, it is usual to have bolts with square necks (*a*, Fig. 22) to fit into square cored holes, thus doing away with the use of one spanner.

Round bolts fit into either cored or drilled holes. In all the best work, both large and small, the bolt holes are drilled, and the bolts are turned on the body (*c*, Fig. 20), so making a close fit with their holes. This is essential, because loosely fitting bolts permit of vibration of parts, and of movement of these parts in relation to one another, and so cause loosening and undue stress. With tightly-fitting bolts there can be no such vibration.

When holes are cored, it is alway necessary to make the holes from $\frac{1}{16}$in. to $\frac{1}{8}$in. larger in diam. than their bolts. Holes must be cored with much accuracy if only $\frac{1}{16}$in. is allowed. The usual practice is to allow $\frac{1}{8}$in. Even then there is frequently so much difference in the centres of the cored holes, that the bolts will barely fit owing to the partial overlapping of the holes.

In cases where there is no flange available, or else not sufficient room behind the flange for a bolt-head, then either a set-screw (Fig. 21) or a stud (Figs. 24 and 25) are used. In some instances, and not unfrequently, the head is cut off flush with one side of the bolt, as in Fig. 23. But this is a makeshift, not recognised as standard practice. Of the two methods of union of set-screws (Fig. 21) and studs (Figs. 24, 25), the latter makes by far the better and more secure union. Set-screws are never used for heavy work, or for work subject to great stress or vibration. They would be very apt to slacken back, and there is no simple method of affording them security against this, as there is with the nuts of studs. The set-screw is not a suitable means of attachment for any except small and light work, and for temporary attachments, as when its function is that of a pinching screw. If a set-screw, used like Fig. 21, is of only moderate length, tightening it up puts torsional stress and spring upon it that is not conducive to a good hold. Of course, for small work there is nothing simpler and better. It is very well in its proper place, and with heads of hexagon, square, cheese, or button-shaped is extensively used.

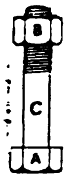


FIG 20

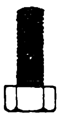


FIG 21

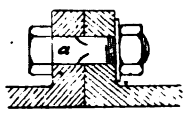


FIG 22

The stud-screw (Figs. 24, 25) is a piece of iron or steel rod, either turned or left black, as bolts are, according to the class of work it is used for. It is tapped indifferently, either into a thoroughfare hole (Fig. 24) or into a blank hole (Fig. 25). A special tool, termed a stud-block (Fig. 26), is used for turning it in. The block A is made of steel, screwed throughout to the same size as the stud for which it is used. It is fitted with a set-screw, B. The stud-block is run over the stud C, which has to be screwed in, and the screw B, bearing upon its end, prevents the block A from turning upon the stud. The spanner D, then embracing the square part of the block, is able to turn the stud C into its tapped hole, as tight as is necessary to enable it to resist the leverage of a spanner in screwing off the nut subsequently. When the stud is screwed in to its proper depth, and suitable degree of tightness, the square block A is run back and off.

In the absence of a stud-block, a common nut would have to be used for screwing the stud in. But then probably the slackening back of the nut would have the effect of slackening back the stud as well.

Occasionally, on some machine parts, it is desirable that circular nuts should be used. Then round holes are generally drilled in the nuts for the insertion of a tommy, Fig. 27, A. The steel nib, *a*, being inserted into one of the holes drilled in the nut, the leverage exerted on the end of A pulls the nut round.

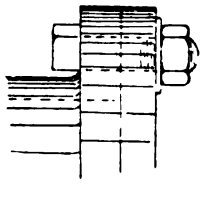


FIG 23

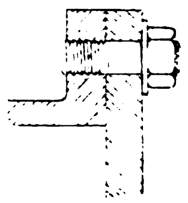


FIG 24

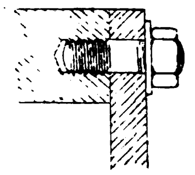


FIG 25

More often, however, the heads of bolts are made of circular form, the nuts remaining hexagonal. This is done when space is restricted, and sometimes for appearance sake. Eccentric straps, and connecting-rod brasses of the marine pattern are often secured with bolts having round heads. In cases of this kind, a little nib, Fig. 28, A, is driven or tapped into a hole drilled underneath the shoulder of the circular head of the bolt, and this is made to fit into a hole of similar form cut out in the bolt hole. These are quite the commonest types in which bolts occur, but the following forms are also of very frequent occurrence.

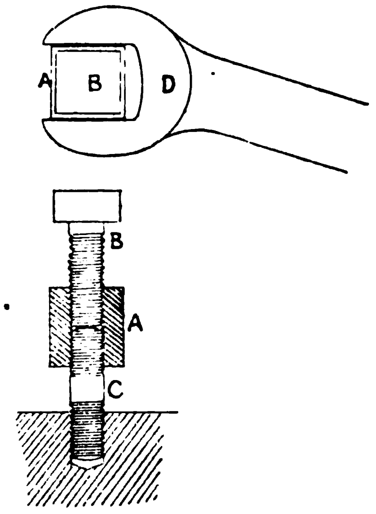


FIG 26

Collar bolts of the two forms shown in Figs. 29 and 30 are used when it is necessary that the movable portion of a mechanism shall be adjustable without moving the body of the bolt out of its fixing. Thus, Fig. 29 shows one of these bolts passing through one end of a plummer block, A. Such blocks are bolted to the angle-irons B of wrought iron crab and crane sides and other structures. The cap C is removable without moving the block A. The shoulder D of the bolt is usually square, fitting into a square recess in A, and the nut E can then be tightened without taking any means to secure the bolt from turning round with it. This is a very useful type of bolt.

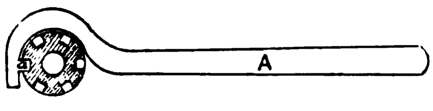


FIG 27

When the circumstances are such that neither square nor round collars can be conveniently made use of, and also in cases where a loose removable piece corresponding with C in Fig. 29 has to be tightened close down upon a piece corresponding with A in that figure, then the collar is of the countersunk and circular form, like Fig. 30.

Fig. 31 is a combination form consisting of a stud-screw provided with a collar A, and called from its very extensive use for the glands of stuffing-boxes, a gland bolt. It is also frequently termed a pillar bolt. It is simply a stud like Fig. 24, with a collar A in addition.

Fig. 32 is a hook bolt, employed when, for some reason or another, it is undesirable or impossible to have bolt-holes in both of the plates that are to be united. In the figure the lower plate terminates at A, and the upper one, B, alone is drilled. This is used in boiler-makers' plated work. The jagged bolt, Fig. 33, is used for bolting engines and machines down to their foundations, and occasionally for bolting light work against walls—seldom, however, for the latter purpose, strap bolts, Fig. 35, being much more secure. The tail A of the jagged bolt is not only tapered, but is hatched or jagged up with a hot-set on all four corners. It is let into a hole, B, cut of tapered form in the stone, C, but of considerably larger size than the tail, and liquid grouting stemmed around it, which, when hardened, renders the bolt as secure as if held in solid stone.

Fig. 34 is a cottar bolt. This is made much use of in the foundations of machines that are built upon concrete. The body A of the bolt, in most instances several feet in length, is built in with the concrete. It is square at the lower end, and pierced with a cottar-way, B. It passes through a square cast-iron washer, C, cored with a square hole. The washer being built in the concrete, and the cottar being driven in B, affords ample resistance to the tightening up of the nut at the other end of the bolt.

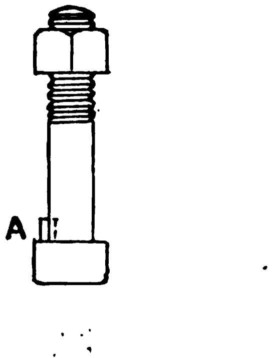


FIG 28

The strap-bolt, Fig. 35, is the best security to structures held against a wall or buttress. These bolts pass alongside, and the tail usually being turned round at right angles for letting into the stone, or for embracing its outer face, and being, moreover, sometimes secured with cross-bolts, it follows that either the threads must strip or the wall give way before the structure or machine can lose its hold.

The eye-bolt, Fig. 36, is employed when neither a stud, nor a bolt with head, can be utilised. A stud, A, is tapped into the side of a piece of work, and is embraced by the eye of the bolt. This method is occasionally employed in the stuffing-boxes of large pumps cast without lugs. It is also a useful expedient to employ when a lug into which a screw or bolt had been secured, breaks off by accident. Latterly it has been largely been made use of for fastening the cast iron male and female rings with which large steel pipes are connected. Lugs are cast in pairs upon the rings, and an eye-bolt fits within each pair of lugs, pivoting by the eye upon a pin passing through a pair of lugs on one ring, while the nut takes its bearing upon the corresponding pair of lugs upon the other ring.

The tee-headed bolt, Fig. 37, is sometimes

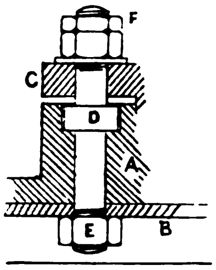


FIG 29

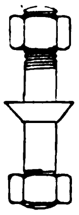


FIG 30

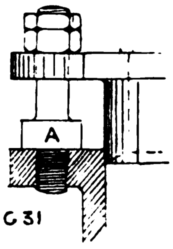


FIG 31

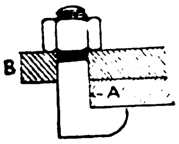


FIG 32

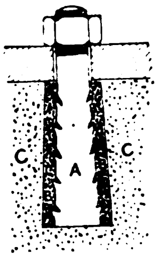


FIG 33

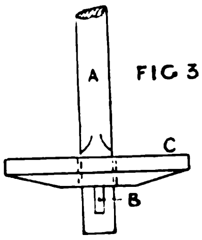


FIG 34

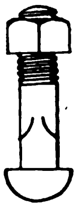


FIG 38

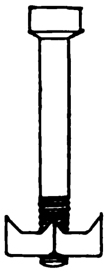


FIG 39

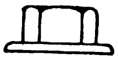


FIG 41

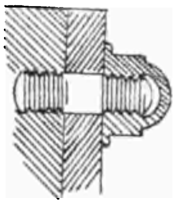


FIG 42

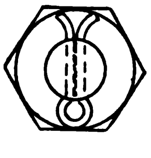


FIG 40

used on the stuffing boxes of sluice cocks. It allows of this portion of the casting being shortened by saving the space for screwing studs. It is also a movable bolt, employed for securing work to the tables of planing, slotting, and shaping machines.

The round-headed bolts with square necks, Fig. 38, are only used on timber work, and seldom by fitters, except for heavy timber work used in constructive engineering. The same remark may be made with reference to the fang bolt, Fig. 39.

In structures subject to much vibration, the nuts are liable to slacken back, and various modes of locking them are resorted to. The commonest device is to screw two nuts instead of one upon the tail of the bolt, as in Fig. 29. Usually one, F, is thinner than the other, and is called the lock or jamb nut. As the two are not likely to slacken in unison, this is a good security. The thin nut is put sometimes on top, sometimes below the other. Also, it is a very frequent practice to use two nuts of the same thickness, thus diminishing the risk of stripping in nuts subject to great stress, and saving the trouble of turning a nut down thin.

Another way by which nuts are prevented from slackening off is by means of split pins, Fig. 40. The pin is driven through a hole drilled in the tail of the bolt upon top of the nut. This is not a good method, excepting in cases where the position of the nut upon the screw is invariable, as when the bolt unites portions whose faces abut permanently.

These two methods are the principal in use. Except for special work, the various nut-lock and spring-washer arrangements, right and left-handed threads, and so on, whose name is legion, and which are illustrated in books, are seldom used.

There are two forms of nuts employed not unfrequently that should be mentioned. One is the flange nut, the other the box nut. The flange nut, Fig. 41, is a substitute for the ordinary nut and washer. The flange is, however, usually larger than the standard washer. It is useful for the purpose of covering over a large hole, or as a neat finish.

The box nut, Fig. 42, is employed where, owing to exposure to rain, steam, or leakage, the common nut would become rusted upon its screw, and difficult of removal for purposes of examination or repairs. These nuts protect the ends of their threads from rust. They are usually cast in gun-metal from wood or metal patterns, and are mostly flanged, as shown.

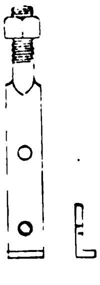


FIG 35

FIG 36

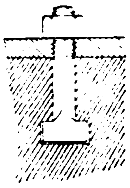


FIG 37

Holes that have to be tapped should always be drilled first. Tapping cored holes soon spoils the cutting edges of the taps. Similarly, bars that have to be screwed should either be turned first to the size, or the scale and skin ought to be removed by grinding. The size of a bar before tapping must be the same as that of the points of the thread, no more and no less. Similarly, the diameter of a hole to be tapped should be exactly the same as that of the root of the thread. If a bar is only a minute amount larger, or a hole smaller than these sizes, the labour of cutting the thread is greatly increased. If, on the other hand, the bar is smaller, or the hole larger, the edges do not come up keen and sharp, but show an amount of flat that is unsightly. The hole whose diameter gives the correct allowance for tapping any given thread, is called the "tapping hole" for that thread; and fitters keep drills by them ground to correct sizes for the roots of all standard threads. Tapping holes in cast iron are, however, frequently drilled a very trifle larger than those in wrought iron, because the edges of the threads in cast iron will not come up quite so clean and sharp as those in wrought.

Tapping requires to be done gently and cautiously. Clumsy rough working will often have these results: The tap may become broken; the cutting edges of tap or dies may be broken more or less; the thread may be torn and jagged, or its surface be roughened up. These are evils to be avoided. When screwing, therefore, the pressure should not be excessive. This is a matter for the sense of touch. A little practice will soon tell a man when he is forcing the screwing tackle. There is a difference in the feeling of *cutting* and that of *squeezing* and grinding. If cutting properly, there should be no elasticity in the lever in the backward direction on removing the hand. Neither should the tap or dies get more than moderately warm. During cutting they should be lubricated with oil, and after turning two or three times in the cutting direction, the lever should be moved back a turn or half a turn, to relieve the friction.

J. H.

HOW TO MAKE A VIOLIN.—III.*

By W. Pickering.

THE belly, to which you have already given the outline, may now be resumed. It will be found to be very much easier to work than the back, owing to the different texture of the wood; but it will be desirable to have your tools even sharper than when modelling the back. The pine is tender, and though it will require less physical strength, it will need more delicacy of manipulation. Having clamped it carefully to the bench, you may repeat the reducing process, working from the higher to the lower part of the model, and not the opposite, or you may pull out too much wood. Make use of the templates frequently, and after having shaped it roughly to your satisfaction, take up the scrapers, finishing off with glasspaper as before; then turn the work over and scoop out the interior. You will do this much better by gaslight than in the daytime, as you will want to make a constant use of the light-test before-mentioned to

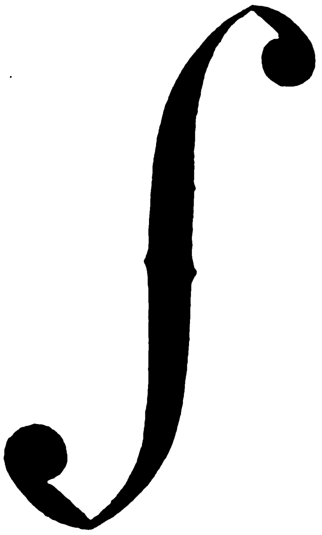


Fig. 22.

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arrive at uniformity in the thicknesses. Different kinds of deal require different degrees of thickness. A piece of hard, close-grained pine will have to be worked much thinner than a soft piece, or than one in which the grain is wide apart. Supposing you to have secured a piece of the latter kind, you may leave it ⅛in. thick all round the flanks for the present, reserving a strip of about 2in. in breadth in the centre of the belly, from block to block, to be a trifle thicker. Scrape and glass-paper carefully, so as to leave a clean finish. If the ribs have been correctly built, the belly should fit nicely when placed upon them. You may now slightly round the inside edges. Next try your hand at drawing a few *f*-holes. It is not a particularly easy thing to design one for the first time, and still less easy to make the opposite one to match it. There is more of the representative character of the maker in the design of the *f*-holes than perhaps in any other portion of the instrument. If you are a fairly good draughtsman, you may prefer one of your own design; but if you have any difficulty, Fig. 22 may be carefully cut out, or traced over, and used as a pattern. Place it on the left side of the belly and trace round it. Then turn it over to the opposite side, and trace the other. It is not only desirable to design decent-looking *f*-holes; but the manner in which you set them in the instrument must be carefully considered, so that they be neither too near together, nor too far apart, not too perpendicular, nor too much reclining. To arrive at a satisfactory result, you may cut out a couple from the pattern given, and place them in different postures and localities on the belly until you have decided which gives the best effect, and having determined on this, fix them and make your tracings. In beginning to perforate them you must make the two circular holes first, and file and paper them with care. Then with a sharp knife make an incision in the middle of the long part, and cut right through the wood, working each way towards the circular holes. A good deal depends, in style, on the point at which you strike the circular holes with the diagonal lines, which form what are called the "wings" of the *f*-holes, and still more depends on the angles which those diagonal lines make with the central line of the model. The diagram, Fig. 23, which illustrates this, shows the diagonal or "wing" line striking the circle towards the right, in the centre, and towards the outer side, and you can make your selection accordingly. For the finishing touches you will find that a bit of glass paper folded two or three times will be useful, and will serve the purpose of a fine file.

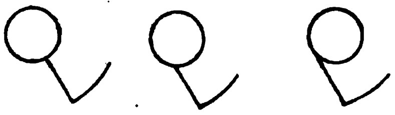


Fig. 23.

The Bass Bar will be the next item to claim attention. It is made from a strip of straight-grained pine about 10½in. long, ¾in. wide, and $\frac{3}{16}$in. thick. It should be scribed to the shape of the belly, and fitted close to the upper circle of the *f* hole on the right side as the belly lies hollow side uppermost. It does not as a rule run exactly parallel to the central line, but slightly leaves it towards the lower or wider part of the instrument. When you have made it fit the belly very accurately it may be glued and clamped, and when set take your chisel, and leaving it about ⅜in. deep at the centre, pare away gradually towards each end, at which it should be reduced to the merest shaving.

The belly may now be placed upon the ribs carefully, so that it shall not project irregularly at any part, and a slight peg should be inserted through it, at top and bottom, into the blocks, to keep it in position. It can then be glued and clamped down with the wooden screws.

The Purfling, or inlaying, must now be attempted. With the purfling tool, composed of bradawl and cotton-reel (see Fig. 11, p. 7), set to scribe a line ⅛in. from the edge, trace cautiously all round the instrument, back and front; an inner line will then have to be traced, the distance between the two lines being equal to the thickness of the purfling to be inserted. When this double tracing has been carefully made—and it must not be done hurriedly—a sharp-pointed knife is to follow all round in each line to a sufficient depth, and the wood between them may be removed with a fine bradawl, or, which is better, the tang of a small file curved and sharpened in the form of Fig. 24. When the groove has been thoroughly and evenly cleared out, the purfling should be cut to the required length, and, beginning with the waist curves, make use of the bending-iron as in the case of the ribs. Then put some hot, thin glue into the groove, and press in the purfling with the butt-end of the knife. If this be carefully but firmly done, the purfling will thoroughly fill up the channel made for it without leaving any spaces here and there, which would look unworkmanlike. When the glue has set, you can cut off each corner to a point, which will make a clean mitre joint with the succeeding pieces of purfling, which must also be mitred to fit. When the whole has set, use a sharp scraper to remove any which remains above the wood, and again finish with glass-paper.

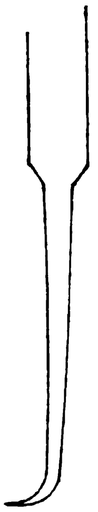


Fig. 24.

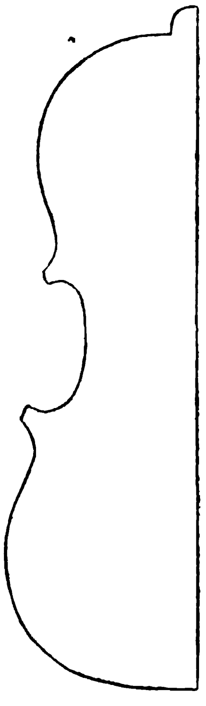


Fig. 16.

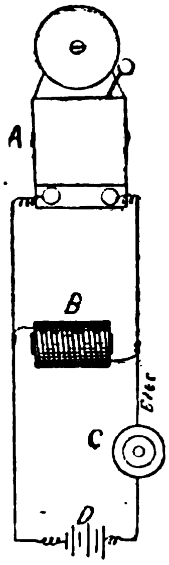
It may, perhaps, be somewhat easier for the amateur to insert the purfling as soon as he has worked the outside model of the back and belly respectively, and before building up the ribs; but this is a matter for choice or convenience. In some cases a double row of purfling is inserted, and occasionally a trefoil or other design; but even when very accurately inlaid, these things, in my opinion, add no beauty to the instrument, and take up time uselessly. Rather devote extra time and care to the correct insertion of the single row, and you will get the best effect.

Tail-pin.—A circular hole should now be bored for the tail-pin (Fig. 21, p. 54), and finished with the rat-tail file to the exact size of the tail-pin, which must fit tightly, but must not be glued in.

Postscript.—I fancy the artist must have had an accident with one of the diagrams in the last chapter, Fig. 16, and I therefore append another drawing to take the place of the one given.

HINTS FOR ELECTRIC-BELL HANGERS.

THE following hint, which may be useful to the hangers of electric bells, is published by *Electricity* (Chicago) as a contribution by a correspondent, who says:—I send you a sketch that I think will be interesting to bell-hangers. I have had occasion to apply the idea on several occasions, and have found it a very handy arrangement. The diagram shows an ordinary bell circuit, in which A is the bell and D is the battery. C is a common push-button for closing the circuit. With this arrangement it sometimes happens that the bell will not ring on account of the high resistance of the magnet coils or because the circuit is too long, or possibly because the battery is not strong enough. The remedy that would naturally suggest itself would be to increase the batteries. It often happens, however, that it is impossible to readily obtain another battery, so I devised the scheme of placing a coil of wire, of a little less resistance than that of the bell, across the circuit as shown at B, and thus causing the bell to ring. My explanation of the action is that when the circuit is closed and the current allowed to flow, part of it passes through the coil B and part through the bell; as soon as the current is interrupted in the bell the whole of it passes through the coil B. When the circuit is again completed by the armature of the bell falling back into its original position, a secondary current is sent through the magnetic coils of the bell. I am not certain that this explanation is correct, or that this idea has not been published before; but I think that it will help a number of bell-hangers out of a difficulty that it has helped me out of.



DESIGNING CAMS.*

IN designing a cam, the usual points given from which to set out are a certain range of motion in the moved piece, to be accomplished during the period of time occupied in the revolution of a shaft through a certain fraction of a circle, and it is usually the case that the shaft which carries the cam has a uniform velocity. Sometimes, however, it is not merely desired to drive a piece from *a* to *b* in a certain time, but at a certain velocity. For example, in what is known as the copping motion of a spinning frame it is required to raise and lower a rail, which controls the winding of yarn upon the spools, at a uniform rate, or very nearly so. For this purpose a special cam, known as a heart wheel, is employed, which gives the uniform motion required.

In the practical design of a cam it is necessary to first design a theoretical cam, or one which will give the motion required to a point. This determined, the actual practical cam is deduced from the theoretical form very easily. As an example, suppose in Fig. 1 we wish to move a point evenly from *a* to *b* and back again; let us design a cam to do so.

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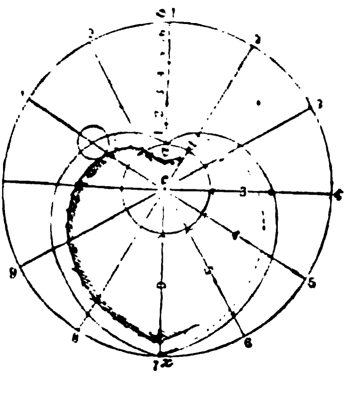
* By W. H. Booth, in the *American Machinist.*

Extend the line *b a* to *c*, and take the distance *a c* sufficient to give a sufficiently strong central spindle. Then with *c* as a centre, strike circles through *a* and *b*. Divide *a b* into any convenient number of even divisions, and draw as many diameters through *c* as the number of divisions of *a b*.



Then starting at *a* equal zero, pass on successively to each radial line and set off distances from the circle through *a*, equal to one, two, three, four, &c., of the divisions into which *a b* has been divided—in this case six.

Then through each point thus found on the various radii draw the cam curves. This heart cam revolving round the centre *c* will give a continuous uniform motion to a point to and fro along the line *a b*, or along any other radius.

Such a cam is perfectly useless, however, for there are no points outside of the geometrical ones, and our practical cam will be required to drive a friction roller in all likelihood, perhaps 1½in. diameter. To find the real cam which will give to a friction roller the same motion that a point receives from the cam already drawn, take a pair of compasses, and set them to the radius of the friction roller to be driven, and with one leg on the theoretical cam outline draw a number of circular arcs inside this, as shown, only very much closer together. Then a line touching these small arcs, and shown hatched in Fig. 1, will be the true outline of a cam, which will serve the required purpose.

This is a simple arithmetical spiral cam. A logarithmic spiral may similarly be drawn by the usual rules for such spirals, and reduced to a practical outline by the exact same process. The chief difference comes in, of course, at the points of change of motion *a* and *x*. In winding yarn on a cylindrical spool or bobbin, it is preferred that the full spool shall be barrelled somewhat.

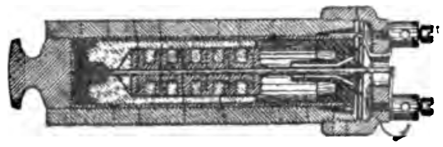
This implies, of course, a slightly slower motion for the middle of the rise and fall, so as to heap up the yarn. The theoretical cam for this would be of the form shown by the dotted lines in the right-hand half of the figure, opposite to the practical form side, but the discrepancy between the two theoretical lines would be less than purposely here shown exaggerated.

From this dotted theoretic cam the practical barrelling cam would be found, as before, with the radius of the friction roller.

The great advantage of a cam motion is that any motion at all possible can be exactly obtained with unerring precision, hence the numerous cam gears found in textile machinery where quick movements require to be made under the action of some other moving part. Amongst these may be classed the shaper rail or copping rail, the heart wheel just described, the strap shifters of the mule headstock, and sundry loom gears. After all, a cam is but a wheel of varying radius, and though I have used so many myself, it has sometimes occurred to me that their use displays a poverty of resource in respect to link-gear design. Still, to effect certain ends by link gear, which are gotten so readily by a cam, would involve complications practically impossible, at least on the score of expense, so that cam motions, with their compactness and absolute accuracy, carry their own justification.

HART'S SEALED CHLORIDE-OF-SILVER BATTERY.

THE chief difficulty experienced in the use of small cells of galvanic batteries is the leakage of the exciting fluid. In some forms of cells this is provided against by making the cell liquid-tight; unfortunately, such sealing also prevents the escape of the gases of decomposition, and the cells burst or a vent is formed which permits the escape of liquid, injury to connections, and damage to apparatus or furniture near which the cell is placed. In a recent patent granted to J. R. Hart, of New York, a simple way of overcoming this difficulty is described. The battery is illustrated in above engraving. A hard rubber case is lined with zinc, and a stem of chloride of silver is hung from a wooden or rubber stopper. A jelly-like composition is used as an excitant. The stopper is perforated with openings which are sealed by a soft rubber washer, thus permitting the gas to escape when pressure is exerted, the elasticity of the washer again sealing the cell and preventing escape of liquid or moisture and preventing entrance of dust.



MUSICAL INSTRUMENTS: THEIR CONSTRUCTION AND CAPABILITIES.—V.*

THE serpent has been already mentioned as the bass of the obsolete zinken or wooden cornets, straight or curved, with cupped mouthpiece. It gained its serpentine form from the facility given thereby to the player to cover the six holes with his fingers. In course of time keys were added to it, and when changed into a bassoon shape its name changed to the Russian bass horn or bassoon Russe. A Parisian instrument maker, Halary, in 1817, made this a complete instrument, after the manner of the keyed-bugle of Halliday, and, producing it in brass, called it the ophicleide, from two Greek words meaning serpent and keys—keyed serpent—although it was more like a keyed bass bugle. The wooden serpent has gone out of use in military bands within recollection, the ophicleide from orchestras only recently. It has been superseded by the development of the valved tubas. The euphonium and bombardon, the basses of the important family of saxhorns, now completely cover the ground of bass wind instrument music. The keyed-bugle, invented by Joseph Halliday, bandmaster of the Cavan Militia, in 1810, may be regarded as the prototype of all these instruments, excepting that the keys have been entirely replaced by the valve system, an almost contemporary invention by Stölzel and Blümel, in Prussia, in 1815. The valve instruments began to prevail as early as 1850. The sound-tube of all bugles, saxhorns, and tubas is conical, with a much wider curve than the horn. The quality of tone produced is a general kind of tone, not possessing the individuality of any of the older instruments. All these valve instruments may be comprehended under the French name of saxhorn. There is a division between them of the higher instruments or bugles, which do not sound the fundamental note, and of the lower, or tubas, which sound it readily. Properly military band instruments, the second or bass division, has been taken over to the orchestra; and Wagner has made great use of it in his great scores. The soprano cornets, bugles, or flugelhorns and saxhorns are in E flat; the corresponding alto instruments in B flat, which is also the pitch of the ordinary cornet. The tenor, baryton, and bass instruments follow in similar relation; the bass horns are, as I have said, called tubas, and that with four valves, the euphonium. The bombardon, or E flat tuba, has much richer lower notes.

For military purposes, this and the contrabass—the helicon—are circular. Finally, the contrabass tubas in B flat, and in C, for Wagner, have immense depth and potentiality of tone; all these instruments are capable of pianissimo.

There are many varieties now of these brass instruments, nearer particulars of which may be found in Gevaert and other eminent musicians' works on instrumentation. One fact I will not pass by, which is that, from the use of brass instruments (which rise in pitch so rapidly under increase of temperature, as Mr. Blaikley has shown, almost to the co-efficient of the sharpening under heat in organ pipes), has come about that rise in pitch, which, from 1816 to 1846—until repressed by the authority of the late Sir Michael Costa, and, more recently, by the action of the Royal Military College at Kneller Hall—is an extraordinary feature in musical history. All previous variations in pitch—and they have comprised as much as a fourth in the extremes—having been due either to transposition, owing to the requirements of the human voice, or to national or provincial measurements. The manufacture of brass instruments is a distinct craft, although some of the processes are similar to those used by silversmiths, coppersmiths, and braziers.

Before proceeding to the various instruments that are accessible by the keyboard to full harmony in any combination of notes, it will be well to consider the keyboard alone and to try to make out its history. Like all inventions that have required time for their recognition, and an ever-widening use to bring out their importance, the record is imperfect and the materials fragmentary that can throw light upon its development. Its origin was either in the organ, when an aggregate of pitch-pipes only, or in connection with the monochord, the normal mediæval pitch-measure. It is accepted that organs, hydraulic or otherwise, existed in the time of the Roman domination, and may have been of Greek invention. In the eighth and ninth centuries organs were heard of in England, France, and Germany; but, up to the eleventh century, there appears to have been no use made of balanced levers or keys to produce the notes. Sliding-rods, like modern draw-stops, seem, from the imperfect notices existing, to have been the only means for obtaining and controlling sound from the pipes. As single notes only were practicable, there could have been no harmony whatever, unless two persons, drawing out slides simultaneously, could have set two notes going. There are three ways open to us to trace historically the construction and improvement of musical instruments or whatever appertains to them. The sure one is the examination and comparison of existing intruments; the next is found in graphic representations, to be valued according to the realistic or conventional treatment the draughtsman may employ. The last and least satisfactory is that of written description, the difficulties of which are made more perplexing by the confusion attending names used by writers in different places and at different times. With the early keyboard we are only left with such indications as we can get from pictorial or written evidence, as no known keyboard is older than the end of the fifteenth century. At this point of our inquiry we ought not to overlook the keys of the hurdy-gurdy or vielle, the viol sounded by a wheel instead of a bow. The fact of this instrument having strings tuned as drones puts back its origin to when the drone was the only addition to melody.

The bagpipe was the wind instrument similarly burdened, and there is every reason to believe that the drone early became characteristic of the organ. It is a principle of great antiquity, perhaps prehistoric, still existing in the East, and particularly in India. The keys of the hurdy-gurdy are simply slides pushed back by the player, with projections to stop the strings and produce notes according to the vibrating length required; and as the instrument is held with the keys downwards, these slides, when released, fall back by their own weight. It is possible that the hurdy-gurdy keys suggested the contrivance of balanced levers for stopping the monochord; and thus the clavichord, a complex of monochords—for at first the strings of it were of equal length—came about; but it is equally possible that the invention of balanced lever keys was earliest applied to the organ. We have to step with great care in this inquiry. Of what happened, if anything, in the eleventh and twelfth centuries concerning keyboards we know nothing. The first glimmering of light is in the thirteenth century. At that epoch a small portable organ for processional use, a shrill pitch-giver and little more, had been invented. One of the valuable results of the Music Division of the Inventions Exhibition of 1885 was the publication of important books concerning music and musical instruments, two of which were undertaken by Mr. Quaritch. The one I now particularly refer to is entitled "Notes on Early Spanish Music," with illustrations of thirteenth and fourteenth century instruments. The author is Don Juan Riano, who was the special commissioner appointed for Spain, in connection with the Music Loan Collection attached to that Exhibition. I had the great privilege to found that collection which was shown in the Royal Albert Hall, and was officially associated with it as chairman of the Special Loan Committee. I may also mention that I was honoured with a gold medal awarded by the Executive Council of the Exhibition for these services. In Don Riano's book there is a drawing, copied from an authenticated manuscript of the thirteenth century, in which a portable organ, or *portatif*, appears. It has nine pipes; but it has been sufficient to the artist to figure three keys, which are hardly keys in the sense of levers, but evidently represent those gimlet-looking finger-stops, of which I shall give other instances. When depressed by the fingers, they lowered, by some internal contrivance, the valves or pallets necessary to admit wind to the pipes they served. There is no clue to the actual notes. The set of drawings this example is contained in belongs to the *codex* of the "Cantigas de Santa Maria," of which there are three manuscripts: one in the National Library, Madrid, and two in the library of the Escorial. The Spanish Royal Academy have just published this work; but these interesting and important musical miniatures had already appeared in "Instrumentaria Espanola," by Don Francisco Aznar, Madrid, 1880.

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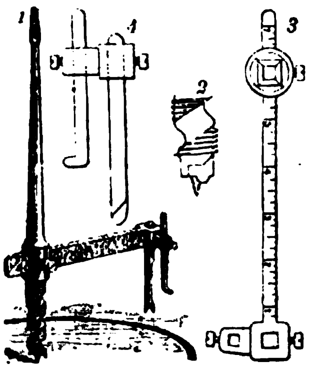
* By A. J. Hipkins, F.S.A. Extracted from a series of Cantor Lectures before the Society of Arts.

BEAUCHENE'S BORING BIT.

IN the expansion bit shown in the illustration, which has been patented by Mr. Charles Beauchéne, Lake Linden, Mich., Fig. 1 represents the device in perspective, Fig. 2 showing the point of its central portion, and Fig. 3 being a plan view, while Fig. 4 is an end view of the extension arm. The shank is squared and tapered to adapt it to a bit-stock, and its spirally-grooved lower end has a gimlet-point and cutting-lips, a screw-thread being formed on the body of the spirally-grooved portion. In a mortise in the shank an arm is clamped by a set-screw, the outer end of the arm having two mortises, in one of which is clamped a cutting-tool, while the other carries a guide-bar. The tool has at its lower edge a pair of spurs, between which is formed a cutting-edge, the spurs being arranged divergently to enable them to cut without pinching the wood, while the shank of the tool is cut away above its cutting-edge, so that the ascending chips will ride up and off the edge of the tool. The upper surface of the arm has a graduated scale to facilitate setting it for boring a hole of the desired size, which is effected by placing the gimlet-point on the centre from which the hole is to be struck and turning the bit, when its threaded portion screws into the wood, as the cutting-tool on the extension-arm forms a channel by which a circular piece is separated from the main body of the wood.



The Prevention of Scurvy.—James Haviland, an English surgeon of repute, and a sketch of whose life and career appeared in the *Lancet* of Dec. 11th, 1869, is credited with having devised a plan for the prevention of scurvy on board ship. He served first as a surgeon in the Indian Mercantile Marine, and when still in his twentieth year he accompanied a large number of soldiers and seamen on board the *Sir William Pulteney* to India. This was the only vessel of the squadron which arrived in port free from scurvy—a result which Mr. Haviland obtained by keeping up a full and fresh supply of mustard and cress, which he directed the crew to grow for their own use in warm, moist flannel. He lost not a single seaman or soldier—a service for which he received the thanks of the Board of Directors.—*Lancet.*

The Markings on the Finger-Tips.—Dr. D Abundo has published the results of some researches on the markings on the tips of the fingers. He examined the fingers of seven idiots, and found that the markings on the tips of all the fingers on each hand were identical, thus showing a marked difference between those of idiots and of sane people. The thumb-tips of one idiot had the same markings as those on his fingers. There was a noticeable smoothness of the finger-tips in all the idiots. In one case Dr. D'Abundo remarked a perfect resemblance between the markings on the fingers of an idiot and on those of his mother. Out of twenty cases of imbecility Dr. D'Abundo found in four only one sort of tracing on all the fingers; in the rest there was a tendency to repetition on almost all his fingers. In hemiplegia, when the lesion was of old standing, he noticed in the part affected a distinct smoothness of the finger-tips, which prevented him from obtaining a clear-cut impression. From a medico-legal point of view, these researches may ultimately have an important bearing on crimes of a sanguinary nature. For instance, if drawings were taken of the impression of a hand bathed in blood the markings would be most clear, more especially if the criminal had not merely laid his hand on any papers, but had actually fingered them. The evidence of crime would be still more valuable if the criminal had some cicatrix or deformity on the fingers.—*Lancet.*

SCIENTIFIC NEWS.

THE position of Wolf's Comet at Berlin midnight on Oct. 1, will be R.A. 4h. 27m. 4·25s., N. Dec. 13° 47·7′; brightness 11·2, as compared with unity at time of discovery.

As mentioned before, there is reason to think that the small planet (312) discovered by Dr. J. Palisa on Aug. 14 is not new, and the calculations of Dr. A. Berberich point to the probability that it is Medusa (149), discovered by M. Perrotin in 1875 whilst at Toulouse.

M. Charlois, of Nice, discovered two more small planets on the 1st and 4th of the present month, which should be 315 and 316; but from the fact above mentioned, it is at present doubtful what position they will hold in the list.

The death is announced at Heidelberg of Dr. Franz Friedrich Ernst Brünnow, F.R.A.S. Trained under Encke at the Berlin Observatory (where he was present during the discovery of Neptune in 1846), he was appointed director of the observatory at Ann Arbor, Michigan, in 1854, and 11 years afterwards succeeded the late Sir William Rowan Hamilton as Andrews Professor of Astronomy in the University of Dublin and Director of the Dunsink Observatory. These appointments he held until 1874, when failing health and eyesight compelled him to resign them and retire from active life. His name is best known through his investigations of cometary orbits and of stellar parallax at Dunsink, which have been continued by his successor, Sir R. S. Ball. Dr. Brünnow also published tables of the orbits of several of the earliest discovered small planets. His "Lehrbuch der Sphärischen Astronomie" is recognised as an authoritative textbook, having passed through several editions, and been translated into French and English. Dr. Brünnow, who was in his seventieth year, was admitted a Fellow of the Royal Astronomical Society in 1869.

At a recent meeting of the Paris Academy of Sciences M. Fizeau stated that several observers had measured remarkably high velocities in solar prominences by the application of the Doppler-Fizeau principle. The subject is purely technical; but the conclusion is that aberration must be taken into account in determining the heights and positions of the prominences.

It is proposed to hold an electrical-engineering exhibition in Glasgow during the winter. The exhibition at the Crystal Palace will, it is understood, be opened in January. It should be understood that these exhibitions will not depend on electric lighting for their attractions, but rather on other applications of the current.

It is stated that the Brighton Railway Co. intend to remove the electric lights from their coaches, and replace them with lamps burning Pintsch's gas, while Pope and Son, Slough, will have an opportunity of showing what they can do. The electric light does not seem to be a success on trains, but it is coming into extensive use for lighting the yards and goods sidings of various railways.

The Brighton Municipal Electric Lighting Station was opened last week by the Mayoress.

The Swiney Lectures on Geology will be delivered at the Natural History Museum, Cromwell-road, S.W., on Mondays, Wednesdays, and Fridays, at 3 p.m., from Oct. 5 to Oct. 30. The lectures are free, and the subject will be "The Great Agents of Geological Change," by Prof. H. Alleyne Nicholson, M.D., D.Sc. A syllabus can be obtained at the museum.

Dr. Gill, the Astronomer Royal at the Cape of Good Hope, is reported to have said that a plan for universal time has been officially proposed to his Government, by which there will be one time for the whole world, starting from the meridian of Greenwich, and changing local times at longitudes separated by an even number of hours from Greenwich.

It appears that Shakespeare was right, after all, about the toad sweating venom. Correspondents of the *Lancet* say that the toad does secrete a venom of a tolerably powerful character; and instead of this secretion taking place, as in the case of snakes, entirely through the salivary glands, it is actually secreted by the skin, so that the word "sweated" is most accurately descriptive. In his interesting letter Dr. Leonard Guthrie mentions that the secretion also occurs in the toad through the parotid glands, and that the venom is a thick milky fluid like the juice of dandelion stalks in taste and appearance. When inoculated subcutaneously it kills small birds in six minutes, and dogs and guinea-pigs in half an hour to an hour and a half; the symptoms in birds being loss of coördination followed by death, in guinea-pigs convulsions, and in the dog depression, vomiting, and intoxication. Dr. Guthrie describes two very interesting observations of his own on the effect of toad's venom. He kept a small toad in a cage with some common lizards, and one day a lizard, having bitten the toad, immediately afterwards rushed wildly round the cage, burrowing its head in the sand, became convulsed, and died in less than two minutes. His dog having siezed a toad, was attacked by instantaneous and profuse salivation, violent vomiting, and collapse. He also noticed that the venom has a most powerful local action on the skin, so that after carrying a toad in his hand he got numbness and tingling in it, with slight swelling and dryness of the skin lasting for several hours.

Visitors to the Natural History Museum should notice the Arctic group which has been placed by Prof. Flower in the Central Hall, to illustrate adaptation of colour to surrounding conditions. White is the prevailing colour of animals which inhabit the Northern regions; but in some species—as the mountain hare (Lepus variabilis), the willow grouse (Lagopus albus), and the ptarmigan (Lagopus mutus), all of which are shown — white is only assumed in winter, the summer livery conforming to the hue of their habitual surroundings in that season.

The Folk-lore Society of Mussachusetts having sent a delegate to Col. Gouraud asking his assistance in obtaining records of the "street sounds" of London and the capitals of Europe, Col. Gouraud has put a phonograph at the society's disposal, while a photographer will photograph the subjects simultaneously with the phonographing of their "sound-waves." This secures the "coincident reproduction" of both sights and sounds by means of the lantern and the phonograph combined—new material, indeed, for the lecture platform.

MM. Labbé and Oudin have communicated some observations on ozone to the Paris Academy of Sciences with especial reference to its physiological and therapeutic action. Ozone for experimental purposes is best prepared by the electrical method. This can be easily carried out by passing a current of air between two tubes across which the electrical discharge is made to pass. When the blood of an animal, which averages usually from 10 to 11 parts per 100 of oxyhæmoglobin, has been examined after the animal has been submitted to the inhalations for a quarter of an hour, an augmentation of one per cent. is found, and this is constant. Ozone has, according to these observers, a therapeutic property hitherto little, if at all, noted, which, in their opinion, may lead the way to some important clinical results—viz., its power of displacing and transporting the metallic substance of the electrode; and they found that this molecular displacement took place with all the metals.

It is claimed that a mile in 29⅗ seconds was recently made by a locomotive on the Bound Brook route, between New York and Philadelphia; but it is not stated what sort of locomotive did it, or, of equal importance, how the time was taken.

At the meeting of the San Francisco Microscopical Society on the 2nd inst., Dr. Wythe read a paper descriptive of his researches on the blood, which he has recently completed by the aid of a Powell and Lealand one-tenth apochromatic of N.A. 1·50. The paper is an important one, and its appearance in full will be awaited with some interest.

Telephony.—The Consolidated Telephone Construction and Maintenance Company, Ltd., of 109, Farringdon-road, London, E.C., have issued a catalogue of the instruments they supply, giving illustrations of all the best and most useful forms of telephone apparatus and accessories, and a useful "telegraphic code." The company has the exclusive right to manufacture telephones of the Edison, Blake, Gower-Bell, and Hunnings systems in the United Kingdom, and those who are thinking of taking advantage of the facilities offered by the telephone should consult this catalogue.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor *of the* English Mechanic, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

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MARS—JUPITER.

[32734.]—In order to reply to "H. A." (query 75246), I have referred to Lockyer's "Elementary Lessons," and find that De la Rue's two drawings of Mars are both given for April 20, 1856, 9h. 40m. G.M.T., though the configuration of the planet is very different. By a blunder of the engraver 9h. 40m. has probably been substituted for 11h. 40m. in the second drawing.

The hour-glass marking represents the Kaiser Sea and Nasmyth Inlet. The semicircular marking consists of the Kaiser Sea on the west, Herschel Strait and Dawes Forked Bay on the south, and Nasmyth Inlet and Lassell Sea on the north. These names are from Green's chart. In Schiaparelli's "Mappa Areographica" the nomenclature is entirely different; thus the Kaiser Sea is called Syrtis Magna, &c. "H. A." had better procure the charts of both Green and Schiaparelli, and the identification of markings will then become an easy matter.

Several of your correspondents have recently mentioned a conspicuous elliptical spot or dark streak in the south hemisphere of Jupiter. This marking was first discovered by Mr. A. S. Williams, of Brighton, on June 1, 1891, and he drew special attention to it in the *Monthly Notices* for June, 1890, p. 520. It was formerly situated in the same latitude as the red spot, but its greater velocity brought it into conjunction with the following end of that object at the middle of July, 1890. It was then pushed southwards by some repelling influence exerted by the red spot, and passed along the southern borders of the latter. Since August, 1890, the difference of motion in the two objects has caused a wide separation, and the dark streak has now gained about 5h. 55m. on the red spot, so that it follows that object across the central meridian at an interval of about four hours. Combining my recent observations of the dark streak with the one by Mr. Williams on March 28, 1890, I find its rotation period 9h. 55m. 18·3s., or 22·6s. less than the rate of the red spot during the last twelve months. If the same relative motions are maintained, the centres of the two objects will arrive at conjunction on about May 30, 1892. The diurnal gain of the dark streak is 54·6s., so that an interval of 655 days elapses between its conjunctions with the red spot.

Bristol, September 19. **W. F. Denning.**

THE TRANSIT OF JUPITER'S THIRD SATELLITE.

[32735.]—In reply to letter 32708, during the transit on Sept. 10 I distinctly saw the black shadow crossing the planet, though could not distinguish the satellite itself till its egress, when it was plainly visible as a slight excrescence on edge of planet, and soon after quite distinct. Telescope used, 2in. refractor, power 50; time, 10.15 to 11 p.m.

Regarding the focus of a telescope on moon or stars, I find that sometimes the same will answer for both; at other times a slight alteration is required, which I think is owing to state of atmosphere.

H. A. King.

Norwood.

CANALS AND LAKES IN MARS.

[32736.]—If I did not reply sooner to Mr. Stanley Williams' letter about the gemination of Mars' canals and lakes, it was because I thought your space much too valuable to be further wasted with a question of anything but general interest.

Mr. Williams has misinterpreted my silence, and attributes it to a "breaking down of our hypothesis." I therefore beg to say that the probable reason why "one canal was seen double, whilst a neighbouring one remained single" was that the former was much darker than the latter, *dark lines geminating much more easily than light ones.*

I must, of course, accept—without being able to explain—Mr. Williams' statement that he has also observed the gemination of the lakes. By a curious coincidence, however, in the only drawing of Mars made by Prof. Schiaparelli which I could get, several lakes are indicated, and yet *not a single one of them* has been put down as having been seen double.

Antwerp, Sept. 19. **H. Schleusner.**

DUPLICATION OF CANALS AND LAKES ON MARS—THE DOUBLE BELTS OF JUPITER.

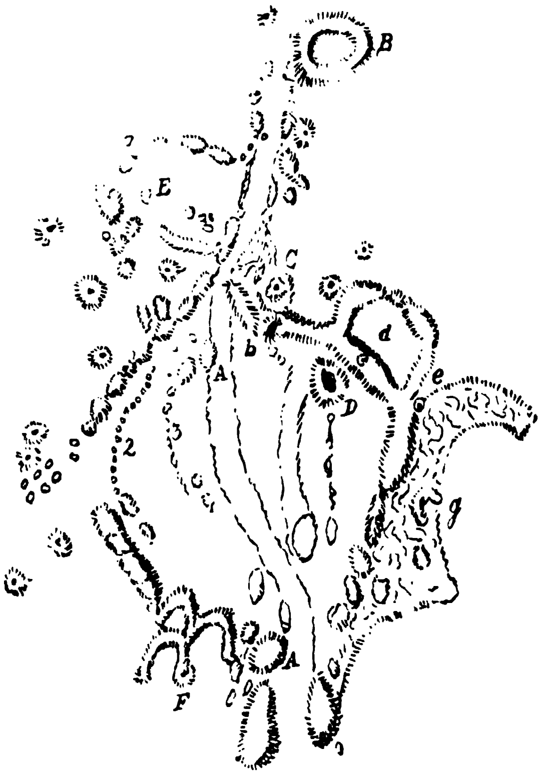
[32737.]—Referring to that part of the long and interesting letter of "F.R.A.S.," on p. 89 and 90, which has connection with the subject of the duplication of the "canals" and "lakes" on the planet Mars, I would remark that the instance of the Nilokeras and Jamuna mentioned by me was only one of a class, and I certainly gathered from his letter an implied acknowledgment that the hypothesis of Messrs. de Boë and Schleusner failed to account for certain important facts. If I was wrong in this I can only express my sorrow. It seems to me, however, that the effect is much the same, since no explanation of these facts is forthcoming, and it is not likely that an hypothesis will be very highly esteemed when its very advocates appear unable to make it account for the facts connected with the phenomenon which it was expressly devised to account for. Here is another little conundrum for the supporters of this hypothesis to solve:—How is it that the *same* "canal" at the same time, and under similar conditions, may appear double in one half its length, whilst in the other half it remains simple?

I certainly had no intention of imputing to "F.R.A.S." the heinous crime (?) of giving the names of "canals" and "lakes" to certain details on Mars. But your esteemed correspondent seemed positive that the so-called "lakes" *were* really vast sheets of water, so much so, that this circumstance in itself was apparently sufficient ground for dismissing with ridicule the observed duplication of certain of these "lakes." Hence my inquiry.

On p. 89, "F.R.A.S." treats us to an interesting little sketch of Jupiter. But neither the south equatorial belt, nor the first dark belt to the north of the north equatorial belt, nor the dark streak or portion of a belt on the south following limb of the planet, are shown double. Neither is any mention made of their double character. Unless an observer is able to see these belts double at a glance, and with perfect ease and distinctness, he is not likely to have the slightest chance with the double "canals" of Mars. For compared with the latter they are extremely coarsely double.

It would be interesting if observers of Jupiter would attend to the subject of these double belts. Comparison of the results obtained with different eyes and different instruments and powers might lead to valuable results.

Sept. 21. **A. Stanley Williams.**



SELENOGRAPHICAL—GUERICKE.

[32738.]—In the *Journal* of the Liverpool Astronomical Society, Vol. VI. plate VI., Mr. Elger has published a fine drawing of the remarkable group of lunar walled plains, Guericke, Parry, and Fra Mauro. In describing Guericke he speaks of a shallow valley which crosses its floor in a north and south direction, and of its prolongation beyond the walls of the plain on the south as far as the west side of crater B. In this portion of the valley he figures a succession of pits which he once took for a rill, but believes now to be a crater row. I have, on several occasions, looked for this crater row, and finally I succeeded in seeing something like it on April 17, 1891. But in looking carefully on those black spots with my 8½in. telescope by With, I found that they were the shadows cast eastward in the valley by the various hills which form its west border. As I have not been able to find any crater row in this valley under any other illumination, I conclude so far that these black spots are not craters. I shall be glad to hear if Mr. Elger has any further observation of this valley confirming his views. There are a few other differences between my sketch and Mr. Elger's to which I wish to draw attention. West of crater B Mr. Elger shows two comparatively large mountains. This was seen by me on March 9, 1891, as an inclosure formed by seven hillocks of various sizes. The east side of the valley is also formed by distinct hillocks; but, as a whole, not quite so important as those of the opposite side. On the plateau G, which is covered with granulations, I find, besides the craterlet, a ring open on the north. I found no central mountain on the large inclosure E, but hillocks and a crater as per sketch. The crater D on the south-east wall of Guericke has a hillock on its north-east side, and a much smaller crater is on the same wall between D and *d*, and another at *e*. Further north there is also the crater *g*. At 1 Mr. Elger figures a crater. I found here four hillocks, of which two larger. Under some illumination they may appear like a crater. On the west border of the valley, near the centre of Guericke, Mr. Elger gives another crater. Here again I found three hillocks. At 2 there is a succession of very small round hillocks very close together. I suspect they are craterlets, excessively small, like those which crown from end to end the top of the wall which closes Stadius on its north-east side, and which I have seen twice. The ridges 3 and 4 are absent on Mr. Elger's sketch. At F a crater, and no central hillock in the open ring west.

Vaison, Sept. 13. **C. M. Gaudibert.**

WOLF'S COMET.

[32739.]—I was pleased to see the remarks (in your current issue) of "F.R.A.S." *re* Wolf's Comet, the paragraph thereon on p. 38, and the letter from Mr. Freeman. As a further encouragement to owners of small apertures to examine it, I may be permitted to say that, with a 4in. achro., I have been watching its course on every available evening since it was situate in Triangulum. I failed to pick it up while in the Pleiades, but did so just before and after that transit. I saw it a few evenings ago near the line between ω^1 and ω^2 Tauri. Power, Kellner 25. J. B.

WOLF'S COMET.

[32740.]—I THINK Mr. L. T. Fleming's statement on page 38 of your Scientific News must have discouraged many who are possessors of only small instruments; but I can assure anyone that it could be seen at the time with less than 2in. aperture. I saw it for the first time on September the 2nd between 2 and 3 a.m.; then again on the 7th, about the same time. I could distinctly see the nucleus both times, so that it is evident that "F.R.A.S." is not mistaken, as he stated on page 89 that it might have been some very small star over which the comet was passing. The telescope that I used was a 5in. reflector, metal speculum, power 90. I could just get a glimpse of it in the finder, the aperture being less than 1in., power 10, so that anyone could see it with less than 2in. aperture if they could only find its exact position.

Hatfield, Doncaster. T. Moore.

THE AUGUST PERSEIDS.

[32741.]—From a careful reprojection and discussion of the lists of meteor paths that have been sent to me, and which were observed during July and August of the present year, I find the following radiants satisfactorily shown by numerous meteors on each night of observation:—

Date.	Radiant centre.	State of radiant.	Observer.
July 27	28 + 58½	5° diameter..	David Booth
July 30	28 + 57½	6° diameter..	J. Sherwen
Aug. 4	39 + 57	Sharply defined	David Booth
Aug. 10	43 + 56	8° diameter..	T. W. Backhouse
Aug. 10	45 + 55	Extensive, very	J. Plassman
Aug. 11	48 + 52	Extensive ..	J. Plassman
Aug. 14	56 + 58½	5° diameter..	David Booth

On July 27 Mr. Backhouse observed three meteors that were, in all probability, from the radiant found by the writer for this date, and he thinks these help to corroborate this radiant. Mr. Sherwen's observations on July 30 give practically the same place for the centre of radiation as that found by the writer's and Mr. Backhouse's observations on the 27th. If these meteors belonged to one system—the one usually understood by the name August Perseids—we naturally expect some displacement from the 27th to the 30th, though it is not shown from my projection of the paths of these meteors. But on August 4 the writer found that a radiant was active which gave a very sharply defined point for the place of divergence. The meteors evidently did not belong to the place of radiation found on the 27th July. There seemed to be no connection between them except in the characteristics of each meteor; the former radiant had apparently ceased, whilst the latter was giving more meteors per hour for one observer than the one on the 27th July. This seems important, as the display of the Perseids this year has been better than of late, and there seems evidence to show that the system gives gradually more meteors as the earth enters it, and as time progresses, until a maximum display occurs on August 10. Mr. Backhouse, observing on this date at Sunderland, found that the meteors increased in numbers in their rate per hour up to 14h. 55m. Afterwards they showed a marked decrease in the hourly rate, and he thinks that it was a true feature of the system and not caused by any interference of observations by twilight, haze, or cloud, for which his work has been carefully corrected.

From the numerous meteors observed on July 27 and 30, and again on August 4, and comparing these with the fairly rich display which was seen on the 10th, we might, perhaps, venture to conclude that in future years if the radiants which are forerunners of the great Perseid system are pretty active in the latter part of July and early part of August, that the annual display on the 10th of this month will be fairly rich, i.e., if the radiants previously given are all members of the same system.

The extensive area of radiation shown by Plassmann's list is a point that might perhaps be termed weak with relation to the shifting of the radiant. But on trying to find sub-radiants, I conclude there is no evidence of them. There was an apparent outside radiant at 26 + 43 where the meteors came to a pretty sharp focus compared with the extensive diffusion of the whole of the projected path; but six out of the eight meteor paths giving this apparent radiant could be most favourably classed as belonging to the true Perseids. Other portions of this area give evidence somewhat similar, and the points 46° + 45°, 30° + 61°, and 60° + 53° (which are the pertions of the area alluded to), can be dealt with in the same manner as the former at 26° + 43°

It is worthy of note that the radiant on August 11 was 8° less in diameter than on the 10th, as shown by Plassmann's list of meteor paths, and the writer's reprojection of them. On August 12 Mr. Backhouse observed 15 meteors, but the Perseids did not show any definite centre of radiation from my reprojection of them.

On August 15 the writer recorded 14 meteors whilst watching the Perseid portion of the sky, but there were no signs of definite radiation.

It would be interesting to learn how Mr. H. Milligan and Mr. Gobriel determined their radiants. Were they the outcome of a discussion of recorded paths, or guess-work during the progress of the shower? If the latter, I am afraid little weight can be attached to it.

The question of the shifting of this radiant is, I think, partly proved from the foregoing collection, and what has previously been accomplished. Unfortunately we are not often favoured with a long spell of fine weather sufficient to get a continuous list of radiants during one season, so we must make the most of what we can get, and strive to rightly interpret our observations. If personal equations, errors of observation, and other disturbing causes are taken into account, the radiants given at the fore part of the letter agree fairly well by those found by Mr. Denning for these dates.

70, North-street, Leeds. David Booth.

METEORIC DUSTFALL ON THE MOON.

[32742.]—IN letter 32678, Mr. Peal refuses to accept "the conclusion that the dustfall on the moon and on our earth must be the same;" and, since the force which leads to this dustfall is the force of gravity, and since the earth possesses a greater mass than the moon, it seems likely that it would attract more meteor dust to itself than the moon can to herself, in proportion to the greater attractive force it exercises on surrounding space. For if meteoric matter is equally disposed through the surrounding space, each planet would receive an amount that depended on its own mass or attractive force. H. G. Dixon.

THE ICE AGES.

[32743.]—I BEG to refer "G." (letter 32690) to Dr. Haughton's papers published in the *Transactions* of the Royal Irish Academy for 1881 and 1886, where he will find most of the information which he is seeking for. Dr. Haughton's figures, however, do not, I think, quite agree with Sir Robert Ball's. I make them 39·62 for winter to 60·38 for summer for the hemisphere; but Dr. Haughton has only computed them for lat. 60° where the proportions are 34·2 for winter, and 65·8 for summer. Dr. Haughton's results would be well worth publishing in a more available form. They do not appear to me (or I think to the author) to favour the theory of Dr. Croll, the secular change due to alterations in the eccentricity of the earth's orbit being small compared with the annual change. He notes specially that the secular change will not account for the coal-beds in East Grinnell Land. W. H. S. Monck.

THE GLACIAL PERIOD.

[32744.]—ONE fact connected with the glacial period I do not remember having seen discussed. In the Glacial period the ice *respected our present Equator*. In both the northern and southern hemispheres we have evidence of glacial action extending down to near the tropics, but it ceases there. To my mind this seems to prove that the Glacial period was not due to a shifting of the earth's axis. Another astronomical cause assigned for the Glacial period is a change of the earth's axial inclination. But would not a lesser inclination lessen the length of the long, cold winter's night at the poles and give snow and ice a lessened chance of accumulating and protecting itself? And would not an increase of the inclination bring an increase of heat in the summer, which would more than counteract the cold to which there is a definite physical limit? Would some of your readers kindly tell me what inclination of the earth's axis would give the nearest approach to equilibrium between the heat and cold around the poles? If the Glacial period came on suddenly, or if it were recent as there is some considerable evidence to show, then neithr of these astronomical causes would seem at all likely. Mr. W. Shone, F.G.S., of Chester, has written some interesting matter to prove that the original diluvial legend was preserved by Neolithic man as a direct tradition of the Glacial period. Prof. Wright, in his book on "The Ice Age in North America," produces a mass of evidence, from different authorities and his own observation, which seems to make the Niagara gorge a clock to tell us that the Glacial period occured not more than eight thousand years ago! Niagara gorge is seven miles long, cut through hard limestone underneath which is soft shale. Midway in the gorge is the great whirlpool where the course of the river turns to the right. At the whirlpool there was formerly another outlet to Lake Ontario, but that outlet has been completely and visibly blocked w
glacial *débris*. When that blockage took place
river sought another course, which is the pres
gorge below the whirlpool; and since that time
Falls have cut their way at a minimum rate
2½ft. per annum from the escarpment over L
Ontario to their present position, seven miles hig
up. The rate of recession is calculated on obser
tions extending from before 1842 to the pre
time, and on surveys made by the geolog
authorities of the Canadian Dominion Governm
and of the State of New York at the time when
land on either side was bought up for conver
into free public parks. The gorge of the Missis
at St. Anthony's Falls, near Minneapolis, is al
the same length as that of Niagara, and corr
rates it in every particular. The general calc
tion for time is also checked by the slight exten
the weathering on the exposed sides of the cutti
even in that climate of extremes. Rougher
mates exist in certain drawings of the Je
missionary, Father Hennepin, who discovered
falls in the 17th century, and in drawings later
his time. Canopu

LIGHTNING—SPACE—THEOSOPH
AND ETHER.

[32745.]—IN reply to the questions of "F.R.A
(p. 89) and Mr. Lecky (32665, p. 41), I do not
quite sure what is meant by the ordinary expl
tions and the "lightning stroke." Mr. Le
own words, "an electric current of imm
velocity passing through conductors of less or
capacity and resistance," convey as nearly
possible the ideas held by scientific men as t
nature of a flash of lightning. It is a sudden
version of an immense quantity of energy from
latent or potential state into kinetic forms, as
and work (not useful to us). There is no reas
suppose that air is consumed, though some is tu
into nitric acid probably, but it is intensely he
But the visible flash is merely the axis, the
intense portion of a widespread distributio
energy, much of which was previously prese
the air space as "stress," and not suddenly em
by the clouds as a discharge. My own opini
that the chief source of the energy of lightni
the rain; that it is the energy of vaporisati
water present in the air and suddenly conde
which generally falls in greater quantity even b
the thunder is heard.

I should doubt the tree having been "struck
low down, as "F.R.A.S." describes. I think th
leaves (which are very good conductors) collected
kind of brush discharge from the surrounding air
and that the current *left* the tree at a point whe
from the nature of the wood, it found obstructi
and went to earth at some favourable spot wh
there was a vein of moisture or some other attra
tion. The fencing wires offered other outlets, a
took part of the discharge. The account of t
man's sensation is curious, and I will not pretend
explain it; possibly he did not receive a real di
charge at all, but formed part of an induc
current. The case of the church is nothing unusu
as the path is often very capricious in appearanc
though resulting from the nature of the material
and prepared during the period of stress, before t
flash occurs.

I am much surprised to find Mr. Grey defendi
the idea of space of four dimensions, because
always poses as the opponent of anything mystic
and outside the bounds of the "real." I cann
attempt to meet all he says, which, indeed, I ha
answered by anticipation on p. 70. I will select o
or two special points. He says "a creature livi
in two-dimensioned space, and such creatures a
conceivable, would be incapable, &c." I deny t
existence of two-dimensioned space, and the co
ceivability of any creature existing in what is mea
by it. In face of the absurdities which are calm
set forth, we must anchor ourselves to first pri
ciples. We have to deal with "concepts," for o
minds, like our eyes, do not see real things, b
pictures formed within the mind. But concep
are of two orders: conceptions or perceptions
things which really exist, and abstract ideas wit
out which we cannot define or comprehend realiti
Now our fundamental concepts are, of necessit
the *locus* or place in which existence occurs, and t
period during which the events of existence occu
These are the two fundamental concepts, "space a
duration," and both are pure abstractions: they a
not existences themselves, but the conditions
which existence depends; and, by the very natu
and necessity of their existence in our minds
concepts, they are limitless or infinite. In anoth
sense they are *lengths*, extensions, and durations
which progress can be freely conceived. As so
as we try to give them a concrete form, we a
compelled to think of them as built up of successi
units, or measures of length, which is dimensio
but duration has only one length, measurable
time, while extension includes an infinite numb
of lengths, because progress can be effected in a
direction. Space cannot be defined in words whic
explain its nature, because it has no nature; the ve
concept itself is the negation of properties, active

ive: it is purely the *locus* in which unopposed tion can be conceived.

It follows that space itself has *no* dimensions; when we try to make the concept a concrete , we find that motion in three directions, at ht angles to each other, will give us definite ts of parts of space, and then, by the addition of ity, of all space. Now begins the function of thematics, exact definition and measurement, we introduce the Euclidean lines of thought. t, we start with the *point*, a locus without ensions. We pass to the *line*, which is mere gth, the straight motion of a point in space, mis- ed space of one dimension. The motion of a at right angles to itself gives us an *area*, mis- d space of two dimensions. The motion of a area at right angles to itself gives us the , miscalled space of three dimensions. But no her motion can give us any fresh conception— because, as Mr. Grey says, "we have no rience of the kind of space corresponding to ations of the fourth (or higher) degree," but use no such equations exist at all related to the ept "space," and because our three motions e already included all possible directions in ce.

Let this be clearly understood. The equations d dimensions do not relate to the concept "pure ce" which involves free motion, but to an altoer different concept—to a structure or limitation his *space* which would control motion, which ture, with all deference to the mathematicians to their present champion Mr. Grey, we know, absolute certainty, does not exist in the true al dimensions of 1, 2, and 3 directions, and ch it is a mere absurdity to attribute to an altoer imaginary directive structure.

I said space of two dimensions has no existence, it is impossible to conceive a creature existing it. Let us prove this. A "line" is pure length; has absolutely *no thickness*—in other words, it has existence, except as a mental definition. The argument applies to the "area," or plane ce; it has no thickness—*ergo*, no existence as a concept—it is nothing more than the line contact with the two spaces on each side of it. , will Mr. Grey tell us that any creature is conceivable which possesses absolutely no ness whatever? What is this but nonstence? Now, non-existence is already preted as to the concept space; but if the creature non-existent, what on earth is talk about what it ld do but idle waste of time? By the very ture of the concept itself, *space has no existence* as a concept) *until the third dimension or ction is introduced*, and beyond that no other nsion is conceivable. So-called "space of two nsions" is not space at all; it may be called dimensions of space, or two directions *within* , but that is a very different thing. Mr. Grey see that this answers his last remark. For all now or care, there may exist a universe in which imaginary limitations to motion exist which stitute the so-called higher dimensions. We all ow that they do not exist in this universe, and t there is not a single "evidence in favour of scendental space," and therefore I am justified calling all discussion about its possible qualities e idle rubbish.

Now to fulfil my last week's promise as to the alleged occult powers, the miracles, and Mahatmas theosophy, and the singular way in which they related to the fashionable make-believe science the ether. It is claimed that it is possible to promaterial substances and forms by the action of mind and will of some specially-gifted persons. let us note that this is precisely the power med to exist by the spiritualists—say by the brated Mrs. Guppy, who in many cases proved possession of this power till her process of erialisation" was discovered. Some little ago a gentleman who was distressed at my ticism in relation to the functions of the r, sent me a pamphlet, "with the author's pliments," entitled "Darkness and Light in the of Egypt. An Indication to Antiquity of ible Sources of Energy in the Physical verse." I am going to use this as my text and ority for the opinions and explanations that I going to deal with, because they are closely ted to the theosophic doctrines.

"In the East it is currently affirmed there are le existing, and not there alone, who, when choose, are able to work prodigies by formuwhich they know by rote: matter can be lved, transferred, and redisintegrated in the ame forms; distant places and occurrences can n; and they, indeed, assert they can do the e class of marvels their predecessors effected the time of the Pharaohs." Yes, we are told ame Blavatsky could call down a shower of by waving her hand, and we know Mrs. y did sprinkle her companions with sand; people are cruel enough to say that examinaproved that sand to have come from a beach in vicinity, which she had visited the day before. will be seen presently that this explanation does get rid of the miracle, if we only have faith in properties of the ether, which Mr. Tolver Preston is so kindly explaining *out of his inner consciousness*—not out of any knowledge of his own or other people.

"That this is not taxing our credulity unduly, or scientifically impossible, is apparent to whoever considers the subject of electricity, as presented in such Vedic writings as those of the late Clerk-Maxwell, which suggest nearly as much as they tell." "The extreme solidity of the ethereal medium of light compels us to alter our entire conceptions about matter, notwithstanding the difficulty of imagining a crystalline mass infinitely harder than steel, and many million times lighter than air, perfectly elastic and transparent, and whose atoms can slide transversely and have no friction." "There is hardly an escape from the conclusion that material bodies move in the ethereal solid by a free and continuous exchange of their atoms with those of the ethereal medium." "The multiform varieties of matter are solely due to the mode in which its particles are combined with energy—the atoms of medium meeting atoms of matter, first coalesce, and then instantly restore the like material shape." There, now we know all about it, and are ready for the miracles.

"In consequence of this property, we are, so far as mere matter is concerned, quite differently composed after we go up a flight of stairs, or cross the street,—what constitutes our personality is not inert matter, but the energy and modes of its distribution, which are preserved intact when we move about." Space of four dimensions! How does Mr. Grey like this development of ether doctrines? But, remember, I foresaw that it must come, when I wrote in my "Electrical Common-Sense" that the ether doctrines, as to transfer of energy in the case of current in wires, must inevitably be applied to the case of transmission by bands and shafts. We only need the question put by the author, "Whether the ethereal medium has not the sense properties of protoplasm, recognising, with a sort of animal intelligence, certain rhythmic intonations," to bring us to Dr. O. Lodge and his suggestion that telepathy, or transfer of thought, is an ethereal action.

"They claim in the East to know how to transfer material objects to, or from, great distances; but are unable to describe by what scientific means this rather commonplace feat, according to their statements, is performed." Now we shall see how honestly poor Mrs. Guppy got that sand. "It is clear that to fetch, for example, a watch and chain from Europe to India does not require a particle of their gross matter to be moved. The objects are, in essence, nothing but the ethereal solid medium in a condensed state, only this is combined with different forms of energy, arranged for each in a special order. All that is necessary—for there is the matter at hand in the ethereal medium everywhere present—is, by hook or crook, to attract the energy merely across to India, and set it to work to re-form the watch and chain, which, having surrendered their energy, melt away into atoms of the ethereal medium in Europe, where they had stood, and become lost to sight there forthwith."

Yes, *that is all!* and yet a faithless "Kappa" wants to know if it is all vulgar imposture. Alas, a faithless generation demands a sign, and I fear—I fear very much—that they will not get it; but we will wait for that little bet of Mr. Stuart Cumberland's to come off. But this I will say: it is not a fraction more absurd than the doctrines which scientific men are teaching and calling "orthodox"; and the pernicious habit of inventing hypotheses to give make-believe explanations—of attributing imperfectly understood facts to the action of an imaginary ether, instead of tracing out the real actions of matter—must lead to some such quagmires of thought as those I have presented for the edification, or, at all events, amusement, of our readers. I have to thank the author for his pamphlet, and for several very enjoyable laughs.

Sigma.

SUNSET PHENOMENA—ERRATA.

[32746.]—The beautiful phenomenon witnessed by Messrs. Clapham and Blakeley (letters 32662 and 32643), has often been recorded in these columns, and has had a variety of causes attributed to it. It has been misnamed the "Zodiacal Light," "Auroral Light," "Sun-pillar," and "Green Ray" again and again, and, with a greater show of reason, "the Afterglow." Dr. Doberck says (*Nature*, Vol. XXXVII. p. 464): "These phenomena known as crepuscular rays are commonly seen in China, and are most frequent at the height of the typhoon season, and afford a warning indicator of their approach." He attributes their cause to invisible cirro-stratus clouds high up in the air; but Lieut.-Col. Markwick ("E.M." No. 1281), says they are "simply due to rays of light passing through apertures in clouds below the observer's horizon, and which by the effect of perspective appear to diverge from the sun's apparent place, although in reality parallel to each other." A very fine repetition of this phenomenon was witnessed on the evening of Sept. 11 from 6.45 to 7 p.m., when two immense cones of pink light, divided by a bright rift or inverted cone of a pale sea-green, brightened up the sunset horizon considerably, and in a few minutes rapidly disappeared.

There are two obvious printer's errors in letters 32711 and 32712. In letter 32711, last line, for "finest" please read "poorest," and in letter 32712, last line of ephemeris, for "Oct. 20" read "Oct. 30."

Sept. 21. **D. E. Packer.**

A GREEN RAY.

[32747.]—I am obliged to Mr. Clapham and to "H. B. F." (32662, p. 3) for their replies to my letter.

I think that Mr. Clapham is probably right in his supposition that what I saw was a rift in the red solar glow, which appeared green by contrast. Though, as I saw *no red glow*, it is strange that I should have seen this green ray. In reply to "H. B. F.," my place of observation was Dewsbury.

Dewsbury. **E. Reginald Blakeley.**

OHM'S FORMULA.

[32748.]—Mr. Benjamin is right and Mr. Harcourt wrong, as regards the working out of the example in question—

$$\frac{4\text{ volts}}{\frac{1}{2}\text{ ohm}} = 8\text{ ampères.}$$

It is nothing remarkable that the ampères of current in a circuit should exceed the number of volts E.M.F. in that same circuit. Consider, for instance, a secondary cell having an E.M.F. of 2 volts; if one cares to short-circuit it, a current of many ampères can be obtained.

W. Perren Maycock, M.I.E.E.

[32749.]—In letter 32730 Mr. Harcourt endeavours to quash Mr. Benjamin's argument against Ohm's Law by correcting (?) his calculation. It is very diffiult to understand how he can metamorphose $\frac{4}{\frac{1}{2}}$ into 4. But, however, I think that without this admirable calculation it is not difficult to upset Mr. Benjamin's argument. Why should not the current have a greater numerical value than the E.M.F.? Current and E.M.F. are essentially different properties. The current is the result of the E.M.F. If there were no resistance (in practice, of course, impossible), the current would be infinite, and as the resistance increases the current gradually decreases in value. The units of measurement taken in all cases are arbitrary, and if Mr. Benjamin wishes to make the current and E.M.F. numerically equal in this case he has simply to take as a unit for the current one twice as great as our ampère.

Stud. Inst. C.E.

BALL-BEARINGS.

[32750.]—We read with pleasure "Ball's" letter (32702) on the application of balls to machine tools, and noting he is a fellow townsman, should be pleased to show him a little we have done in this direction. We are hardly prepared to go into the question of running heavy crank-shafts on balls; but from our experience should say it was not impossible, as we are using them under great pressure, and without any difficulty, in a shaft-straightening machine taking bars up to 4in diam. We are also using them in a shafting lathe, equal to 12in. centres, for taking the end thrust of fast-head spindle doing very heavy work, the balls having been running for three years without a single one being displaced. The first lot applied did not last as many months, owing, we guess, to balls not being of uniform diam. and hardness. This arrangement we patented several years ago, and now make a speciality of same in lathes and drilling machines, never sending either out without ball thrust bearing to spindle. We may add the corner drive pulleys running on balls at Coventry, mentioned by "Ball" in a former letter, were made by us.

Ketton and Hollis,
Meadow Works, Nottingham.

HINTS FOR EXPERIMENTALISTS.

[32751.]—It has occurred to me that Prof. Crookes's radiometric experiments furnish one out of many partial solutions of the question how to differentiate the effects of various colours in photography, &c. Prof. Crookes found that, assuming the radiometric effect of a certain quality of dark heat to be 100, that of the visible rays in the extreme red was 85, in the red 73, orange 66, yellow 57, green 41, blue 22, indigo 8½, violet 6, and in the ultra-violet or most highly actinic rays, only 5. If, therefore, in an exhausted glass vessel we had a surface composed of many little blackened aluminium discs, suspended by very fine wires, these discs would be repelled in the degrees just indicated by the rays of light in a projected image, and the sensitiveness of this arrangement would be of a different order from that of most sensitive plates..

Of course, the readiest method of reading and of recording the effect of light upon such surfaces would be through a system of carbon contacts, such as are used for microphones. Small currents of electricity would be passed through the fine wires, the discs, and the spring contacts, and thence through delicate relays, and we should thus secure somewhat similar effects to those which have been obtained with selenium cells. The most obvious, but not the only, commercial application of this idea would be in telephotography. I propose also to employ absorbent discs, &c., of different materials, so as to analyse the nature of the mixed lights in different parts of a projected image.

A. D.

THE ELECTRIC FLUID (?)

[32752.]—IN letter 32691 Mr. Septimus C. Gurney inquires if it is correct to speak of the electric current as a fluid, as newspapers invariably report it as such in connection with accidents resulting from lightning. As Mr. Gurney is probably aware, at least one of our eminent electricians is convinced, that electricity is a fluid, but this does not necessarily make it so, unless, indeed, energy can be called fluid. Perhaps this is where the mistake is. Take, for example, a primary battery. If we place within the exciting solution a plate of carbon and a plate of zinc, without any metallic connection between them, we get no evidence whatever of the existence of electricity, for the simple reason that without the conductor there can be no current, inasmuch as the energy developed as a result of the decomposition of the positive element is going to waste, having nothing outside its source upon which to act, and thereby manifest itself. It may be a very difficult matter to many to thoroughly comprehend that energy manifests itself in such a variety of ways; but by this time it should be clear, at least to our scientists, that electricity is purely and simply the result of energy acting on certain bodies; in short it may be described as the peculiar condition of the conductor under the influence of energy.

As regards atmospheric electricity, Mr. Gurney will find an exact parallel in an overcharged secondary battery. Under the effect of a superior disturbing force, a degree of tension is produced in the air molecules which can no longer be maintained, resulting in the rapid alteration of their position, and it is where the atmospheric conditions are most suitable that the effect—viz., the return of the molecules to their normal condition—giving rise to the flash, takes place. Owing to the rapid motion of the disturbed—or, more correctly, escaping—molecules, combustion takes place, rendering the path of disturbance luminous. There is no doubt but that it is this luminosity that has so long deceived us, for many appear to think that the spark is pure electricity, whereas it is merely the effect of energy on that which is capable of being rendered incandescent. We can easily understand why our forefathers looked upon it as fluid fire, for at that time they could not be expected to comprehend that in the apparatus at their disposal they had the means of producing, confining, and transmitting energy in a most convenient manner.

Wm. Laughton.

SPACE OF FOUR DIMENSIONS.

[32753.]—THE argument which Mr. Wm. John Grey (32719) considers the best in favour of the existence of space of four dimensions, reminds us of our youthful days, when we were asked whether we would have the "first slice" of a leg of mutton! I suppose that slice is of two "dimensions," and yet none of my acquaintance, as far as I ever heard, got anything out of it, nor have I ever heard of anyone who ever found anything in it, whether living or dead. Perhaps Mr. Grey lives in hopes that he some day will, since he talks of its being conceivable that creatures may exist in space of two dimensions? If this is so, alas for the untold labours of the microbe investigators; they may as well begin at once to rest and be thankful to Mr. Grey. Surely the brief remark of "F.R.A.S." (32706) is a sufficient hint to a reasonable man.

L. B. B.

A NEW GAS-STOVE.

[32754.]—I HAVE recently heard of an invention which is likely to be very useful in warming rooms economically, unless it has an injurious effect upon the air of the room. It is a small steel globe which can be used on any ordinary bracket.

The gas is not lighted at the burner, but at the small holes in the steel globe, through which the mixed air and gas is forced, and where it burns in a small blue flame. It is said that the intense heat to which the united air and gas are subjected, consumes all the injurious products of combustion. Would this be so? Perhaps Mr. Fletcher or some of your readers would kindly express an opinion.

I once used a regenerative gas-stove that did its work well as to giving heat without any unpleasant smell; but the products of the combustion were decidedly injurious.

Householder.

MAGIC SQUARES.

[32755.]—HAVING noticed in your issue of the 4th inst. some examples of magic squares, I take the liberty of sending you two arrangements, viz.: one for the numbers 1 to 36, and the other for the numbers 1 to 25, which I succeeded in putting together some time ago, but which I have not seen in the particular forms, as shown below.

(1) The square with the numbers 1 to 36.

FIG. 1.

16	13	18	19	22	23
7	6	11	34	25	28
33	36	27	2	8	5
32	29	35	10	1	4
9	12	3	26	31	30
14	15	17	20	24	21

FIG. 2.

−2½	−5½	−½	+½	+3½	+4½
−11½	−12½	−7½	+15½	+6½	+9½
+14½	+17½	+8½	−16½	−10½	−13½
+13½	+10½	+16½	−8½	−17½	−14½
−9½	−6½	−15½	+7½	+12½	+11½
−4½	−3½	−1½	+1½	+5½	+2½

In Fig. 1, the sum of the numbers in each column, row, and diagonal, is 111. The square itself can be divided into six portions, as shown by the thick lines, and the sum of the numbers in each is 111. If the total sum, viz., 666, be divided by the total number of squares, viz., 36, the number 18½ is obtained. Subtracting 18½ from each number, and keeping the resulting sign, the numbers will appear as in Fig. 2, from which it will be seen that the numbers in the second row are identical with those in the fifth row, but in the reverse order and with opposite signs. The numbers in the third and fourth rows follow the same law. The numbers in the first and sixth rows follow partly the same law, and similarly in regard to the columns, the third and fourth deviating.

(2) The square with the numbers 1 to 25.

FIG. 3.

1	22	20	5	17
15	3	18	19	10
24	12	13	14	2
16	7	8	23	11
9	21	6	4	25

FIG. 4.

−12	+9	+7	−8	+4
+2	−10	+5	+6	−3
+11	−1	±0	+1	−11
+3	−6	−5	+10	−2
−4	+8	−7	−9	+12

In Fig. 3 the sum of the numbers in each column, row, and diagonal is 65. The square itself can be divided into portions, as shown by the thick lines, the sum of the numbers in each portion being 65. Other groups of five numbers can be found in this square giving the same result.

If the total sum—viz., 325, be divided by the total number of squares—viz., 25, the number 13 is obtained. Subtracting 13 from each number, and keeping the resulting sign, the numbers will appear as in Fig. 4, from which it will be seen that the numbers in the first row are identical with those in the fifth row, but in the reverse order, and with opposite signs. The numbers in the second and fourth rows follow the same law, and the middle row is symmetrical, and similarly in regard to the columns.

J. H. Truscott.

STONEHENGE.

[32756.]—I HAVE before me your number of July 10, and the interesting article by Rev. J. M. Bacon, F.R.A.S.

Mr. Bacon appears to have made his visit without providing himself beforehand with the accurate bearings of the sun at rising on the morning of last solstice, which are easily got from the usual nautical tables, and would have assisted him in his observation of the sun from the Altar Stone when rising, and on the top of the Friar's Heel.

To supply this deficiency in future to anyone who chooses to make the pilgrimage, I have made a few calculations, and here give the results—premising that these results are for the sun on the real horizon, and that they must be modified to adapt them to the actual horizon as visible from the Altar Stone.

The latitude of Stonehenge is 51° 11′ N. The sun's extreme declination N. at present is 23° 27′; and the magnetic declination, as near as can be estimated, 17° 20′ W.

With these data it is easily found that on the morning of last summer solstice the sun appeared on the real horizon, allowing 58′ for atmospheric refraction, at an angle of 49° 37′ from the North Pole, or as seen with a prismatic compass, 66° 57′ from the Magnetic North Pole.

But possibly it may occur to few to reflect that this angle of the appearance of the sun, however accurately it may have been fixed by the Druids about 14 centuries ago, cannot possibly be now correct, on account of the gradual decrease of the angle of the Ecliptic, which is giving one amounting to 51·13″ per century, or in the 14 centuries, to 12. A corresponding alteration has taken effect in the same time on the point of rising of the sun, which at the summer solstice is 22′ of angular distance nearer to the Pole than it was 14 centuries ago. The effect being that, if one of the Druids could now come on summer solstice morning, and look over his own line, he would find the sun rising about two-thirds of its diameter to the left of what it should do by the line.

It might be possible, by minute examination of the ground, to fix accurately the original bearings, and by accurate measurement and adjustment for horizon, &c., to ascertain accurately the corresponding present line of sight. The actual difference of these two lines would fix approximately the true time of erection of Stonehenge from an astronomical record, and check or disprove the statements of tradition.

Sept. 16. **E. Erskine Scott.**

CHILD-MARRIAGE IN INDIA, &c.

[32757.]—"Eos," is right—it is terrible to think of the "future troubles" we are sowing in India (together with the good seed) that so few at home can realise. "F.A.M.'s" letter is a case in point. In all the latter says, in regard to absolutely cruel customs, I most cordially agree, as in the suppression of Sati, female infanticide, and the forced cohabitation of little girls of nine and ten years with adult husbands, under the plea of religious observance.

But in matters of opinion, regarding what he calls "morality," we have as little right to interfere with local races here, as the Hindus have to stop us, in India or England, killing and *eating* cows.

A most dangerous and widespread agitation is, I hear, imminent over this custom of ours; fanatics proposing to boycott us here and send or go to England to enforce their views and stay the sacrilege. I would ask "F.A.M." to slowly and carefully reperuse my letter 74338, and he will see that the sexual liberty before marriage he is so shocked at is a most widely-spread *racial* custom, a relic of the stage of human development ere marriage arose. The extreme antiquity of it is obvious by its survival among races now differentiated into Negro (Masai), Mongol, Papuan, Sawaiori, and Malay. "F.A.M." must recollect that, except among so-called civilised races (all over the world), juvenile chastity is not valued, and that any well meant attempt on our part to curtail this liberty by penal laws, would most certainly be disastrous.

He, of course, considers our system of morals (our *mores*—customs) right, and the others quite wrong. That is a *racial* "matter of opinion." Surely, we are not perfect? and able to throw the first stone at the (so-called) sinner. If a (poor) native goes to the bazaar for some Manchester cotton cloth, he, at times, finds it 20, 30, or even 35 per cent. *clay!* Say, is that moral? And has he not a right to complain of *our mores*, or customs? Have we not some 80,000 prostitutes in London alone, and do not our capitalists gamble in the food that poor children pine for?

Had we not better take such beams out of our own eyes, before we begin on the mote in our brother's eye?

Except among semi-savage races, where missionaries can do a vast amount of good, native converts to Christianity cost about their own weight in silver—would not this be better sunk in Barnardo's homes and helping the slum children?

Regarding drink and opium,—both, in excess, are bad, like beer, and here, should be regulated; but folk at home are often woefully misled over these matters by benevolent fanatics. That "we have taught the natives of India the use of drink and opium," is simply untrue. Drinking *many* sorts of liquor, soma included, was known in India when Englishmen and women were painted savages. As a F.R.G.S., fond of travelling—I have at times,—when across S.E. Patkai, and at Dapha Búm, where there are no inhabitants, met extreme difficulties, which my men could not surmount, and often and often the cry has been for the "Konia," the *opium eater!* and he did the trick for us.

The "frightful harm" "F.A.M." refers to is on a par with the excesses we (at times) see at home, as due to too much beer.

I do not indorse all that the "Government of India" is doing, but certainly acquit it of a desire to raise the revenue at the cost of sobriety among the people. That is the clap-trap laid before the Britisher who knows not India, and who cannot see the *other side* at all. Most of your thoughtful readers could at once see that the custom of running out to India during the cold season, and rushing about for information of a particular kind, and then publishing it for the general information (?) at home, necessarily *must be* often most misleading. But the general public do not see this, and hence the danger.

I shall always be glad to answer questions about India *that I know anything about*, and I hope "F.A.M." does not think that I object to well-meant (feasible) reforms out here. In 1866 I had schools among my workmen long ere the Government started the present educational craze. Can "Eos." give me no clue to his identity? **S. E. Peal.**

Sibsagar, Asam, India, August 8.

WASTED FOOD.

[32758.]—As Mr. Jerrard (p. 94) asks me, I will say that it is difficult to distinguish all the fungi to be picked up in woods and fields merely by studying books, excellent as some of them are. The object of my previous letter was to induce those who really do know to do what they can in their districts to show those who are willing to learn the distinguishing features amongst the common fungi by taking them out where the specimens are to be gathered, and pointing out the differences on the spot. Fungus forays are held about this time of the year by many of the natural history societies, and I am sure that the leaders would gladly give any information in their power. There is surely some society of the kind in the New Forest or in a town in the vicinity; if not, there ought to be. Dr. Badham's "Esculent Funguses of England" has some coloured plates, and is published by Reeve, of Fleet-street (the old house about to be pulled down, near St. Dunstan's church), at 12s.; but a useful book is Dr. M. C. Cooke's "British Fungi," with coloured plates (Allen), at 6s. The illustrated sheets drawn by Mr. W. G. Smith, which I think are still to be seen at the Bethnal-Green Museum, and which are published with letterpress under the title of "Mushrooms and Toadstools," by Messrs. Allen, at 10s. 6d., would be eminently useful to any student who would take up the subject. The *Transactions* of the Woolhope Club (Hereford), for 1869 contains much information on mushrooms which are useful as food, but are often destroyed; and also Mr. W. G. Smith's "Clavis Agaricinorum," which is, however, for the scientific student rather than for the field teacher. Perhaps that gentleman, who, I believe, is now living at Dunstable, if he sees this, may inform us which work he considers best suited to the wants expressed by Mr. Jerrard; but it is certain that clergymen, schoolmasters, and those kind-hearted ladies in country districts who are always seeking for some good work, might be of much benefit by teaching children to distinguish the edible from the poisonous fungi. Most country people know the common mushrooms, Agaricus campestris and A. arvensis, as well as the Champignon or "Fairy-ring" mushroom; but even the last named is often destroyed because "accidents" happened with its cousin, Marasmius urens, and coloured fungi are invariably classed as toadstools and smashed, as is the Boletus, which, as Dr. Badham says, in vain calls himself "edulis," and, as Mr. Bottone can tell you, is bought largely in Italy by people who would not eat what we call our common mushroom.

Saml. Ray.

[32759.]—Mr. Jerrard is correct in thinking that it is not an everyday task to distinguish between edible and poisonous fungi. The only proper way is to first find out the genus and family, and then, if it apparently agrees with an esculent species, to cook and eat a very small portion. If no fatal result follows, it may be safe to indulge more extensively. The best book I know on the subject is by Cooke, price, I think, about two guineas; but the first volume only will be required for the majority of edible species. There is also a small, popular book, published at 1s. by Worthington Smith. It is very good of its kind, and has plates; but it must be remembered that fungi are variable and do not always grow in accordance with the pictures, either in form or outward colour. Still, there are certain kinds, e.g., Agaricus campestris, Ag. procerus, Ag. arvensis, Coprinus comatus, Hygrophorus virginius, &c., which once recognised can scarcely be forgotten. The Giant Puff Ball (Lycoperdon giganteum) is very delicious when toasted in slices and eaten with jam.

Regarding the want of dissemination of micophagic knowledge, I think there is another reason besides its difficulty, and that is the scarcity of edible fungi in this country tends to make those who know of their existence preserve the knowledge for their own use.

I am not going to write a complete dissertation on fungi: I could not now if I would, since circumstances have not permitted me to follow the pursuit for some years past, and I do not possess any books to which I can refer. I can, however, give some idea of the subject. Treating only of the larger fungi, they are divided into several families. I., Agaricus, consisting of a pileus or cap, which bears on its under surface the gills, on which are found the spores. The pileus may be campanulate or flat or umbonate, possessing various degrees of convexity and concavity. The spores are either white, pink, brown, purple, or black. The stem is either solid or hollow or stuffed, and is either continuous with, or distinct from, the flesh of the pileus. The gills may be fixed or adnexed, or adnate or decurrent (running down the stem). The stem may bear a ring, or be ringless. It may be glabrous, or hairy, or reticulated, &c. All these and other characters have to be noticed, such as size and form of spores, habitat of growth, &c., before deciding upon the species. II. Cortinarius is allied to Agaricus; but I never found more than a single specimen, and do not know much about this family. III. Hydnei has spines instead of gills. IV. Marasmius is represented by the champignon, M. oreades. V. Russula has always white spores. The pileus is usually flat or umbonate, and the gills are fixed, or decurrent. Vivid colouring is frequent, and the flesh is very firm. VI. Hygrophorus (or water-bearing) runs small in size. VII. Coprinus. The gills turn black when old, and the whole plant turns to an inky substance. The form is allied to that of a pine-cone set on a stalk. VIII. Boletus possesses tubes instead of gills—i.e., like a sponge. The form is very varied, from a mushroom shape to a formless excrescence growing on a tree. IX. Lycoperdon, or Puff Ball family. These are a few of the many known families, and all contain edible species. **Sm.**

[32760.]—Worthington Smith's is, I believe, the best book in a cheap form on fungi; while as to cooking, simple toasting is the best, to my view; but as all fungi are to me more or less digestion's, &c., disturbers, I cannot utilise the most delicious abundance growing in the fir grove on my place; while the gorgeous *Agaricus muscarius*, one of the most powerfully medicinal agents of homœopathy, used in Kamschatka as an intoxicating infusion, is in profusion enough to supply for that end several Kamschatkan communities.

Now as potatoes—Patterson's Victorias, at least, big as a man's doubled fist—become, within a few hours after raising, a bubbling, frothy mass of dissolution, it is evident that potatoes will, until next autumn, be dear; therefore a return to one of the foods for winter's consumption ousted from England by the potato—*saurkraut*: cabbage preserved by acetic acid fermentation, will *pro temp.* be a luxury and a most valuable conservator of health.

Probably Covent Garden, "the market," according to the immortal facetious one, poor Chas. Dickens, for "that great pickle shop" in Soho-square, at least has the best quality and quantity supply of any one city in the whole world, and will meet the wants of most of "Ours" desirous of obtaining some new material for saurkraut, which as a salad, pickle, or boiled vegetable is most delicious.

Purchase at a butter factor's, &c., an empty butter tub or a lard pail. Split your cabbages vertically through the stalk. Cut out the stalk, leaving a V-shaped channel. Place the half cabbage flat on a table; slice it into ribbons. Bore a cork-hole at bottom of side of pail, so as to run off the liquid when the fermentation, &c., is complete. Place in the cabbage shreds in thin layers, well compressing with your knuckles each layer. Proceed thus until full, cover with the outside leaves; place thereon a round piece of wood same diameter as the bottom, under that a folded cloth; well weight the wood so as to give pressure to the mass in the tub. Set in a cellar or cool outhouse. In four to six weeks remove cork, and draw out the stinking liquor; replace cork, and saurkraut is then ready for use. Some people add salt to each layer, others add cloves or peppercorns, other condiments.

In Greek-street, Soho, vast barrels, &c., of acetic-acid preserved French beans, cucumbers, and saurkraut can (or used to) be seen by would-be purchasers; but no saurkraut was ever met with in London superior to what has been grown and made by "The Lydney Dispenser."

It was my misfortune, during the wheat and potato famine of 1847-8, to be sent to a so-called first-class boarding school at Kidderminster, one of Edward VI.'s endowments, where Latin, Greek, and Divinity formed the boys' curriculum. The bread was what would, in 1891, be condemned by any Poor Law Board; it had a most unpalatable flavour, and the quantity doled out to each boy was anything but liberal. During those two years, all physical development in me was stopped. Vegetable supply was practically *nil;* and this, too, for boys full at the age when the bone structure was in its most rapid stage of formation. Many years afterwards, an accidental visit to a bone mill, grinding it into a *dry* powder, recalled the flavour, through the bone-dust entering my nose and mouth, of the bread of my Kidderminster school-days. "I was being fed upon bone-dust!!" and this at a cost to my father of 2 guineas a week; in consequence of which life-long ill-health resulted. So much for Church education.

The Lydney Dispenser.

MARINER'S COMPASS.

[32761.]—In reply to "Metes" (32680), the earliest account of the mariner's compass that I can at present come across is that the Chinese Emperor Chiningus, a celebrated astrologer, made use of the compass 1120 years before the birth of Christ. As "Metes" seems to have a good knowledge of the early history of the compass, it is not necessary for me to say any more now.

I may add that about six weeks ago I had the pleasure of seeing one of the early Chinese compasses; it was in working order, though rather sluggish in its movements.

John Sherwen, Jun.

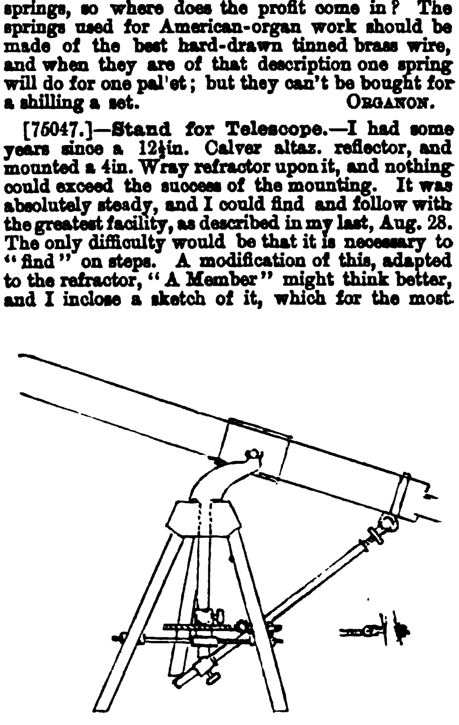
Egremont, Cumberland.

REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75000.]—**American Organ.**—If this querist has used the springs which "Practical Organ Builder" says (p. 95) can be bought for a shilling a set of 61, no wonder he asked if two springs were not necessary for each pallet. Why the wire alone—proper wire, that is—would cost that amount, and then it has to be turned into suitably-shaped springs, so where does the profit come in? The springs used for American-organ work should be made of the best hard-drawn tinned brass wire, and when they are of that description one spring will do for one pal'et; but they can't be bought for a shilling a set. Organon.

[75047.]—**Stand for Telescope.**—I had some years since a 12½in. Calver altaz. reflector, and mounted a 4in. Wray refractor upon it, and nothing could exceed the success of the mounting. It was absolutely steady, and I could find and follow with the greatest facility, as described in my last, Aug. 28. The only difficulty would be that it is necessary to "find" on steps. A modification of this, adapted to the refractor, "A Member" might think better, and I inclose a sketch of it, which for the most part will speak for itself. I adopt the trunnion of Mr. Calver's altaz. with a long axis, 14in., 18in., or more, according to the size of the telescope, which passes through a metal bearing in the wooden block, ⅝in. or ¼in. resting on this bearing all round, turned down for the purpose, to avoid too great friction. The axis at the bottom passes through a disc of brass, into three points of which iron rods are screwed, passing through the legs of the stand, with nuts on both sides. This keeps the disc perfectly firm, adjusts it in the centre, and also makes the legs of the stand quite rigid. To the bottom of the axis is fixed one of Mr. Calver's elevating rods, which steadies the telescope, gives a fast motion in altitude when unclamped, and when clamped, a slow motion from the screw tapped into it at the telescope end. The fast motion in azimuth is, of course, evident from the sketch. The slow motion is obtained with a fine worm and wheel, 12 or 14 teeth to the inch. The mounting of the worm passes through one of the legs, with nut also each side, by which it can be set exactly, and is worked by a Hook's joint. The wheel is cast on an axis through which the axis of the telescope passes, and which is clamped to the axis for the slow



motion. The stand should be solid, and made of walnut, oak, or ash, and stout, according to size of instrument. The legs must be high enough to get a vertical view, and screwed into the top block. The simplest plan is to put it on a table the height required, with flange round, on which it can be easily moved when the elevating rod comes in the way of the legs. The table, if this is adopted, must be solid and firm. If preferred, the legs of stand can be longer, to give centre of motion 5ft. 6in. high, say, for 4in. o.g. They will then want ½in. iron stays 1ft. or so from the bottom. The telescope can be brought in, and the stand left out of doors. All the parts must, of course, be in proportion to the size of the telescope.

Fordingbridge. T. Westlake.

[75075.]—**Five-string Banjo.**—If the querist cannot see the back volumes, he might possibly be able to procure the number for March 7, 1890, in which he will find some information about banjo-making; but he should also endeavour to get Vols. XXXVIII. and XLIV. L. M.

[75076.]—**Heating Garden Frames.**—Frames are not usually heated except by means of fermenting manure; but a little flue might be made round the interior, and the temperature be kept up; but 9ft. square is a peculiar shape. R.

[75084.]—**Ladies' Travelling Basket.**—Cover the basket with thin rubber cloth. That is waterproof, and if put on in a proper manner will last a long time. R.

[75088.] — **Stove (Slow-Combustion).**—Any ironmonger in a large way of business can show a slow-combustion stove, either by itself or by illustrations in trade catalogues. There are a good many patterns now, and a large number can be seen in the warehouses in Thames-street.

E. C.

[75093.]—**Papier Mache.**—This query points to the Willesden paper, which is rendered waterproof by being treated with a solution known as cuprammonium. The process was patented, and is, I think, still protected; but the full details can be found in back volumes. Almost any of the ammoniacal salts of copper will render paper or cellulose waterproof. M. T.

[75099.]—**Fuller's Earth.**—The natural fuller's earth is a sort of clay, which is dried in ovens and washed so as to get all fine particles and leave the coarser. The process is not injurious to health, and does no more injury to adjoining property than does ballast burning—if so much. R.

[75109.]—**Atmospheric Gas-Burner.**—Heat being simply a matter of the combustion of so much fuel, the "greatest" heat is a question of quantity and intensity. Warm air assists the combustion of coal-gas, because it unites at once with the gas without exercising any chilling influence on the gas. That is the principle on which the modern burners are constructed. The flame heats the supply of both gas and air. L. T.

[75118.]—**Distorted Toes.**—This querist should see some illustrated articles which have appeared recently in the *Lancet*. A surgeon would be able to say what can be done—after examining the feet. But there can be no doubt that wide-toed boots would be an advantage, and if the patient is young the distorted toes would perhaps take their proper positions. R.

[75121.]—**Voice Culture.**—There are several works on the art of voice culture, and it is rather invidious to recommend one; but the querist may read, perhaps with advantage, Brown and Behnke's "Voice, Song, and Speech" (Sampson Low and Co.), and Dr. Holmes's "The Science of Voice Production" (Chatto and Windus). There are other works on the subject which can no doubt be seen at any large library or good bookseller's.

Musicus.

[75122.]—**Epilepsy.**—To P. W. Stanley.—I quite appreciate the kindly interest evinced by "The Lydney Dispenser" in his note addressed personally to myself on p. 43. When I stated (p. 19) that I had seen Dr. Brown Sequard's prescription used with good results, I spoke the simple truth, and that fact cannot be affected by any other prescription of his which I may or may not have seen. I did not quote him as an authority on therapeusis; but his position as one of the principal consulting physicians of the epileptic hospital surely entitles him to be regarded as an authority on this particular class of disease. Furthermore, in criticising my reply, the "L. D." seems scarcely to have apprehended my meaning, for he apparently credits me with the extraordinary assumption that the human body possesses the power of annihilating elementary bodies, and that the value of a chemical compound as a remedy depends on such annihilation! Does "L. D." really wish us to understand that chemical compounds, when taken into the body, are under all circumstances resolved into their component parts? For, if so, why did he recommend the "M.D." (581) to study the secondary action of each of the elementary bodies of that powerful drug [KBr] and also of the salt (*sic*) itself? How is one to study the actions of the "salt" if it possesses none? Also, while elucidating this matter, will "L. D." at the same time kindly inform us exactly what meaning we are expected to attach to the rather curious expression, "causative results," a few lines further down in the same reply? I may add that as a searcher after truth I shall be pleased to study any literature on above subject "L. D." may be pleased to send me, and shall meanwhile watch with considerable interest for his reply to query 75221 (p. 46), addressed to him by J. Foakett.

P. W. Stanley, Analytical Chemist.
5, Billson-street, Poplar, London.

[75242.] — **Truffles.** — I inclose recipe for cooking truffles, which, I think, may suit your correspondent:—Cut ten truffles into thin slices; put them into a sauté-pan, with one tablespoonful of minced parsley, one minced shallot, 1oz. butter, salt and pepper to taste; stir over the fire for about 10 minutes, add half-teacupful of brown gravy, and the juice of half a lemon. Stir over the fire again till on the point of boiling, when serve. Fresh truffles are often wrapped in buttered paper, and baked like potatoes; they will require rather more than one hour in a hot oven. They are rather difficult of digestion, and should be used only in moderation. Mrs. Chambers.

[75255.—**Valley and Hip Tiles.**—Set out on paper height and width of span, and work out as shown in Fig. 1. Let A B be width of span, C D height or rise of roof. Draw the lines A E, E F, and F B, which will be plan-line of toes of rafters. From C draw centre line C G; from G set off G H equal to A C or C B. Join E H and F H, which gives plan of hip rafters. From point H erect H J perpendicular to E H and equal C D. Join E J, which will give elevation line of hip. At any point K in E J erect K L perpendicular to E J, and cutting E H in L with radius K L, describe a circle. Through centre L draw M N perpendicular to E H. Join O M and O N, which lines form the angle of back of hip, and the same angle used reversed will be the angle of valley. Should the plan of building not be rectangular, but to an angle, then work out each hip separately, as in Fig. 2, which will be understood by referring to the working of Fig. 1.

Dollar. J. McG.

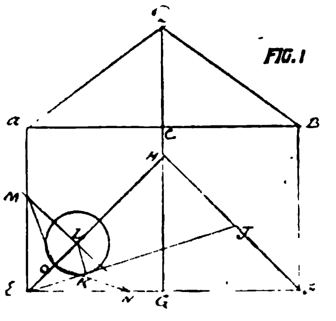


FIG. I

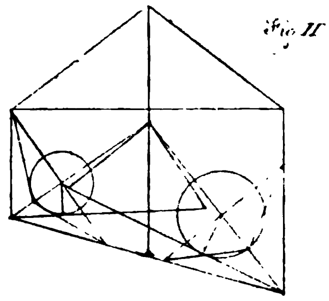


Fig. II

[75260.]—**Pitch of Roof.**—For ordinary slates 33° is low enough; very large slates, say 26° at the very lowest. Try zinc, copper, or lead, and to prevent condensed moisture inside, line the ceiling with ⅝in. ploughed and grooved lining. I have put also concrete on for roof, supported with ⊥-iron every 2ft. or 2ft. 6in., filled in with corrugated iron to carry concrete; and to prevent condensed moisture lined the ceiling, having air space between lining and concrete. Any of these materials will work at 5°.

Dollar. J. McG.

[75265.]—**Piano Pedals.**—I am much obliged for the kind replies from "Schofield," "A Practical Organ Builder," and "P. F." I am afraid this latter gentleman is rather "down" on me; but I remember seeing a set of pedals with wires complete, being an independent instrument, shaped like an oblong box, and forming a platform, on to which any piano could be lifted, and the pedals were made to draw out, and pushed into the "box" again when done with. This was in my mind when writing the words that appear such a "query" to "P. F." I now understand it will be cheaper and more simple to fix them to act on the piano-keys, and hope to see further remarks and assistance from our kind friends, "Practical Organ Builder," &c. Pedals.

[75269.] — **Harmonium.** — Will Mr. Schofield kindly describe the octave coupler he recommends for use in this too-heavy-in-the-bass instrument? He might, at the same time, give a description of the "American harmonium reeds" (see p. 96). Are they some new make? Smilax.

[75273.]—**American Organ.**—What does Mr. Schofield mean by saying that if the tongues of the reeds are too thick, "which is probably the case, file them down"? American-organ reeds, if from a good maker, are milled to a proper thickness, and all the tuner or voicer has to do is to bend them and just take off the burrs of the mill—not even that sometimes. If the querist does as Mr. Schofield suggests, "files down" his reeds, he will inevitably spoil them. The reeds in question cannot be too thick, as they speak in another row, and the tongues must also, therefore, be "clear of the slot in block." Such comments are absurd. Organon.

[75276.]—**Carbonising Wool.**—If "Fibre" will call at my address, I shall be pleased to show him a drying-closet which has been used for drying wool. See this week's Exchange Column.

R. J. Crickmer.

[75276.]—**Carbonising Wool.**—The reply given before will probably be unsatisfactory to your inquirer, "Fibre." If he really wants the information he asks for practice on a large scale, I can put him in the way of obtaining it. Carbonising wool—or, more correctly expressed, carbonising the cotton or other vegetable matter mixed with it—is not so simple as many think. The chlorides require more heat than the wool will bear without injury. Hydrochloric acid gas in a dry state, heated to a proper temperature, will effect the desired end.

Sea-Side.

[75283.]—**Case-Hardening.**—I think if "Back Centre" will heat his own fittings to red hot, rub them with prussiate of potash, and plunge them into cold water, he will find them quite hard enough. E. R. Dale, C.E.

[75286.]—**Heliograph.**—To describe this instrument properly, would require a drawing of it. The following is taken from the "Manual of Instruction in Army Signalling." The heliograph is an instrument for directing the reflected rays of the sun alternately on and off a distant station by means of a movable mirror. The mirror is mounted with trunnions on a U-frame fixed to a plate, which moves horizontally on another plate fixed to a tripod stand. A tangent screw working between these plates gives the mirror a slow horizontal motion, so that it may follow the sun in its path. A vertical screw rod attached to the back of the mirror draws the upper part slowly down, or again pushes it up, thereby altering the inclination of the mirror to suit that of the sun's rays. By the motion of these two screws, the light from the mirror can be kept steadily fixed on any selected point. To make signals, the above-named rod is pressed down against a spring, and after a short or long pause released, thus throwing the light on the distant station for the space of a dot or a dash.

Rifle.

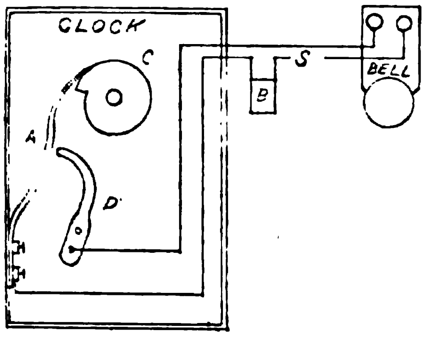
[75293.]—**Small Furnace.**—Having had some experience in making small iron and brass castings, I may mention that I have lately been using the furnace of a vertical steam boiler with a tall chimney for both brass and bell-metal with great success. E. R. Dale, C.E.

[75294.]—**Red Colour for Oil.**—The compositor has put rosin in place of eosin. This is the more remarkable since the next answer contains the word in question. Sm.

[75295.]—**Skin Eruptions.**—To "Mallett."—The charcoal I mentioned is made from oak, and is sold by most chemists; some sell it at 2d., others 3d., and others 4d. per ounce, but I have bought it in High-street, Bristol, at 9d. per pound. It is an excellent thing for indigestion, acid rising, sore throat, and also for stomach disorders, and gives relief very quickly. The cause of its great value as a medicine lies in the fact that it absorbs poisons and carries them off. Most of us know that charcoal is a purifier, being used in filters, and some people put a lump in with boiling meat that has been kept too long, and it purifies it. I have heard it said that medical men do not use charcoal because it cures too quickly; but I should rather think it is because their patients would object to it because of its appearance. But those who want good health must not mind the appearance of their medicine. Take charcoal to cleanse the stomach, and salts and magnesia mixed together to cleanse the blood, and, other things being favourable, you may depend on good health. Mallett.

[75299.] — **Photometer.** — The "standard candle" is one ⅞in. in diameter, burning 120 grains per hour, and is generally made of spermaceti (six of these weigh 1lb.) I, however, consider that if you want great accuracy it is better to use an argand burner, showing a light through a slit equal to 2c.p., these being manufactured especially for photometric work. I suppose "Lux" knows how to get the candle-power of his lamp. If i_1 = intensity of one light at distance d_1, i_2 = intensity of others at distance d_2. Then $\frac{i_1}{i_2} = \frac{d_1^2}{d_2^2}$. [illegible] C. P.

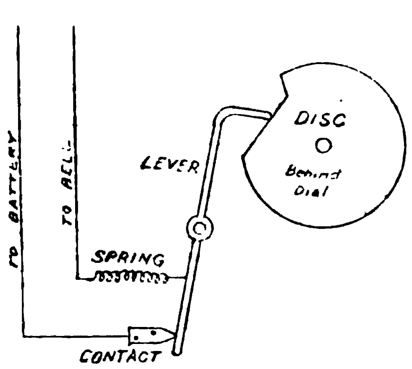
[75305.]—**Electric Bell to Clock.**—If "Ignoramus" will make a spring, A, out of brass, 5in. long, ¼in. broad, and a pleat like D, screw to back of inside of clock, and connect wires to them and to bell, when wheel C comes round, spring A will



drop in and make contact with D, and S is a switch or interrupter to stop the bell ringing; C is the wheel with the plate taken off to let you see the spring on the wheel. I have one working for twelve months. Don't wind the alarm up.

LAMPMAN.

[75305.]—**Electric Bell to Clock.**—Your best plan will be to take the alarm works out of the clock altogether, leaving only the dial and lever in; then fix a spiral spring to the bottom part of the lever, so that it will keep the latter pressing gently on the disc behind the dial; when the flat part of the dial comes round, the spiral spring will pull the lever into it, at the same time pulling the bottom of the lever against a contact. Now fix



one wire from the battery to this contact, and the other battery wire to one terminal of the bell, and from the other terminal of bell take a wire to spiral spring. You can now dispense with the continuous arrangement, as the bell will ring until the clock works the lever off the contact. You can also set it to ring by the dial, as before. I inclose sketch (if space will permit), showing position of lever when circuit is closed.

Chapeltown, Sheffield. T. HAGUES.

[75307.]—**Size of Bars for a Crane.**—If "Seaside Farmer" will write to W. Hosken, Penryn, Cornwall, stating the nature of the top of cliff, if rock, hard or soft, or earth, if cliff is perpendicular on face, he will send sketch of what will prove a useful lift; and if he has an intelligent smith at hand he can, for little money, get what he requires. He must not think of a concrete pillar or stone, unless in one piece. The idea is a good one, and many doubtless are similarly situated, and will venture on something of the kind.

WM. HOSKEN.

[Then why not kindly have given the sketch and information through our pages, so that the many might have benefited?—ED.]

[75308.]—**Wood Vats.**—I should not cement or do anything between joints, but tighten the vertical bolts a little all round if possible, then soak well with water until you can fill them. If the joints were ever sound, this will be all that they require. You can easily put new bottoms in if the sides are sound near the bottom; if not, perhaps you could reverse it upside down. BREWER.

[75310.]—**E. P. S. Storage Cells.**—The causes may be many and various. The acid may not be right strength, viz., 1·21, when discharged, and 1·5 when charged. Some of the plates may be buckled, and short-circuiting, or there may be pieces of paste touching; or, again, the plates may be badly sulphated. The addition of sodium sulphate to the fluid in the cells, with careful charging and discharging at frequent intervals, especially charging fully, will remedy this. S. BOTTONE.

[75309.]—**Sparking Dynamo.**—To MR. BOTTONE.—The following are the probable causes of excessive sparking in a shunt-wound dynamo running incandescent lamps:—1st, poor condition of brush-holders and brushes. 2. Faulty adjustment of brushes. When the brushes are rocked too far forward in the direction of the commutator's motion, the sparks will quite disappear; but the lights will also disappear at intervals, long sparks appearing at the commutator on these occasions. The brushes should be rocked as far forward as may be without causing extinction. 3. The brushes may not be pressing at diametrically opposite points. 4. The commutator has got oily or greasy. 5. Two or more sections of the armature coils are short-circuited, or 6, some coils of the armature have more wire on them than others. 7. The dynamo is overloaded—not necessarily with lamps, as there may be a leakage in circuit, or a ground contact, or bad connections. S. BOTTONE.

[75311.]—**Arc Lamps.**—To MR. ALLSOP OR OTHERS.—Probable causes are: Excessive resistance in leads; possibly actual breaks in connection. This seems likely, as you say the dynamo raced as if it had no work on. Or, leakage, through the wet. Perhaps there is a "ground" somewhere.

S. BOTTONE.

[75312.]—**Screw-cutting.**—There is no occasion for "Novice" to descend to decimal fractions, or to make any other elaborate calculations. The rule adopted in the workshop is to drill the hole $\frac{1}{16}$in. less in diameter than the spindle. If, therefore, "Novice" drills his hole $\frac{15}{16}$in. diameter he will find on tapping it that the thread is of correct depth.

STUD.INST.C.E.

[75313.]—**Dynamo.**—In calculating the length of wire for Siemens drum armature, you will do well to reckon 1 volt per yard if the peripheral velocity of armature is 1,250ft. per minute. The fact of the current being, as you call it, a split current has nothing to do with the E.M.F., which is dependent solely on the strength of the magnetic field and the number of lines cut in a given time. The fact of the current being split reduces the resistance in the armature to quarter that of the total resistance of the wire employed. You will find this subject fully treated in the last edition of my book, "The Dynamo: How Made and How Used." S. BOTTONE.

[75314.]—**Old Parchment.**—If you place them in a damp place so they can absorb moisture, they ought to lose their stiffness. SM.

[75315.]—**Small Self-Starting Electro-Motor.**—To MR. BOTTONE.—The motor figured and described in last week's issue of the "E.M.," pp. 78, 79, and 80, will answer your purpose admirably. You will need, however, a bichromate or chromic-acid cell. Leclanchés are no use for this work.

S. BOTTONE.

[75319.]—**Motion.**—Theoretically both balls would reach the ground at the same instant of time. The force from the cannon is answerable only for the horizontal distance travelled by the cannon-ball; gravity draws both balls through the same vertical distances in the same time. The equality in weight has nothing to do with the result.

WALTER HERBERT.

[75319.]—**Motion.**—Adopting the usual formula for motion under a uniform acceleration, g, viz.:—

$$S = \tfrac{1}{2} g +^{2}, \text{ we have—}$$

$$A = \sqrt{\frac{25}{g}},$$

whence we deduce ·612 second as the time a falling body will take to fall 6ft. from rest. Horizontal motion does not affect this time, and so, in the absence of air, a ball fired from a rifle 6ft. above a plane would reach the plane in exactly the same time as a ball dropped from that height, and falling vertically. The initial velocity of a M.H. bullet is 1,320ft. per second, so the bullet would travel 1,320 × ·612 = 807·84ft. before reaching the ground. In practice the resistance of the air would modify this last result very considerably; the bullet would not travel so far, and would drop sooner. It is always necessary to give "elevation" to a rifle or piece of ordnance, in order to hit an object at any distance. The popular idea that a bullet goes in a straight line from a rifle to a target is, like very many other popular ideas, wildly erroneous.

WM. JOHN GREY, F.C.S., Analytical Chemist.
Newcastle-on-Tyne.

[75321.]—**Electrical.**—Reckoning 746 watts per horse-power, and allowing 20 per cent. for conversion, it would need 4,470 watts supplied to the motor to give 5H.P. Your 50 E.P.S. cells will supply current at a pressure of 100 volts only, so the current must be 44·7 ampère to produce the 4,470 watts. Since the ratio between the armature and field-magnet resistance is as 0·18 to 7·, or 1 to 39, it follows that when the motor is standing still 1·11 ampère will pass round the F.M. coils, while 43·59 ampères will flow round the armature coils. When the motor is doing its best work, the E.M.F. of the motor will reduce these numbers to exactly half the above values, say 0·555 ampère in F.M., and 21·795 in the armature. S. BOTTONE.

[75323.]—**Making Volt and Am-meter.**—To MR. BOTTONE.—I believe it to be perfectly possible to make the above of the form figured by you in last week's issue, since it is the same as the Kolrausch, plus the rack movement. The diameter of A might be 1½in., the length 2in. The travel of B (the core) would naturally depend on the delicacy of adjustment, the tension of the spring E, the nearness of the core to the coils of the selenoid, and the fineness of the teeth on the two gearings. The G.S. wire to enable you to measure 80 volts should be equal in resistance to 80 × 50 = 4,000 ohms, or, say, 2½ No. 40 German silver, ·005in. in diameter. For the ammeter 3 or 4 turns of No. 8 single cotton-covered copper 0·165in. diameter would be best. The stranded wires take up more room, but of course you can use any stranded cable of similar conducting capacity to No. 8 wire.

S. BOTTONE.

[75325.]—**Magnetic Polarity and Medical Electricity.**—To MR. BOTTONE.—The beneficial effects of electricity in many cases are undoubted; but most of these so-called electric belts are purely frauds, and the more advertised, bepuffed, and testimonialised they be, the more they are to be avoided. In practice a good effect is not noticeable unless a current of from 20 to 30 milliampères can be supplied. Now the skin presents a resistance of about 4,000 ohms to the square inch. No single cell of battery (much less those dependent on the natural moisture of the skin) have a voltage exceeding 2 volts. Hence the highest attainable current would be $\frac{2}{4000}$, or ½ a milliampère. Supposing your pile to give 1 volt per pair of zinc and copper, you would need 80 pairs to give 20 milliampères, since $\frac{80}{4000} = \frac{20}{1000}$. But how you are going to keep such a pile charged and insulated while being worn, I fail to see. S. BOTTONE.

[75326.]—**Battery.**—The cost of charging your battery will depend on what you pay for chemicals, and these vary in price. Reckoning bichromate at 8d. per lb., your six cells should cost about one shilling to charge. Allow 4oz. of bichromate to 1 quart of water. To charge the cells, put equal parts of this solution and muriatic acid into the carbon department. Charge the porous pot with a saturated solution of salammoniac, to which about 1oz. of muriatic acid has been added. This will be found to work better than the ordinary chloride of zinc solution. F. ASKEW.

[75326.]—**Battery with Chloride of Zinc and Chromic Acid.**—You will need 1¼ gallon of water, 1lb. 2oz. of chromic acid, and 1 pint of hydrochloric acid in the outer cells. This should cost about 1s. The chloride of zinc for the inner porous cell would cost, say, 2d. or 3d. at most. This cell will run eight or ten hours with one charge, giving 1·8 volt per cell, or 10·8 for the six cells coupled in series; enough to light a 5c.p. lamp of 10 volts. As the fluids mix rapidly when the cell is not in action, it is better to run the battery to exhaustion; empty and recharge. It is not advisable either to take out the elements or leave them in when no work is going on. If the battery must be stopped before it is exhausted, it is better to pour off the fluids into separate bottles, and wash and dry the zincs, the carbons, and the cells. S. BOTTONE.

[75330.]—**Electrical.**—No. 8 copper wire will carry safely 20 ampères of current, No. 000 iron wire will do the same. About 95 yards of either of these wires at 60° Fahr. will present a resistance of about $\frac{1}{10}$ ohm. The resistance of a half-pint chromic-acid cell, freshly put up, is about 0·09 of an ohm. You could not grade a voltmeter by inserting resistances or shunts, since these alter the current, but not the pressure in volts.

S. BOTTONE.

[75334.]—**To Mr. Bottone or Mr. Askew.**—Cores about 1¼in. long. ⅜in. diameter. No. 36 is too fine; better use 1lb. No. 28, silk covered. The two-part commutator, unless the gaps are cut very wide, will not give shocks, but only a very mild current. Better use the regular triangular break-piece. See my book on "Electrical Instrument Making" for full details and cuts.

S. BOTTONE.

[75334.]—**To Mr. Bottone or Mr. Askew.**—Cores 1in. by ⅜in.; about 1½oz. of wire on each bobbin. A split-tube commutator will not answer, since this will rectify the currents, which, for shocking purposes, will not answer. Connect the end of one wire coming from the armature to the spindle, the other end to an insulated ring on the spindle. Brushes bearing on these; collect the currents. One brush should bear on the spindle, the other on the insulated ring. F. Askew.

[75339.]—**Four-leaved Clover.**—Does "B. H." know the botanical name of the plant, as there are more than one kind of white clover? Sometimes very pale yellow clover has been taken for white; but if "B. H." will send me one of the leaves with the four lobes, and if possible a flower of the same plant, I shall be glad to supply him with all the information within my power.

Wakefield-road, Dewsbury O. H. Ingham.

[75340.]—**CO_2 from $HNaCO_3$.**—The molecular weight of dry $HNaCO_3$ is 84, and this yields 44 parts of carbon dioxide gas; hence an ounce avoirdupois, which is 28·35grm., will yield 14·85grm. A litre of the gas weighs 1·9712grm. under standard conditions; hence 14·85grm. will measure 7·53 litres, which is equal to 13·25 pints. This volume is calculated for zero centigrade, and 760 millimètres pressure. The change in volume for the pressure mentioned by the querist—viz., 30in.—is almost inappreciable. The change in volume due to a rise in temperature to 60° F. = 15° C. is—

$$273 : 288 :: 13{\cdot}25 : x = 13{\cdot}97 \text{ pints.}$$

The molecular weight of tartaric acid is 150, whence (the acid being dibasic) we get—

$$168 : 150 :: 28{\cdot}35 : x = 25{\cdot}25\text{grm.}$$

as the quantity needed to decompose 28·35grm. of sodium bicarbonate. The water takes no chemical part in the change, and the less used the better, as it dissolves and retains part of the gas. Its use is to bring the molecules of the acid and the carbonate within the sphere of chemical action.

Wm. John Grey, F.C.S.

Analytical Chemist, Newcastle-on-Tyne.

[75343.]—**Induction Coil.**—Core, 12in. by 1¼in.; primary, four layers of 14 or 16 d.c.c. B.W.G. wire; condenser, 100 sheets, 9in. by 6in. The secondary, in two sections, should give 2in. spark, with a battery of six (pint size) chromic acid cells. Leclanchés are not suitable for large coils.

F. Askew.

[75348.]—**Coil.**—To Mr. Bottone.—Proportions altogether wrong. Let your paper tube be ¼in. diameter, 5in. long., fill up with No. 18 iron wire, put on two layers No. 24 for primary, and ¼lb. No. 36 for secondary. Make a projecting loop of this wire at the end of each layer, and connect these layers to the studs for different strengths.

S. Bottone.

[75351.]—**Cancer.**—Mr. Stead, editor of *The Review of Reviews*, who has done so much (see also Sept. 15, pp. 286 and 296) towards making the Forest of Dean, Mattei's cancer cure, and allopathy's mischievous tenets, practices, &c., world-famed, may possibly obtain admission for the present cancer subject as one of the test cases in St. Saviour's Hospital. If not, then as the Mattei remedies are, I think, but 2s. each, a trial thereof may relieve pain, if not ultimately cure; but I have no experience of them. It may, in case both of the above fail, or are impracticable, become advisable to fall back upon the known remedial action of the various (one or more) medicines of homœopathy—i.e., the salts of *arsenicum*, kalium, iodine, sulphur, calcium, carbon, ferrum, phosphorus, aurium, and silicon; while, from the vegetable kingdom, hydrastis, thuja, some of the ranunculaceæ, selections *pro temp.* according to the individual symptoms, may have beneficial, if not curative, actions. Hemlock (*conium*) is one which has been used in homœopathy, and with success, in the earlier stage. "Disease Relationships," as well as an article on cancer, in the *Homœopathic World* of September, both bear directly on the query, and should be read by "Lancet." The Lydney Dispenser.

[75352.]—**First Aid to Injured.**—I am not a "medical gentleman"; at the same time, as I have considerable experience with acids, which we have used daily for the last fifty years, and during that time have frequently had accidents, either with carboys breaking when being emptied or otherwise, the result of that experience may be of use to others. After trying various expedients, we found that at once plunging the part affected in water instantly neutralised its power. I believe if you were to dip your finger in the acid and immediately plunge it into water, no effect would be felt. Girls occasionally revenge themselves by throwing acid in each others' faces; if, in place of running for a doctor, they would at once plunge the face or other part hit in water, they would not be much worse for it.

Wm. Grimshaw.

[75353.]—**Micro-Photography.**—From my point of view, I find that the best book on landscape photography is by T. C. Hepworth, published by Cassell and Co., but I wish to know whether the same author has written a book on the art stated above; if so, I should like to have it, but if not, then I wish to know how to photograph, by a Sciopticon lantern, some animalcules (say a bunch of bell animalcules). It is impossible, from their rapid movements, to secure an image, and only in very rare cases would the living animalcule remain in the field of view, or in the desired attitude, for a sufficient time. Could any of your readers kindly tell me how to render infusoria stationary while they are photographed. J. A. Bellringer.

[75352.]—**First Aid to the Injured.**—I hasten to reply to this query because for many years I was engaged as manager in chemical works, and often had to take in hand such cases as alluded to. For a long time I maintained the practice of sending at once to the nearest medical man; but several of the cases turned out badly, and I soon found that the doctor did not immediately take steps to neutralise the strong alkali or acid which had caused the injury. I therefore adopted the plan of seeing to this before I sent the case to the medical man, and after that, in nearly every instance, the results were satisfactory. My method was to always keep a stock of acetic acid diluted until it tasted only moderately acid, or until I could drink it without very great difficulty, and this I kept in a large "wash bottle," by means of which the patient's eye or limb could be well washed, and so continued till the moisture adhering to the wound or affected part remained acid to litmus paper, after the lapse of, say, two minutes. This, in the case of a splash of strong caustic soda or potash, was no easy matter to accomplish, as it required very persistent efforts, and generally against the strong protests of the patient, who therefore had to be held by some of his comrades. If done smartly and immediately after the accident, I have known wonderful cures effected. In cases of splashes from oil of vitriol, the ordinary wash-bottle was used but very freely, then a final washing from another wash-bottle containing very dilute liquor ammoniæ, so weak indeed, like the other, that it could be drunk with but a little difficulty. These wash-bottles were made out of ordinary strong glass bottles, not flasks, so that the men could use them in my absence. In the case of oil of vitriol, I often sent them away with a bandage soaked in solution of bicarbonate of soda over the affected part. After the foregoing treatment I found the doctor generally only ordered a poultice to take down any inflammation, and finishing, perhaps, with a dressing of Goulard water. I have treated terrible cases of the eye injured by strong caustic soda, and when part of the lid has been eaten away, and yet the eye has been saved. In some of these cases, I know from experience, that the eye would have been utterly lost. In such cases no half-measures must be used; the washing must be done freely, the man held down securely, and no stoppage of the treatment until neutralisation is complete.

Vindex.

UNANSWERED QUERIES.

◆

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

74860.	Telephone Wire, p. 461.
74866.	Magnetic North, 461.
74868.	Letter Engraving, 462.
74869.	Solenoid, 462.
74870.	Polariscope, 462.
74872.	Telephone Switch Board, 462.
74873.	Horological, 462.
74875.	Ruhmkorff Coil, 462.
74876.	Open and Closed Circuits, 462.
74879.	Straw Paper, 462.
74880.	Steam Coppers, 462.
74891.	Annuity, 462.
74897.	Wet Plate Lantern Slides, 462.
749.0.	Jigs, 462.
74911.	Fire Revivers, 463.

75072.	Photo-Tracing Process, p. 558.
75074.	Street Telescope, 558.
75077.	Oval Bradawl Handles, 558.
75080.	Electric Gas-Lighting, 558.
75087.	Water Meter, 558.
75096.	Tangent Galvo., 558.
75106.	Gauging and Mensuration, 558.
75110.	Guitar, 558.
75113.	Theatrical Stage, 558.

The German Government has decided to lay telegraph cables along the whole of the German East African coast. Three officials have left Berlin for Bagamoyo to arrange the preliminaries. The first section will be laid from Bagamoyo to Saadani. The French Government are also about to lay cables from Marseilles to Oran, and Marseilles to Tunis, thus improving their Algerian service. The completion of communication between French Guiana, Dutch Guiana, and the French West India Islands has recently been effected. The old cable between Dover and Boulogne is, we understand, to be lifted and relaid across the Channel from Folkestone to Boulogne. It appears that the rocks at the foot of Shakespeare's Cliff are very injurious to it.

QUERIES.

◆

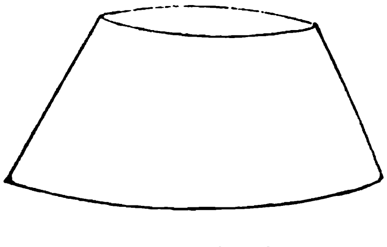
[75353.]—**Paint for Organ Pipes.**—Can any readers inform me if there is any particular way of mixing colour (paint) for organ pipes, or will the ordinary dead colour we use in the coach-painting trade do? They are new pipes. Also, is there any particular pattern for the stencilling? Any hints will oblige.—W. J. Parker.

[75354.]—**Venus on the Night of April 12, 1782.**—To "F.R.A.S."—Pardon the liberty I take; but I wish to know if Venus was visible on the evening or night of the 12th April, 1782 (rather a long time to hark back), from Martinique or Castries, W.I.? I have consulted James's "Naval History" and other standard naval works, and find that the night was clear and brilliant. If Venus were not visible, which other planet had sufficient altitude to be visible there? My brother has been in Barbadoes, and thinks it probable that Venus was visible then. I have consulted Philip's planisphere and other means, but cannot correctly determine the question. Could you kindly tell me, or direct me so that I could find out, and be *quite* certain about it?—Wm. Munro.

[75355.]—**Galanty Shows.**—Is there a cheap book on making galanty-show figures? I should like to start for the dark nights. I saw some good ones in America, and, by the noise of them, should think they were metal; but they worked very well, especially the stag being shot and struggling for life, and finally falling on its side.—A Villager.

[75356.]—**Retouching.**—I should feel obliged for a good retouching medium, not spirit varnish. I get on very well with a pinch of rosin in turps, and can retouch well on it; but what I require is a medium so that, after it has been retouched once, more can be applied without removing the retouching that has been done, so as to be able to further retouch it, as in wrinkled faces once retouching is not sufficient. Any hints will oblige.—A Constant Subscriber.

[75357.]—**Striking out Plates.**—Will some reader of the "E.M." kindly give me the rule for striking out plates, so that when bent they come this shape—



principally for chimney tops?—Fred A.

[75358.]—**Testing Manganese.**—Will one of our chemical friends be good enough to explain how to test the quality of manganese dioxide, as used in Leclanché cells? It is sold as being of a certain percentage pure. How may this be checked by the purchaser?—Battery.

[75359.]—**Windmill.**—Will some kind reader assist me by giving dimensions of small windmill, say 3ft. diameter? I have a wooden boss 5in. diam., one end of which I have turned down to 3in. diam. to serve as a pulley, and propose to mortise the arms or sails into the boss, and mount on a spindle ⅜in. diam. As I am ignorant of the proper dimensions of arms, kind of wood to use, and also angle at which they are set, should be much obliged for assistance, with rough sketch if possible. Also what work the above size would be capable of doing.—Disc.

[75360.]—**Gilding Solution.**—If I dissolve 1oz. 96 per cent. cyanide of potassium in one pint of water, will this be the right strength to use for making a gilding solution by battery process when using a 22c. gold anode, and what weight of gold should I dissolve from the anode per pint of solution to give a rich deposit? I have a Daniel's battery of four cells, 6in. by 4in. in size. Is this battery suitable for gilding, and if so, should it be joined together for quantity or intensity? I have done a great deal of plating, but no gilding. If there is any battery more suitable than the above, will you please give its name?—F. Simpkin.

[75361.]—**Dynamo.**—I have an armature ring wound with 130 yards of No. 20 d.c.c. wire. Now, will the same wire do for F.M.'s in series if I take three strands, and will 60 yards of the compound wire be about right for each limb of simple magnet?—J. M. K.

[75362.]—**Accumulators.**—To Mr. Bottone.—If accumulators are used simply as regulators to a current from a dynamo used for lighting, do they have to be of the same size and number as if they are charged and discharged separately, assuming, of course, that the number of lights is the same in each case? Is it not a disadvantage to use lamps of high voltage when accumulators are used as the number of cells, and, therefore, the expense, has to be so large?—A. G. Abington.

[75363.]—**Compressed Air Engine.**—What is the best form to give to an engine to be worked by compressed air, the same as a steam-engine? Can any one tell me the construction of the "Tower spherical engine," advertised in *Engineering*, and said to be suitable for compressed air?—A. G. Abington.

[75364.]—**Covering Copper Strips with Indiarubber.**—I want to cover some copper strips with thin coats of indiarubber—must be inodorous, not sticky, and bend easily. Can any of "ours" advise how to get it done? Have advertised address, in case any one can communicate the information privately.—W. H. Earle.

[75365.]—**Tractive Resistance on Inclines.**—The inquirer seeks a simple method of approximately computing the variable resistances to traction on gradients as the angle to the horizontal increases. Does the resistance increase according to any direct law of proportion?—A. J. S.

[75366.]—**Decomposition of Iron and Steel.**—Does not iron decompose more rapidly than steel under any conditions—e.g., whether, under atmospheric influences, sulphurous vapours, acid or alkaline waters, &c.?—A. J. S.

[75367.]—**Slotting Metal.**—I have some pieces of sheet brass in which I want to make a narrow opening or slot. The metal is ⅛in. thick, and the slot is wanted 1in. long, perfectly straight, and the width of slot is to be about 1-40in. Can any reader inform me how this is to be done? I have a lathe with slide-rest, &c.—Omelo.

[75368.]—**Support in the Water.**—Can anyone tell me what the diameter should be of two pontoons, each 20ft. long, to support the weight of two persons, and yet not be immersed in water more than half their diameter, the other half to remain above water?—Golconda.

[75369.]—**Brazing and Soldering.**—I am fitting up a small amateur workshop, and though a good fitter and turner know nothing of the above. Would any reader kindly give me a few hints as to the tools necessary. I have gas laid on, but at present no forge. Can the necessary heat be obtained with a blowpipe? also the titles of any books on the subject.—S. R. H.

[75370.]—**Tainted Beer.**—Can anything remove the musty taste from beer which has become so through using a tap which has been imperfectly cleaned before insertion in the barrel?—Rab.

[75371.]—**Gas-Furnace Casing.**—Will anyone kindly tell me how to make the fireproof casings for Fletcher's small gas-injector furnace. It is of a porous texture, similar to pumice-stone. I should very much like to be able to make my own casings.—F. Simpkin.

[75372.]—**Fireclay.**—I have bought some fireclay which is in a dry powdered state. Must this be soaked in water for any length of time, or should it be mixed with water and used immediately? Any information on working the above will be thankfully received.—F. Simpkin.

[75373.]—**Moulding Gas Carbon.**—I have a quantity of gas-carbon which is of no use to me in the state it leaves the retorts. Could any of your readers inform me how to prepare it after it is ground up, so as to make it set hard again, as I want to mould it in various shapes?—W. L. R.

[75374.]—**Calculating Power.**—Would some kind theoretical mechanic tell me how to calculate the power expended per second in holding the pea suspended in the air above the schoolboy's clay pipe shank, or on the ball kept up on the fountain jet—the only data given being the weight of the pea or the ball?—P. Shanks.

[75375.]—**Strasburg Turpentine.**—Would be grateful for any information respecting "Strasburg turpentine." It is one of the ingredients of a recipe. It does not seem to be known at any of the chemists' shops; but was mentioned in the "E.M." a few years since. Will someone kindly say if it can be obtained in small quantities?—D. C.

[75376.]—**Geometrical Drawing.**—Wanted, to know how to describe the envelope of a cylinder, one end of which is cut off to a mitre; or, in other words, how am I to cut out two pieces of sheet-metal so that when they are joined together they will form an angle pipe?—Fat.

[75377.]—**Blower for Gas Generator.**—I make my own gas for lighting by driving the air from a gasometer through one of Fletcher's generators. How can I keep the gasometer supplied with air? Can I make some sort of blower to work with a weight? As it is, I have to pull the gasometer up every six hours. Any hints will be thankfully received.—M.R.C.S., &c.

[75378.]—**Dynamo.**—To Mr. Bottone.—For 5amps. read 50, as the nothing does not appear distinct. The dynamo is compound-wound 6½lb. No. 16, and 3lb. No. 10 on F.M.'s, and 1½lb. No. 10 on armature. Since last issue of "E.M." with your kind reply, I have increased speed, and find great improvement. Formerly the revs. were about 900. I suppose I could increase output by adding more wire to F.M.'s, as there seems to me to be an excess of metal in F.M.'s. Of course, I would require larger armature.—Volt.

[75379.—**Accumulators.**—What is the latest and best form of accumulator, and how to make it; also chemicals and paste, &c.? How many hours will the large plates 12 by 12 retain their charge?—Alpha.

[75380.]—**Microphone.**—Kindly describe the best form of microphone. Will the diaphragm of this instrument work at its best if constructed of two ferrotype plates, half an inch apart, and the intervening space filled up with coarse carbon?—Alpha.

[75381.]—**Electric Light Economy.**—Is it cheaper to light the lamps from accumulators charged by a dynamo driven by a gas-engine, or direct from the dynamo so driven?—Alpha.

[75382.]—**Constant Batteries.**—Can anyone tell me how to construct a small but very powerful battery for constant current to apply electricity to various parts of the body. I have been using a voltaic pile of 25 pairs, the size of a penny; the current is strong enough, but the trouble of cleaning and remounting after each application is very great. I want a battery that is at once powerful, simple, easily thrown out of working, little or no wear of the elements, or trouble of amalgamating zincs, &c.; also explain how to control strength of current. Would a Bunsen or bichromate battery do, or how many?—Sufferer.

[75383.]—**Water Motor.**—I am anxious to drive a small dynamo, about 15 volts 8 ampères, by means of a small water motor. I have an unlimited supply of water at a very fair pressure. Will Mr. Bottone, or some other correspondent of the "E. M." kindly describe, with sketch if possible, some simple form of water motor which would suit my purpose?—R. L. Walker.

[75384.]—**Etching.**—Can any of your readers give me any information on deep etching? Can a copper plate be cut 3-16in. in depth? What is the process used in this kind of work, the time it takes to cut it, and the kind of acids used?—A Reader.

[75385.]—**L. and N.W. Locos.**—Outline sketch wanted of No. 3026 of the above Co. This is the only one of its kind being built on one of the old Metropolitan bogie tank frames. It runs, I believe, from Broad-street to Mansion House. "St. Aubyn," "North Western," or others please oblige.—A. C. B

[75386.]—**Electric Sores.**—Can any of "ours" tell me why, after wearing an electric belt a short time, there comes first an intense irritation in the skin under the discs and then open sores, so that it is impossible to wear the belt for a considerable time, or till the sores have healed? It is the experience not only of myself, but also of many others. Can this evil be remedied? Can "Video" (75008) vouch for the curative properties of his flannel belt by results? If so, would he kindly fully describe the make and positions of metals?—although I can't see how the electric current is generated unless the discs touch the skin.—Electric.

[75387.]—**Electro-Plating.**—I dissolve mercury in nitric acid diluted, and on adding sulphuric acid, a whitish precipitate is thrown down. What is wrong?—as this quicking solution turns zinc black.—D. H.

[75388.]—**Edison's Phonograph Motor.**—To Mr. Bottone.—Have you seen the motor which works the Edison latest phonograph? If so, will you kindly give a short description of it with the sizes of field-magnets, armature, and sizes and quantity of wire to run on a 5-volt circuit, as I understand the Edisons are wound for this. I have just got a glance at one for a moment, but could not get to examine it. The armature on it appeared to be about 5in. dia., and was fixed to work vertical. Do you supply castings for this type of motor, or any parts that will come in for it, as I am making a phonograph as near like Edison's as possible, and I am keeping to as near his sizes as possible.—F. Tyler.

[75389.]—**Refining Gold.**—Will any of our friends give the best process for refining 18 c. gold into perfectly fine gold. I want to use it for an anode in gilding. I have about ½oz. in weight. No doubt, it would be cheaper to send it to a refiner to do; but I wish to be able to do it myself. I have a furnace, if one is required.—F. Tyler.

[75390.]—**Judson's Cell.**—I have a medical coil with four Judson's K cells. The cells are composed of a corrugated carbon cell and a rod of zinc. They are in very bad condition through neglect. I am going to put in new zincs; will any one please to tell me how to charge them? I put in a charge of the ordinary Leclanché solution, and they worked all right for a time; but after leaving aside for a day or so, they have ceased, and a white scale is over the top of the solution.—Abuntra.

[75391.]—**Astro. Telescope, &c.**—Will "F.R.A.S." please tell me whether the o.g. (3⅛in.) of a transit instrument could be adapted to an ordinary telescope for astronomical observations? as I have one which I thought of utilising for that purpose, if possible. The objective is composed of three glasses in one, the centre one concave on both sides, and the other two convex on both sides. The latter fit accurately into the cavities of the centre glass. I had hoped that by removing the inside convex glass it would answer the purpose of an ordinary o.g. What is the difference between a marine and a land telescope? Is the difference in the eye-lenses or the object-glass? And could the objective of a marine telescope be used for astronomical purposes? When did the Jones's of Charing Cross exist? and had they any repute as makers of the astro. telescope.—E. Strother.

[75392.]—**Fireworks.**—Will some reader kindly inform me how to make red and green fire for illuminating purposes?—B. B. C. A.

[75393.]—**Silicate of Soda.**—Could any reader inform me of a substance that, when mixed with silicate of soda, would facilitate its drying when applied to woodwork as a priming? Any hints would be gratefully received by—Tommy Hawk.

[75394.]—**Varicose Veins.**—"Quilp" would greatly oblige a sufferer if he will give him particulars of the ferrum phosphoricum from which he has obtained benefit for the relief of varicose veins.—W. W.

[75395.]—**Vaucanson's Endless Chain.**—What is the nature of this chain? How is it constructed? What is it used for? Any information will oblige.—J. G. Bartel.

[75396.]—**Stereographs of Non-Planar Vibrations.**—On page 246 of the "E. M." for May 15, 1891, these words occur: "Among which were some very fine stereographs of non-planar vibrations, drawn and kindly presented by Mr. A. Stroh." I wish to know what non-planar vibrations are, and how to produce stereographs of them? Accurate instructions, please.—J. G. Bartel.

[75397.]—**Polishing.**—To Mr. Allsopp.—I am making a microphone as described by you in this week's "E. M.," and have finished the case, but do not know how to polish it. Would it be asking too much of you to tell me how this is done?—J. J. B.

[75398.]—**Freezing Machine.**—Have a brother in South Queensland, who wishes me to inquire as to the best hand-machine for making ice on a small scale. They have some in use there worked with vacuum pumps and sulphuric acid; but they do not answer in that climate; also some worked with freezing powders; but these do not work well either. Practical information will be thankfully received.—A. Chargois.

[75399.]—**To Mr. Bottone.**—I have made a dynamo according to your instructions in "Electro-Motors: How Made and How Used," July 19, 1889, but cannot get it to work. Field-magnets wound with 2½lb. of No. 22 c.c. wire; armature wound with a little over 1lb. of No. 20 c.c. wire connected up in shunt. The wire does not touch the bare iron anywhere. When the field-magnets are excited by four bichromate cells the armature gives a current equal to the four cells. Can you tell me what is wrong?—Amateur.

[75400.]—**Buzzer.**—This electrical instrument was invented by an officer of the Royal Engineers. Can any of "ours" give a description of it? It was largely used in the manœuvres at Hampshire this year.—B.

[75401.]—**Bunsen Burner.**—I shall be much obliged if someone will tell me how to arrange a line of Bunsen gas-jets. I want them to heat a small saddle-bottomed boiler about 10in. long and 5in. broad, for driving models. Methylated spirit does not keep up enough steam, and the reservoir gets very hot.—A. F. C.

[75402.]—**Harvest Moon.**—Will "F.R.A.S." or some other astronomical contributor kindly explain as simply as possible why there is so short a difference in the time of the moon's rising when she is near the full in this month?—A. F. C.

[75403.]—**Lever Watch.**—Would any of "ours" kindly assist me to correct the following? Watch goes all right lying on face; but when turned up and laid on back there is a sort of rub at beat until it stops, and sometimes when hanging up it will do the same and stop. Sometimes there is a slow double beat as well.—Tom.

[75404.]—**Microscopic Optics.**—With regard to multiplying power of eyepiece in relation to micro-objectives, I assumed that each objective possessed a magnifying power in itself, such power being multiplied so many times according to the strength of eyepiece used. Assuming, therefore, that the power of ½in., ¼in., and ⅛in. objectives be 21, 41, and 81 respectively, what would the augmented power be in each case with an eyepiece composed of a 1in. and 2in. lens? What is the power of the A, B, C, &c., eyepieces of English makers? Will "F.R.A.S." or Mr. A. Gadd kindly give me the above information?—Tyro.

[75405.]—**Force Pump.**—Will some able correspondent kindly send particulars and sketch for a small force pump of ¼in. bore, 1in. stroke, with lever handle, capable of pumping up to 2 tons on square inch, and suitable for working small hydraulic press? Also size of feed and delivery pipes, and thickness of metal?—R. A.

[75406.]—**Electrical.**—A current whose strength in "absolute" electro-magnetic was equal to 0·05 traversed a wire ring 2 centimètres radius. What was the strength of field at centre of ring? What was the potential at a point P opposite the middle of the ring and 4 centimètres distance from the circumference of the ring?—Electric.

[75407.]—**Semi-Incandescent Lamps and Sun Lamps.**—I wish to produce the electric light by means of a battery, but find that incandescent lamps are expensive to work, and that arc lamps will need a battery of at least 25 cells, besides being unsuitable for a house. I hear that lamps which hold an intermediate position between these are made: in one a carbon rod presses against a block or disc of carbon; in another a block of marble is made incandescent by the current flowing over its surface between two rods of carbon. Will any reader kindly tell me about either of these lamps?—1. Number of watts required per candle power. 2. Lowest current and E.M.F. needed for a steady light suitable for a room 30ft. by 20ft. 3. Details of construction of lamp.—W. S.

[75408.]—**Organ Light.**—Can any reader advise me of a good light for an organ, that will throw the light on the music only? Oil is too dangerous and hot. Is there a candle-lamp similar to the reading or photographer's lamp, with plated reflector—one that will throw the light straight (not down) on the music, so as not to affect the eyes with straining to see? Or can one of the fairy lights be made to answer, but putting it in a frame, like a carriage lamp, fixed on to a piano sconce? Perhaps one of our organists has something novel that answers well. —W. S.

[75409.]—**Pump for Model Locomotive.**—To "J.H." and others.—I have been very much troubled to get a satisfactory pump for a model loco. The loco. in question is a model of the Midland four-coupled bogie, 46in. long, without tender, cylinder 2in bore, 3in. stroke, steel boiler, working pressure 60lb. The first pump was worked from cross-head, was 3-16in. bore and had ball valves. This one utterly failed to keep up the water in boiler, so then I made the present one of 5-16in. bore, again worked from cross-head, and though this one is much better, it is far from satisfactory. The valves are the ordinary conical ones, ¼in. diam., full 1-16in. lift, width of seating 1-32in. The valves seem tight, and yet very little water is forced past the back pressure valve, though if the pipe is uncoupled from boiler it makes a splendid stream. Is a long stroke pump as good as a short one? Should I get more satisfactory results from a pump of short stroke and larger diam. of ram worked by an eccentric? If so, what size ought it to be to supply an engine of the size named, or would a long stroke pump of larger diam. again, than the one I have tried, be better? Any suggestion will be esteemed.—Lohengrin.

Electric Condensers.—The experiments of M. Leblanc make the possibility of using paper and paraffin for the construction of condensers very hopeful. The success which he met in using thin ebonite does not appear to be so important, as the thickness is still too great; and the fact that the ebonite condenser stood 11,000 volts does not prove its superiority for practical purposes over such well-known, cheap, and easily-handled materials as paraffin and paper. Paraffin of great purity is commonly used for electrical purposes; its impurities are easily detected, and it can be well relied upon for not changing in any way with time. But there is hardly any material of which more varieties and qualities are to be found than paper; though, after experiments with a great number of kinds, Messrs. Swinburne and Co. only found one satisfactory sort. The "forming" process of M. Leblanc, although supported, now that it has been hit on, by excellent theoretical reasons, was not likely to have been thought of deliberately, and was the result of a happy accident. Knowing the rubbish that is used in making paper, and the potent chemicals employed in inducing this rubbish to present a respectable appearance, we would hardly go so far as M. Leblanc and say that one need not trouble oneself about the quality of the material so long as it undergoes the process of formation described. Continuity is the first essential, and homogeneity the second; while the process of formation is itself the best possible test of the finished article.—*The Electrician.*

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, quaries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, September 23, and unacknowledged elsewhere:—

Anxious to Know.—F. Buxton.—Fumes, Worcester.—Grateful.—A. T.—A. D—W. A. Jenner.—J. T. M.—Ironmonger.—Rocket.—S. R. Bottone.—G. F. S.—A Twelve Years' Subscriber.—R. C. Phillips.—C. G. M. Bennett.—A Fellow of the Royal Astronomical Society.—Jas. F. Vickery.

Fifteen Years' Subscriber. (We are of opinion that, as your committee blundered by not carrying out your own rules, it is evident that reference ought first to have been made to the books to make sure that the member in arrear had not paid up his subscriptions—the whole proceedings were void, and a fresh ballot is necessary. It is also our opinion that we should ourselves at once withdraw from a society where matters are so loosely managed.)—J. R. (The only printed directions for making a phonograph with which we are acquainted are those given recently in our columns (one article appeared last week), and Mr. Shelford Bidwell's article, "Description of a Phonograph," which we printed so long ago as April 26, 1878. The number in which that appeared has been out of print a long time; but the more recent articles can be had. There are descriptions of the phonograph in several works; but detailed directions for making are not given, except as above stated.)—Gardener. (Whereabouts are the weeds? On gravel paths? Any chemical which will destroy weeds will also kill other vegetation. If on paths, you can try dilute sulphuric acid, a solution of sulphate of iron, or carbolic acid. Weeds growing in flower beds, or in the kitchen garden, must be hoed up, or pulled up.)—Rodger. (Yes, "ordinary blacklead" is graphite. There are many suggested methods for making carbon plates for batteries in back numbers; but perhaps the best plates are those cut from the gas carbon of the retorts.)—Geo. Panter. (The method of making vulcanised rubber stamps has been frequently explained. The rubber must be "masticated" and mixed with sulphur, and then, while in the mould, be exposed to a temperature of 270 to 300° Fahrenheit for a few minutes, preferably in a "vulcaniser," but it is done by means of a couple of iron plates which can be screwed together while being heated over a gas-jet. Suitable apparatus and proper materials must be obtained to do good work in the way of rubber-stamp making.)—F. A. (The best cure for stammering is "determination." Get some sentences in words of one syllable, and keep on repeating them until you get full command of the organs of speech. To begin with, try to say "No" and "Yes" with firmness, and then make up some short sentences in monosyllables. Practice will do the rest.)—Inlayer. (We do not think there is any cheap book published on the subject of inlaying in wood, and the art is only to be learned by practice. Information can be found in such a work as "Practical Guide to Fretwork, Wood-Carving, Marquetry, Buhlwork," &c., which is published by Savory, Cirencester; but there is not much to say about such work of the common kind. The wood is built up and forced together, and is then sliced into veneers. For real "inlay" the hole must be cut, and the "inlay" be made to fit it.)—W. H. (Magnetised watches can be demagnetised by placing them in the field of a dynamo; but see pp. 321, 341, 579 of the last volume, or the No. for Dec. 26, 1890, for an illustration of a method of operating.)—R. J. H. (The question has been answered many times. The furniture can possibly be baked; but the simplest plan is to force grease of some kind into the holes, and so destroy the insect. Paraffin oil or ordinary sweet oil is effective if it can be forced into the holes. Corrosive sublimate solution is often used. See No. for May 16, 1890, p. 252.)—Ajax. (See previous answer. In your case it is almost necessary to inspect the place; but you might try washing over with a solution of corrosive sublimate, or, for the rough work, creasote thinned with coal oil.)—Arthur Dixon. (We do not know, and do not think it likely that any such details are published. You should make inquiries of those who cut wood type, or of the "printers' brokers," as they are called, who could tell you where such machinery is made, if it is made at all.)—Anxious. (Longmans, Macmillans, Lockwood and Son, and several other publishers, issue works suitable for students intending to enter for the examinations of the Science and Art Department, and the teacher at any of the classes will be able to advise as to the most suitable books.)—Pharmaceutist. (The secretary of the Pharmaceutical Society, 17, Bloomsbury-square, W.C., can give all particulars as to the examinations.)—Novice. (You will find something of the kind you want in the number for Aug. 7 last, p. 532. The tightening up would depend on the manner in which the spokes are fixed.)—J. A. Noble. (We do not see what we can do in the matter. They are not novelties exactly, and if you wish to introduce them the ordinary means are available.)—One in a Fix. (Without knowing what has been stated in the provisional specification, how can we form an opinion? Would-be patentees, especially those who seem to be in doubt as to what it is they wish to patent, should certainly employ an agent.)—William Taylor. (We do not know; but you could apply to those of our advertisers who deal in musical instruments. We think the paper sheets were made at Blackburn at one time.)—Magnetised Watch. (Certainly. Keep it in a tinned iron box.)—Telhara. (It must be analysed before a definite opinion can be given. 2. Something wrong with the gastric juice. Put the question to Dr. Allinson through the *Weekly Times and Echo*. 3. A bookseller could no doubt show you several works that might suit. A copy of the "Pharmacopœia" would perhaps do.)—Anxious, Glasgow. (Works of the kind that may suit are mentioned every week in our columns; but, as a guess, perhaps Sir D. Salomons's "Electric Light Installations," Whittaker and Co., will do.)—Phono. (He can send it on in the usual way; but we cannot undertake to publish anything without seeing it. Why does he not protect it, if of any value?)—G. Ryan. (See answer to "Z. Y. X." last week.)—B. J. Hopkins. (We cannot reproduce the sketch sent creditably, we regret to say.)

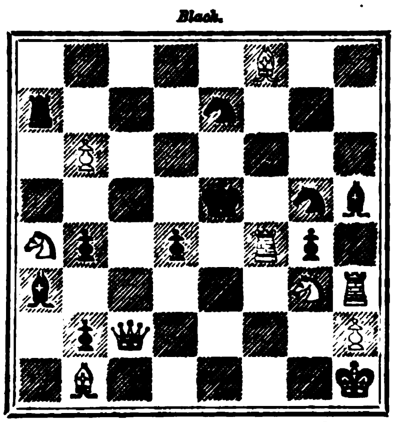
Is it a means of obtaining health and strength without drugging, that you require? If so, obtain and wear one of Mr. Harness' Electropathic Belts. They cure all rheumatic and nervous affections, liver, kidney, and other organic disorders. Book of testimonials, pamphlet, and consultation free on application to the Medical Battery Company, Limited, 52, Oxford-street, London, W.

CHESS.

All communications for this department must be addressed to "J. Pierce, Knollside, Yawl, Lyme Regis, Dorset."

PROBLEM MCCLXXIII.—By T. Guest.

Black.



White. [10 + 10

White to play and mate in three moves.

Solution to 1271.

White.	*Black.*
1. Q to K-B 2.	1. Any.
2. Mates.	

NOTICES TO CORRESPONDENTS.

Correct solutions to 1271 by Biene, A. Fellows, H. Fellows, R. W. Houghton, G. Collins, W. L Martin, J. Johnston, T. H. Billington, F. H. Guest, and T. Guest.

W. T. Hurley.—See notice in our last respecting 1270.

W. F. Kipper (Madras).—Many thanks for your good wishes and suggestion. The latter, unfortunately, cannot be entertained. Your solution to 1265 is correct.

G. Collins.—Your last two mover is too easy.

The *British Chess Magazine* for September contains some interesting autograph letters of Staunton giving a peep into his character as well as his style of writing, which is very firm and pointed. There is a careful analysis of the Steinitz-Gambitt, by Mr. W. Timbrell Pierce, in which the results of modern investigation of this curious opening are placed before us, and some original suggestions made. Mr. Tomlinson gives this month an interesting paper on the celebrated blindfold player Paulsen, now no more. There is a good portrait of the late Mr. Miles.

The *Surrey Gazette* has just started a chess column.

The *Dudley Times* is about to start a solution tourney. Twelve problems will be published in two and three moves. There is no entrance fee.

The *Pictorial World* will commence in October the second year of its quarterly solving competitions. There will be *six* money prizes instead of three as heretofore, and book prizes will be given to all who send in correct solutions of all the problems published in the quarter. For these competitions an entrance fee of one shilling is required. Names should be sent in as early as possible to the Editor, 149, Strand, W.C.

Holloway's Pills are specially adapted for the young and delicate; their gentle and purifying action ranks them above all other medicines. In indigestion, nervous affections, gout, and rheumatism, these pills have achieved for themselves universal fame. They expel all impurities from the blood, and thus restore cheerfulness and vigour.

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OUR EXCHANGE COLUMN.

The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.

Wanted, Harmonium, American Organ, or Musical Box out of repair; cheap. Exchange.—Harding, 196, Holloway-road.

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40 plain **Slides** in exchange for like number.—Hawkins, Cedar Villa, Latchford.

To Amateur Organ Builders.—**Two Manual,** about three-fourths finished, ill-health forces owner to part. Full particulars—C., 42, Christie-road, S. Hackney.

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The Chenies-street Exchange offers best value in cash or instruments for scientific appliances and tools of all kinds.—Caplatzi, Chenies-street.

"**Every Man His Own Mechanic,**" six parts, "Photography," Nos. 112-145; "Photographic News" (Vols. I.-V.) 61 numbers; "Work," 34 numbers; set of strong Organ Pedal, cost 25s.; Electric Bell and Case. What offers?—No. 76, Keith and Co., Advertising Agents, Edinburgh.

Model Slide-valve Locomotive, with circular railway, Mechanical Designs by various engineers, Selected Designs for Country Residences by Dean, Silver Watch, Dress Suit. Above exchanged for equal value.—Box 1, Mallow.

Old Stamp Collection, about 1,100 different stamps. Exchange for Corrugated Iron Roofing, pure Brown Leghorns, Galvanic Battery, Safety. Prepaid.—Tyler, 18, Station-street, Burton-on-Trent.

Bench Lathe, 3in. centre, 2½ft. bed, back-gearing, three-groove pulleys and few tools, value £4; also 3in. Leg Vice. Offers.—J. Beddard, Cleveland-road, Wolverhampton.

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The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, OCTOBER 2, 1891.

SMALL BOXES.—II.

Of late years a form of joint has come into use which was designed specially for the American sections or supers used for storage of honey in beehives. Bass wood of which such sections are made is exceedingly well suited for this form, owing to its toughness and little liability to split. It is something like sycamore in general appearance, and is, I believe, properly speaking, the American lime or linden. The jointing up of the square boxes or sections is effected by first sawing the stuff into strips 2in. wide, 17in. long, and ⅛in. thick. Angular grooves are then cut very nearly through at distances of 4in., so that the whole piece can be folded into the form of a square box measuring 4in. on each side, inside measure. Only one joining is thus needed, and is effected by cutting on each a row of equidistant notches ⅜in. apart, so arranged that the intermediate tongues of one end fit exactly the notches of the other end. The result is a firm union of the two, which hold well together even without the aid of glue. Fig. 12 shows the section as purchased, Fig. 13 the same when folded as a honey receptacle. Being sold literally by thousands at the very low price of 3s. 6d. per 100 ready for folding, it may be readily conjectured that these sections are produced by machinery. Those who have a lathe, however, can cut the notches by small circular saws ranged on a spindle with washers between, the *set* of each saw equalling in width the thickness of the washers. If kept solely for this sort of work thick saws can be had on purpose, but an ordinary saw set wide will answer very well.

It is hardly likely that bass wood is obtainable unless here and there by favour of those who are hive-makers on a large scale, and still less likely that any one of our readers will care to make his own sections; but the same principle is available for small boxes of ¼in. deal. Nor is a circular saw a matter of necessity, as the fine mitre saw and ¼in. chisel will do quite as well. Before using the latter, however, it is a good plan to grind off just a shade of the width, not more than the thickness of a thin card. Mark across a line ¼in. full from the end of each piece. You will need four separate pieces, as deal will not stand the cutting and bending as described above. The best way is to work by inside measure; say the box is to be 4in. square inside, then you can cut each piece 4⅝in., and the line stated to be drawn across at ¼in. *full* may be at $\frac{5}{16}$in. from the ends of the pieces, so that the little bits left between the notches will stand out $\frac{1}{16}$in. each way; the projections are then to be cut level after the glue is dry. Having carefully marked on each of the above-named lines, divide into ¼in., and mark these from the said line to the end of the piece. Then with a pencil mark alternate spaces with a cross, that no mistake may occur in cutting out the interstices. But remember that if one bit has a cross on divisions 1, 3, 5, 7, &c., the one to fit it must be marked on 2, 4, 6, 8, to bring the edges of the box level.

Fig 12

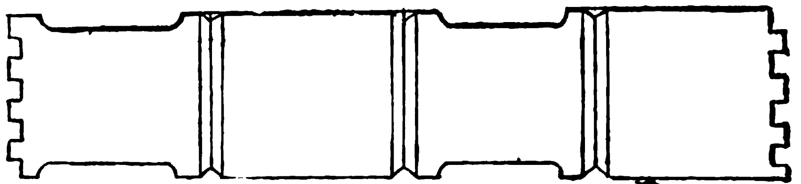


Fig 13

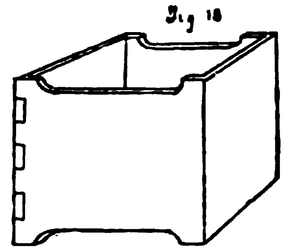


Fig 14

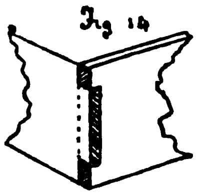


Fig 18

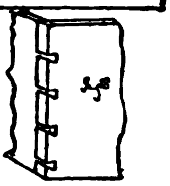


Fig 15

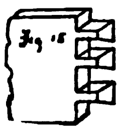


Fig 16

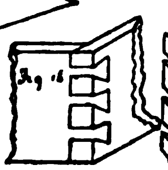
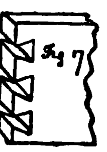


Fig 17



Now, observe that the secret of a good fit is to leave the marked lines on each side of each pin, taking the saw-cuts out of the intermediate pieces, which are to be removed; and to facilitate this the ¼in. chisel was slightly narrowed. This joint is, in fact, a sort of dovetail with straight pin. It is a joint easily made, and almost as strong as a true dovetail. If in putting the pieces together you find them too tight a fit, a penknife will set them to rights; but there is no fear of a split, except as regards the outer ones. When fitted the box should feel quite stiff, even before it is glued. The figures will make the whole process clear. Speaking of the American sections, I may remark that they make not only excellent small boxes for post parcels; but they are also suitable for small drawers, such as are so often needed for drills, tacks, rivets, screws, and various such necessaries of a workshop. Being all exactly similar in size and shape, it is easy to make a carcase of deal to receive them. Two of their sides are hollowed to give passage to the bees, but two are left uncut, and will form the front and back of the drawer. The bottom must be put on just above where the sides are cut out, and must be glued to strips put on to receive it. There will still be enough left at each end of the hollowed part to form a runner; but if not, it will be as well to cut all the four sides to a level at the part which is to be below; still, however, fixing the bottom inside, and ⅛ above the lower edges. A drawer is never made to rest upon its bottom, because it would be so heavy to slide in and out. It rests on the lower edges of the sides, which are left to project below the bottom for this very purpose, and so to form what are called "runners." We will, however, for the present, return to the simple box-making. It is plain that, if we so decide, we may reduce the number of pins in the last described box, making them larger accordingly. Some of the first sections were so made: the two outer pins narrow, and then after the ¼ or ⅜ interval the entire central part remained uncut. In the piece fitted to it, this order was reversed. If, however, Fig. 14 is consulted, it will be seen how very little hold is thus obtained, compared with the other arrangement. In this case the glue should be supplemented by a brad driven into the broad central pin. The next step—I will not say *in advance*, because the joint above described is an exceedingly good one—the next step, let us say, in more difficult jointing is that known as dovetail. This is considered thoroughly workmanlike, and is very extensively used in joinery, joinery being light carpentry relating chiefly to indoor work. It leads up to the still more aristocratic branch of woodwork known as cabinet-making. A dovetail is not difficult to cut and fit if care is taken, as in the former case, not to obliterate the fine lines by which the work is set out. It is usual to mark these with a point or scriber, and not with a pencil; but on white wood like deal scribed lines need good eyesight, and the mark made by an H or HH pencil may be almost as fine, and is decidedly much more visible. At any rate, my own eyes prefer it. But for best work, where possible, a scribed line is undoubtedly desirable, and the best tool with which to make it is a knife—a common pocket-knife is as good as any; a tool is, however, sold called a scriber, which has a point at one end and a sloping chisel-like edge at the other. It is no better than a knife. The pins of a dovetailed joint may be few or many, according to circumstances, which means according to the nature of the wood and the fancy of the workman. There is no need with our present material—¼in. deal—to multiply them unnecessarily, or we shall be in difficulties when cutting out the recesses which are to receive them. Moreover, we shall make them too weak for practical purposes. With ¼in. wood, especially deal, two, or at most three, pins in an inch will suffice, although more may, of course, be put if preferred. Two are decidedly better than three so far as strength is concerned. There seems indeed to be no rule in this matter. Cabinet-makers put small pins a long way apart, Fig. 18, to show as little end-wood as possible, and carpenters make a few much wider ones, Fig. 16. In either case, the process is the same. The edge of the wood is carefully squared up, and a gauge-line drawn on both sides, so that the pins shall project a little above the piece into which they are to fit. The pins are then marked on the end and on the sides, and are neatly sawn out, the intermediate wood being removed by a chisel (see Fig. 15). The pins are then stood up on the other piece, and carefully pencilled upon it, and, in cutting out the dove-tailed recesses, all lines are carefully retained on the stuff that is to be left (Fig. 17). This will insure a tight fit. Careful cutting to the lines will make a neat joint if the work is truly squared up, and if it is not, a true fit is an impossibility. Thin glue, i.e., glue about as thick as ordinary cream, is to be used, or even glue of the consistency of new milk. No more general mistake is made than using thick glue—and another secret is always to warm the pieces that are to be joined, and to use glue boiling hot. No good work can be done otherwise. There are, indeed, so-called glues advertised that are to be used cold. I have tried two of these samples, sold under different names, but both appearing to be French polish, which is nothing but shellac dissolved in spirits. Shellac is a gum often used by jewellers as a cement, and, variously incorporated with other similar gums, it no doubt answers this purpose; but for permanent work commend me to ordinary glue, troublesome as it is in its preparation. No joiner or carpenter uses the many makeshift applications now in the market. Fish-glue is the only one which I am inclined to except, as this holds very securely. Still, there are very many things for which the cold glue is convenient, as it will stick together substances which ordinary glue fails to unite; and for small boxes it is not to be despised if the old-fashioned sort is not at hand. This being intended for a practical paper, it is as well to state the ordinary causes of failure in amateur dovetailing, because it often is a failure unquestionably. First of all, the wood is badly squared up—truth being, in this respect, an absolute essential. Secondly, the dovetails are carelessly set out, the eye being trusted to instead of gauge and square. Thirdly, the cuts are not made accurately to the lines, and these are often cut away or partially cut into, instead of being left just visible. In cutting the pins, again, a chisel is often set up on the end of the piece close to the marked line, and struck with a mallet to split off the wood. In most cases it will perhaps run straight, but if the grain is the least crooked, away goes a little bit of the pin. Use a fine saw, cut neatly, and you need no chisel at this part, or, at most, just a keen paring chisel, used as a knife. Accurate squaring, marking, and cutting is the whole secret of neat, workmanlike joinery.

O. J. L.

THE OPTICAL LANTERN: ITS CONSTRUCTION AND USE.—V.

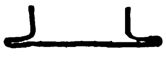
By Chas. A. Parker.

The Rolling Curtain Effect—The Jet Trays—The Containing Case for the Lantern.

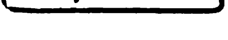
BEFORE proceeding further, it may be advisable to call attention to the rolling curtain diaphragm, which has now become an almost indispensable accessory to all lanterns of a superior class. This diaphragm, which takes the form of a thin plate of brass, having a rectangular opening at its upper end of a sufficient size to admit the full light of the top lantern, is made to slide from one stage to the other through a couple of small-grooved wooden frames which are attached to the stage plate between the condensers and the picture to be shown, the top and bottom of each frame being furnished with a slot of sufficient size to admit the metal shutter. The working of the curtain may be thus described. The two lanterns are fully lighted, and the curtain is drawn up so as to obscure the light from the top lantern, which thus allows the plain white disc of the lower lantern to appear on the screen. A slide painted to represent an arrangement of curtains somewhat similar to the act drop of a theatre, is now put into the slide stage of the lower lantern, and the opening slide of picture set or series of views to be shown is placed in the stage of the top lantern. If the diaphragm is now pushed slowly and steadily downwards with a uniformly even motion, the curtain will appear to gradually roll up on the screen, and disclose the view behind, thus forming a very attractive opening to the evening's entertainment. A reversal of this movement will, of course, present the appearance of a curtain being dropped from the top, as it must be understood that everything shown in the optical lantern appears reversed when thrown upon the screen.

If it is desired to fit the lantern with a curtain diaphragm, as above described, it will be necessary to double the width of the stages by fitting them together with supporting rods 2in. in length. This, however, is the only alteration that will be necessary. The curtain diaphragm as above described, which is shown in Fig. 26, is formed of a perfectly flat strip of tolerably thin sheet brass measuring 17in. by 4¾in., cut to the shape indicated in the illustration by means of a pair of shears, and afterwards brought up to an even semi-polish by rubbing with pieces of pumice stone and blue stone, using water plentifully as a lubricant. When this has been done it must be provided with a rectangular opening at the upper end, and measuring 5in. by 4in.; after which, all the cut edges are carefully smoothed by the aid of a file, using a half-round file for the curved portions. It will now be necessary to make a couple of light wooden frames, through which the diaphragm may be slid. For each of these frames prepare a strip of mahogany 21in. in length, and ¾in. by ½in. in width and thickness, care being taken to plane it uniformly even throughout its length. Having been prepared, a narrow groove must be run along the entire length of the ½in. side to the depth of about ¼in., thus forming a strip of wood similar to the section shown in Fig. 27, which may now be cut up into a couple each, of 6in. and 4½in. lengths. Previous to fitting the frame together, each of the 6in. pieces should be slit through the ½in. sides until within ⅜in. of either end by means of a circular saw. Some may perhaps prefer to leave the cutting of this slot until the frame has been fitted together; but this is immaterial so long as a clear passage is left for the metal shutter. The frame is now put together with mortised joints, the tenons being cut in the top and bottom rails, and the mortises in the sides, as shown in Fig. 28. A couple of saw-cuts are first made at each end of all four strips of wood to the depth of ¾in., after which the outside cheeks of the top and bottom rails are removed by means of a saw in order to form the tenons, the mortises to fit them being formed by removing the central portion between the saw-cuts in the other pieces of wood by the aid of a small chisel, thus forming a mortise and tenon similar to Fig. 29. When the frame has been fitted together it must have a hole drilled through each corner of sufficient size to take the supporting pillars of the slide stage, on to which it should be tightly and firmly fitted until quite close against the stage plate, and when properly adjusted in the manner above described, it will be found that the curtain diaphragm may be slid through each frame from one lantern to the other. It may not be out of place to describe another method of making the frames for the rolling curtain, which will doubtless be preferred by many by reason of its simplicity. Take a couple of pieces of well-seasoned mahogany measuring 6in. square and ½in. thick, and then cut a 4in. circular aperture in each of these by means of a fret-saw or lathe, after which the two should be glued together in the manner indicated in Fig. 30, with a thin slip of wood ⅜in. × ⅛in. on either side between them. This plan, which saves the trouble of grooving the wood, will be found to furnish a frame equal in appearance to the foregoing if carefully made. When ready for attaching to the stages these frames will, of course, require to be pierced with a hole at each corner, the same as before.

We shall now require a couple of supporting trays for the jets similar in appearance to Fig. 31. These trays may be made from a single sheet of brass turned up and soldered together to form a shallow tray ⅝in. deep, having a slight projecting ledge on either side to allow it to slide along the grooves in the jet shelves, one end of the tray being furnished with a metal rod, on which to support the lime jet. For each of these trays a sheet of brass, measuring 8½in. by 7in., should be cut in the form of Fig. 32, and then marked out in lines in order to indicate the position of the bends. The bottom of the tray measures 6in. by 4½in., and the two sides A and B 6in. by 1¼in., with the three lines at ½in. and ⅜in. distance from each other. The front end of the tray, indicated at C in the cut, will measure 4½in. by ¾in., and should be intersected by a single line along the middle, the back of the tray shown at B being a similar length, 1¾in. wide, and divided by a couple of lines 1in. apart in the middle, which thus leaves ⅜in. on either side. The sheet of metal should now be sharply bent along the dotted lines, and afterwards brazed together at the four corners in the usual manner, the metal presenting the following appearance if viewed in section across from A to B, thus:—



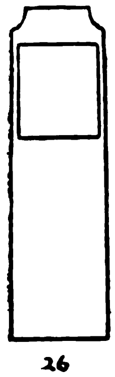
and from C to D thus:—



At this stage of the proceedings, a 5in. length of ¼in. brass rod should be firmly fitted into a hole punched in the raised shelf at the back of the tray, being afterwards hard soldered in position. This rod may, with advantage, be flattened on one side opposite to the binding-screw of the jet, as this will have the effect of imparting greater steadiness to the jet. The handle of the tray is formed by soldering a ½in. length of brass tube of small bore on to the back of the tray. A small piece of brass wire bent to the triangular form indicated in Fig. 33 is then sprung into either end of the tube, thus forming a very neat and simple handle.

The lantern is now completed, with the exception of polishing the woodwork and lacquering the brasswork, each of which subjects will shortly receive treatment. At the present it behoves us to turn our attention to the construction of the containing case, which has already been illustrated in Figs. 1 and 2. At the outset it may be stated that the outside dimensions of this case, when completed, will be 26in. by 16in. by 10in., and anyone capable of putting a box together will be competent to construct this.

Now as to the construction of this case. The most suitable timber to employ will be some of the best yellow pine, which may be easily worked, and presents a good appearance when finished. To insure proper seasoning, it should, of course, be bought some days previous to being worked up. A couple of ¾in. boards should first be prepared for jointing in the middle, in order to form one of the 16in. sides of the case. To do this, take one of the boards and proceed to accurately plane one of the edges by means of the half-long plane, gripping the piece at one end instead of in the middle, and when the edge has been carefully shot, place a couple of parallel slides thereon, and then look across these with one eye in order to see if they are both horizontal, and if not, continue to alter the surface until they are so, always remembering that it is an advantage to have the edge slightly hollow in the middle lengthwise. When one board has been prepared in this manner, it will form its own test-edge for the other board, which is then planed up in a like manner. By placing these boards one on the other in a vertical position, it will be possible to get them to fit accurately, and by moving one end of the upper board crosswise, it will soon be seen whether they are round in the middle, as this would cause it to turn freely as if on a pivot. When this is the case it becomes necessary to again shoot the edge of one of the boards until it is slightly hollow in the middle. After having been prepared in the manner above directed, the two boards will be ready for gluing together. The edges of the boards should be warmed at the fire for about ten minutes previous to the glue being applied, after which they are firmly secured up in a couple of bench cramps of suitable size. When these two boards have been joined together as above described, a couple more will require to be treated in a precisely similar manner, in order to form the other side of the case, after which they are placed aside for the two ends to be prepared in a like manner, the outside dimensions of the latter when finished being 16in. by 10in. It must be understood that these end-boards should not be joined along the middle the same as the sides in order to get the required width of board, as this would considerably reduce the strength of the case when made up. The necessary width should be secured by means of three pieces of stuff glued together in order to obtain the required width of 16in. Thus prepared, the first piece will be ready for dovetailing together, the dovetails being placed at 1½in. apart, with the pins on the end pieces. Having carefully shot the edges of all the boards to the exact measurements required, run a line by means of the marking gauge across both ends of each board at a distance of ½in. from the outer edge of the wood. When this has been done, take the two end boards, and mark out the position for all the pins (see Fig. 34), planting them at a distance of 1½in. from each other; then cut each one to the gauge-line by means of a tenon, or dovetail saw, and afterwards clean out all the wood between the saw-cuts (as indicated by the shaded portions in the above diagram) by the aid of a mallet and chisel of suitable size. After having finished the ends of the case in this manner, the two sides should be provided with corresponding mortises, into which these pins may be fitted. To draw the mortises from the pins just cut, lay the side flat on the bench, and then, holding one of the boards just finished vertically on the end of the wood, as shown in Fig. 35, proceed to draw close to each pin with a draw point, after which the remaining dovetails are drawn in a like manner, and the mortises carefully sawn to the gauge-line, and afterwards cleaned out in the usual manner by means of a small chisel. The body will now be ready for putting together with hot glue, which



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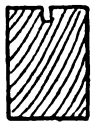

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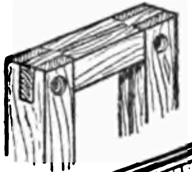

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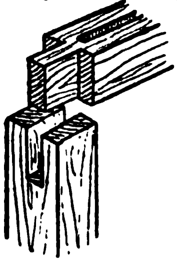

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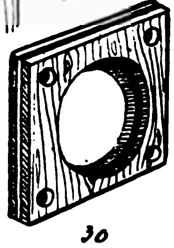

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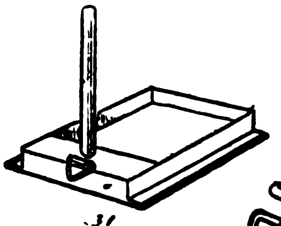

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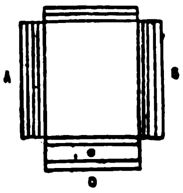

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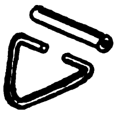

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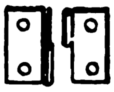

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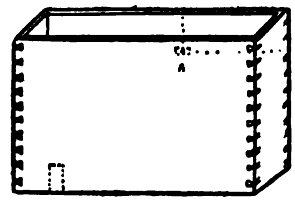

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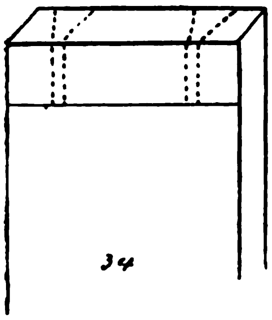

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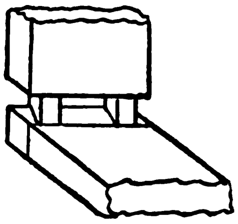

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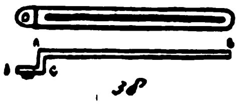

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should be applied to the dovetails by means of a small brush, care being taken to see that no glue gets on to the inner surface, as this would be liable to leave an unsightly mark on being wiped off. In rapping the dovetails together, a heavy hammer should be used, with a piece of wood in front of it in order to protect the frame from injury. When the four corners have been rapped up quite close, the frame must be accurately squared by applying a try-square to the inside, and pressing or hammering the faulty part to agree with the latter. By the term "square" here used, rectangular is the word meant, as the frame is not square, but oblong. A bottom board, ¾in. thick, should now be planed up, and glued and nailed on to the underneath of the frame, after which the whole of the box should be truly planed up on the outside, until it presents a smooth and level surface. The lid, which is 3in. deep, is now formed of four strips of wood, and dovetailed together to form a frame the same size as the body just finished, the top being glued and nailed on in the usual manner; after which the lid is evenly planed and squared to the proper size. When ready the lid must be hinged to the box by means of a pair of heave-off hinges, the construction of which will be understood by reference to Fig. 36. It will thus be seen that the lid may be readily removed from the case without the necessity of removing the hinges.

Some kind of a lock will now be required, in order to keep the instrument secure from prying fingers. It may be fitted with an ordinary till lock, which should be let into the woodwork flush with the surface, the top plate being screwed on to the lid of the case. Before the lock is finally screwed into position it will be necessary to cut the keyhole, the shape of which is too well known to need any description. It should be cut as accurately as possible by means of a small keyhole saw, and if it presents an unsightly appearance afterwards, it will be advisable to hide its defects by screwing a brass escutcheon over the keyhole. An escutcheon, which is simply a brass plate pierced with an opening for the key, will effectually hide an ill-cut keyhole, and be in itself an ornament. A block of wood the exact width of the inside of the case, and 3½in. by 1½in., should be glued to the bottom of the inside of the case (in the position indicated by the dotted line in Fig. 37), and 3in. from the end of the case. As this is intended to form a support for the back of the lantern when the latter is packed, it will be necessary to cover the top edge of the wood with a strip of green baize in order to protect the polish on the instrument. When the case is completed a couple of ordinary japanned iron handles should be screwed on to either end.

It will now be time to hinge the lantern to the case and provide it with the slotted arm which forms the support of the instrument when in use. This slotted arm, which is shown in plan and side elevation in Fig. 38, should be cast in brass from a carefully-prepared pattern. The length of the arm from the elbow A to the end B will be 9in., and the width 1in., with the elbow 1in. in length from A to C and from C to D, the uniform thickness of the arm being ¼in.

Some of our readers may be sufficiently skilled in brass casting to prepare the pattern and cast the arm for themselves; but those who do not care for the work may pack it together with a few shavings to prevent it falling about, and send it to the nearest brassfounders with a request to have it cast in moderately soft yellow brass. A brass casting of this character varying in price according to the locality from 1s. to 1s. 4d. per pound. Those resident in London may send to Mr. F. H. Simmonds, 21, New Charles-street, Goswell-road, E.C.

When the arm is returned from the brassfounders, it will require to have the surface filed up until quite square and true in all directions, using an old or partially worn file first for removing the outer rough skin; otherwise a new file would soon loose its cutting power if it were permitted to come in contact with the sand and grit of the casting as it comes from the foundry. As soon as the arm is ready for attachment to the apparatus, a T-bush provided with a T-screw to fit (No. 105 in Mr. Platt's list, price 6d.) must now be let in flush with the surface of the wood on the inside of the case, at 3¼in. from the top and 11½in. from the front end in the position indicated at A in Fig. 37. A milled nut, No. 61 in Mr. Platt's list, which should be fitted with a large circular nut-plate about an inch in diameter, or a T-bush the same as the other, will be required for the lantern body. The nut-plate or T-bush belonging to this must be let in flush with the surface of the right-hand side of the lantern at 7in. from the base and 1¼in. from the outer edge, as will be seen by referring to Fig. 6. Thus prepared the lantern is supported in a level position inside the case, with the back resting on the baize-covered block of wood, whilst a pair of substantial 2in. brass back flap hinges are screwed to the bottom front edge of the lantern body and the inside of the front end of the containing case, having eight stout ¾in. brass screws to each hinge. On the lantern being raised in the case, the elbow end of the slotted arm may be pivoted to the right-hand side of the lantern by means of the milled nut, which is inserted in the hole at the end of the arm and screwed into the bush affixed to the instrument, the other nut being pushed through the slot and screwed into the bush affixed to the inner woodwork of the case. It will thus be seen that by clamping the latter nut firmly in position it will be possible to support the instrument at any desired angle. On releasing the nut when the lantern is lowered into the case, it will cause the clamp to completely revolve round the nut, thus enabling the latter to be again screwed up tight in order to retain the instrument in a perfectly rigid position when packed.

Since writing the last paper it has come to my knowledge that Messrs. Taylor, Taylor, and Hobson (late T. S. and W. Taylor) have revised their prices for lantern stages. I may also mention that Messrs. Platt and Witte, Birkbeck Works, Birkbeck-road, Kingsland, can also supply all parts of lanterns, either together or separate. Should any difficulty be experienced in making the inner body of the lantern, Mr. T. C. Woggett, 4, Church-lane, Upper-street, N., metal worker to the optical trade, would doubtless give a price for making this portion of the instrument according to the measurements given.

Errata.—The slotted plate illustrated on p. 103, chap. iv., is drawn half actual size.

FITTING.—VI.

I SHALL not waste time in discussing the conditions of mechanical power, strength, and durability that determine the forms of screw-threads, nor the history of the evolution and ultimate selection of the standard Whitworth threads, for all that can be read in textbooks. But I want to look at the matter from the standpoint of the workman, whose aim is to give practical effect to the principles which have long been laid down and settled. It depends upon the skill of the workman, and the class of tools he makes and employs, whether the screw-threads be keen, sharp, and smooth, or rough and jagged; whether time is lost or economised, and whether fitting is good or bad. Let us see.

To begin with the formation of taps and dies. Everybody knows that there are great differences in the manner of operation of different sets of screwing tackle. I do not mean, of course, when the tackle has been bought of approved makers, but when it has been made by different men in jobbing shops; for there is, and always have been, a lot of tools made in such shops, though the general tendency is to purchase

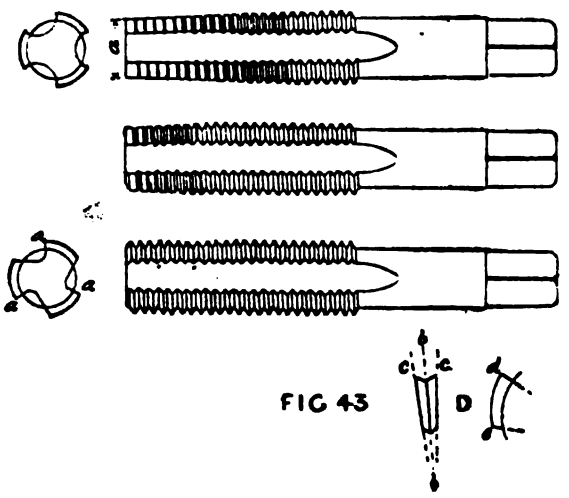


FIG 43

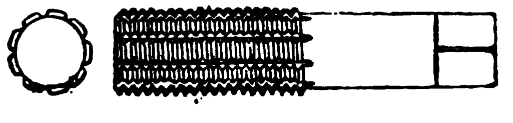


FIG 44

more and more articles of those kinds that have been made specialities in recent years. Thus many firms, most large ones in fact, not only buy all their screwing tackle, but also all their bolts, washers, and nuts, and their keys, brass fittings, emery wheels, rivets, and many other things. But screwing tackle costs a deal of money, and while, therefore, a few sets will be bought, the practice still is, in many of the smallest firms, to make a large number of taps and dies for their own use.

It not unfrequently happens that good workmen have somewhat crude ideas as to the correct principles of tool formation; and working in a tentative fashion, they do not always get the very best results. I think there are few tools in which very slight, very minute departures from correct form, will so greatly increase the labour of working them as screwing tools. One sometimes sees taps so large as ¼in. or ⅜in. with flat instead of fluted cutting edges, or taps with edges not grooved-out sufficiently to cut freely, or taps kept still in use long after all their original keenness of edge has been worn off, and taps chipped and damaged, or dies cut over hobs of unsuitable diameter, and so on. A few remarks on the correct formation of common screwing tackle may therefore be of value to some workmen, as well as to apprentices and amateurs.

Hand-working taps are made three in a set (Fig. 43), the taper or entering, A; the middle or second, B; and the plug or bottoming, C; with each set of working taps a plug, master, or hob tap is also included.

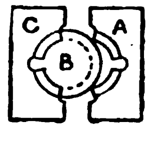
The entering tap A is tapered from the point to the sixth thread from the top. The diameter *a* at the point is the diameter of the bottom of the thread. This tap, as its name implies, is used for commencing the thread in a drilled hole. The second tap B is tapered from the point to the sixth thread from the point. Its diameter at the point is also equal to that of the root of the thread. This is used for continuing and deepening a thread commenced with A. In the plug tap C there is no taper whatever, and its purpose is the finishing of threads down to the bottom of a blank hole. The entering and the second taps are backed off, or relieved with the file throughout their entire tapered portion; the plug tap is not backed off in any part of its length; the actual cutting being done chiefly with A and B, C only finishing the bottom of the thread and smoothing the remainder. The master tap, Fig. 44, is neither tapered nor backed off. Its diameter is also greater by twice the depth of the thread than that of the working taps, and the number of flutes or grooves is greater. The reason for this will be apparent directly.

The object in "backing off" is to afford an angle of relief, or clearance to the cutting-edges, of the same nature as that imparted to turning and other cutting tools. It is imparted by the file after the taps are screwed, but before hardening. It is very minute in amount, but I have shown its nature in an exaggerated diagram in Fig. 43, D. If *b b* is the point of the thread, its flanks are filed to the angles *c c*, and this has the effect of making the radius of the leading edge *d* greater than that of the leaving edge *e*, and the whole of the sectional area of the tap thread diminishes from *d* to *e*. Though very slight in amount, the backing off has the desired effect of relieving the tap from the stress of excessive friction.

Dies are cut in the solid screw-stock or screw-plate for very small threads. In all sizes above about $\frac{3}{16}$in. diameter, they are made movable, and contained in stocks of suitable forms, two or else three dies being embraced in a stock. In general workshop practice the two-die stocks are mostly used. Those with three dies are, however, superior in all respects.

Dies are cut on the master tap (Fig. 44) just now mentioned, and the reason why this tap is larger by the depth of two threads than the diameter of the working taps will be evident if we consider the action of the dies when cutting.

When a screw-thread has to be cut by means of dies, the screw blank is of the same diameter as the points of the threads. If the dies were of the same precise curvature as the screw-threads, that is if they were cut on a hob of the same diameter as the screw threads, this would happen:—On first commencing to operate, the extreme corners only of the dies, Fig. 45, A, would scratch a screw-thread on the outside of the blank B, the angle of which thread would differ considerably from that of the ultimate screw point, and, further, the guidance of the dies would be very imperfect. By the time the thread was finished, the curvatures of the dies and of the thread would be precisely alike, C, and no more cutting action could possibly take place. So that if the thread made too tight a fit with its tapped hole, it would be impossible to reduce it even ever so slightly. When these dies became worn blunt, it would be impossible even to cut a thread quite down to its correct size. Moreover, as the angle of the thread being cut would be continually altering as the thread was deepened, a deal of friction would be developed during the operation.



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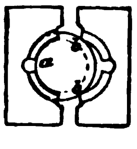
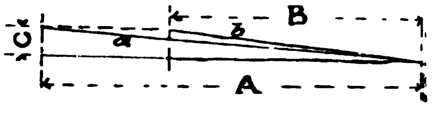


FIC 46

But when dies are cut upon a master tap larger in diameter than their thread, the effect is this:—In the first place, Fig. 46, the curvature of the smaller diameter of the tap and of the outside of the blank are not so dissimilar as they were in the previous supposition. There is, therefore, somewhat better guidance. Then the difference in angle is lessened. And when the screw has been cut to its correct diameter the curvatures of the dies and of the thread are still unlike, and the inner edges *a* will cut the thread smaller, if so required, to make an easy fit with the tapped hole.

Dies, therefore, properly formed, that is over a master tap of two threads larger, when operating, cut first upon the outside corners *b*, Fig. 46, until the thread is nearly completed, when the inner corners *a* begin to cut, and continue to do so until the thread is finished.

Fig. 47 will make the reason of difference in angle at root and point clear. If the length A, Fig. 47, represents the circumference of the point of a screw, and the length B the circumference of its root, and C the pitch, then *a* will be the angle or slope of the point, and *b* the slope of the root. In dies cut over a hob two threads deeper than standard, the angle *a* will be that first traced on the blank. In dies cut over a hob of the same size as standard, the angle *b* will be that first traced, which will be gradually changed to the angle *a*. Fig. 48 illustrates the best form of die stock used for the dies shown in Fig. 45 and 46. It is termed the "angular pattern," because the pinching-screw A is set diagonally in relation to the handles. It is better than the straight pattern where the screw is either set at right-angles with the handles, or forms a prolongation of one of them. In Figs. 49 and 50 a better type is shown. It is called the "guide screw stock," and its dies are of different construction from those in Figs. 45 and 46. Fig. 49 shows the general appearance of the stock. Fig. 50 shows the operating parts enlarged. In the figures, A is the body of the stock, provided with three grooves, in which slide the guide B, which does not cut, and the actual cutting-dies C C. These cut by their inner edges, *a a*, and are thrust forward to their work by means of the wedge D, tightened up with the nuts *b b*. The dies are kept in place with the plate E, screwed upon the body of the stock. The screws *c c c* always remain in place, and the plate E is slotted to slip along them. The guidance of this stock with B in place is excellent, while the narrowness of the cutting-edges of C C diminish the friction due to alteration of angle. These are cut over hobs two threads deeper than their taps.



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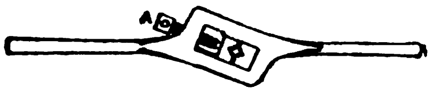

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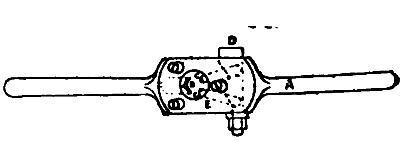


FIC 49

With reference to the forms both of taps and dies most suitable for cutting freely, some difference exists in practice. Of course the old style of grinding three or four flats on taps to form cutting edges has long since been discarded, except in the case of very small ones of $\frac{3}{16}$in. or less in diameter. In all taps of larger sizes than those, grooves or flutes are cut, and in this way, assisted by the backing off, serviceable cutting edges are obtained. There are two or three ways of cutting these grooves; Fig. 43 shows the best methods.

Fig. 43, A, is a very common way, but it is being superseded by C; the latter is stronger by comparison than the former; it has a more perfect cutting angle, the cutting edges *a* being radial past the bottom of the screw-thread, while in A the cutting edge turns off into a sharp curve at the root of the thread, and makes the cutting angle slightly obtuse instead of at 90°. There is also quite as much room in C for holding the chips or swarf, as there is in A; therefore it embodies the best form of flute in use.

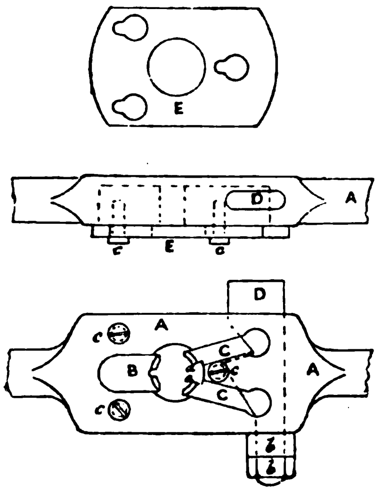


Fig. 50.

In Figs. 45 and 46 the best form of groove for dies is shown. These are radial. Not unfrequently they are filed out parallel with a parallel file; but it is better to make them as in the figure. In the case both of taps and dies, cutting or squeezing action predominates, according as the cutting edges are radial or not, and according to the sharpness or smoothness of those edges. We cannot get a sharper angle than that afforded by a radial disposition of the edges, without weakening the leading corners, and making them liable to crumble off. But neither should we have a more obtuse angle if we want to economise labour and cut sharp threads. Nor should taps or dies be used after their edges are dulled without regrinding them.

In the next I propose to say a little about the making and tempering of these and other cutting tools used by fitters.

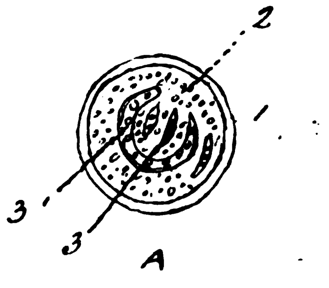
J. H.

PRACTICAL MICROSCOPY FOR STUDENTS.

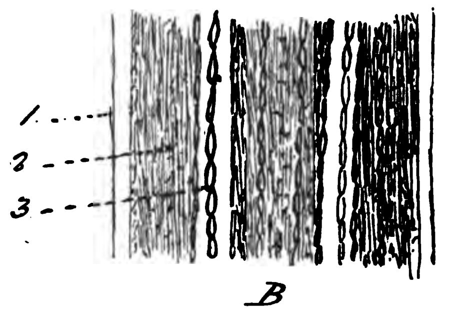
By Frederick Davis, B.Sc.

In the forthcoming series of articles it is my intention to treat this subject practically; at the same time, it is imperative to impress upon the student the necessity of understanding the theory of the subject also, because practice is of very little utility without theory; and again, on the other hand, theory is of paramount importance, if the practice is to be rightly carried out. The student should also remember there is no "royal road to knowledge," but that with diligence and care, results may be achieved which otherwise would be far removed from the most sanguine hopes of the tyro.

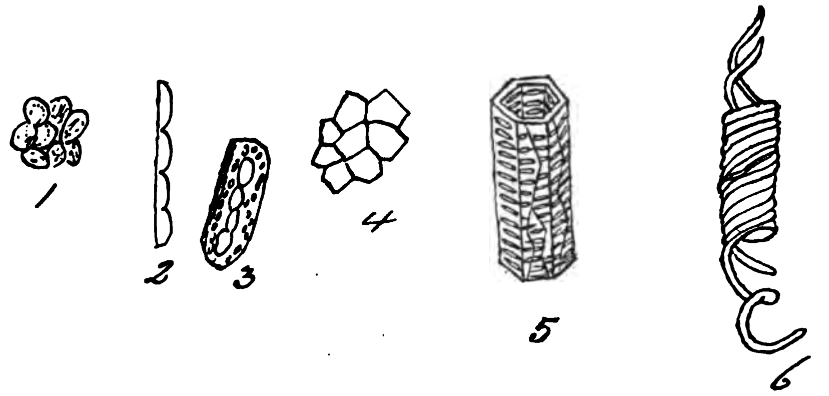
A full description of the optical phenomena of the compound microscope may be found in any work dealing with optics. It will not be necessary, therefore, to enter into or describe the same here. A brief description, however, will be given respecting the various parts of the instrument, after which I intend to plunge *in medias res*, describing the methods of preparing, mounting, and staining the more important vegetable and animal tissues, together with the modes of manufacturing the solutions, &c., employed for such purposes.



A.—Transverse Section of Fern Stem.
1, Epidermis; 2, Parenchyma; 3, Sclerenchyma.

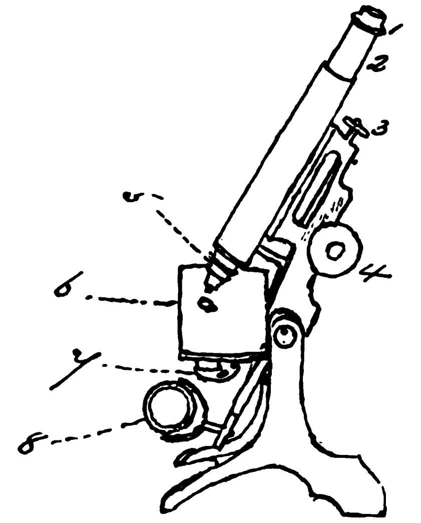


B.—Longitudinal Section of Fern Stem.
1, Epidermis; 2, Parenchyma; 3, Sclerenchyma.



Histology of Fern Stem.
1, Cells of Parenchyma; 2, Cells of Epidermis; 3, Cross Section of Fibro-vascular Bundle; 4, Arrangement of Polyhedral Cells; 5, Scalariform Duct; 6, Spiral Duct.

The points of the instrument are essentially that the stand be firm, and, in whatsoever position it be placed, with the draw-tube fully extended, there should be no tendency to overturn; the coarse and fine adjustments should be smooth in their actions, the stage provided with fixing clamps, and a few easy movements for altering the position of the object during observation, a diaphragm beneath the stage for regulating the light thrown upon the object from the mirror beneath, and, above all, the objectives (i.e., object-glasses) should be of the best, having a flat field, and showing no colours towards the margin when the instrument is looked through with the eye closely down to the eye-piece. Any instrument not answering to these requirements, should not be entertained. There are, however, a large number of makers; but it may be well to remind the student to provide himself with a fairly good instrument at the outset, and thus to guard himself against disappointment later on. Beck, Collins, Swift, Watson are all reliable makers, any of whom would supply an instrument of the required standard for about £5. The figure represents an instrument satisfactory in every detail, costing £5 10s. This includes stand, with coarse and fine adjustments, stage, diaphragm, mirror, &c., eyepiece and two objectives. The full cost of the complete instrument, with all accessories, is £13 10s. Other instruments may be equally good; but having used one of the above for the past ten years, I am able to recommend it for histological work.



1, Eyepiece; 2, Draw-tube; 3, Fine Adjustment; 4, Coarse Adjustment; 5, Objective; 6, Stage; 7, Diaphragm; 8, Mirror.

Having obtained an instrument, the next point is to find an object; the student should have no difficulty here. If he takes a stroll in the garden or across a field he will find plenty of botanical specimens.

I would suggest he first examine the fern rootstock or rhizome, treating it in the following manner for the purpose of showing its structure. Firstly, cut the rhizome transversely, and having sketched its appearance as seen with the naked eye, proceed to place the section, which must be very thin, upon an ordinary glass slide (3in. by 1in.). Mount in water, being careful to exclude air bubbles, and place a cover-glass upon it and carefully examine with a 1in. objective (it is advisable in every case to use a low power at first and afterwards the higher power), when the following parts will be easily seen and should be drawn by the student in every particular.

The external brownish layers which consist of the epidermis and sub-epidermis. Then travelling inwards we come to the yellowish-white substance, consisting of parenchymatous cells, called sometimes ground tissue, and forming the greater portion of the section. Imbedded in or about its centre, we find an incomplete ring of cells. This is sclerenchyma, and consists of cells, to be described later on.

There will also be observed dotted about in the ground tissue or parenchyma a number of patches. These also consist of sclerenchymatous tissue; and then in addition we have the vascular bundles lying within and without the ring of sclerenchyma.

It will be noticed the epidermic cells have much thicker walls than the other cells. Notice also the opaque character of the external sclerenchyma or sub-epidermic cells, the large polyhedral cells of the parenchymatous tissue, and the opening of the ducts and vessels in the fibro-vascular bundles.

Proceeding now to the stem, cut a thin longitudinal section, and examine, as before, under the 1in., and afterwards with the ¼ or ⅛in. objective. It will be observed the epidermis and parenchyma are practically the same, but the sub-epidermic cells are longer; the sclerenchyma is composed of elongated cells, becoming finer at each end.

In the vascular bundles the individual cells of the bundle sheath are much the same as in the transverse section; but the bast fibres are elongated and have thickened walls; the bast vessels are possessed of irregular patches of pores termed sieve-tubes; all of the cells are more or less elongated.

If we examine the vessels we shall find there are practically two forms—i.e., scalariform and spiral, the spiral fewer in number than the scalariform.

GEOLOGY FOR STUDENTS.

By Edward Aveling, D.Sc. Lond., Fellow of University College, London.

Chapter XV.—The Metamorphic Rocks.

WE saw in Chapter XIII. that there is a series of rocks forming a transition from the aqueous sedimentary rocks to the igneous rocks. These metamorphic rocks will be considered in this chapter. The student is advised to keep the important table given in Chapter XIII. (Table V.) before him, as he works through the following paragraphs.

In studying these rocks, our plan given on p. 81 (Table VI.), will be followed. As, however, it may fairly be assumed that the student has mastered it by now, I shall henceforth only give the letters A, B, C, D, E, F as heading in the descriptions. The student must be depended upon to remember A stands for derivation; B for the nature, or the What, of the rock, with its two divisions of (1) Structure, (2) Composition; C, for the distribution, or Where; D for the palæontology; E for the method of formation of the rock or rocks, the How; F, for the uses of it or them.

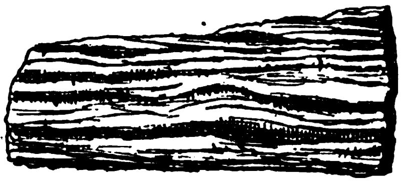


Fig. 53.

In dealing with the metamorphic rocks, as in dealing with the igneous, we shall first consider them as a whole, and afterwards take each of them, gneiss, the quartzose rocks, clay slate, crystalline limestone, serpentine separately.

Metamorphic Rocks Generally.

A. — μεταμορφοσις (metamorphosis) change. They are, probably, sedimentary rocks originally, that have been greatly altered by heat, pressure, chemical changes.

The name hypogene has also been applied to these rocks by Sir Charles Lyell, because of the fact that their present condition appears to be the result of internal actions and agents, rather than of the epigene action of such agents as air and water. ʽυπο (hupo), under; επι (epi), upon; γη (ge), the earth.

As the metamorphic rocks do not contain, except in very rare cases, any remains of plant or of animal life, they are also called azoic. α (a), without; ζωη (zoe), life. This name must not be understood as denoting that no plants or animals have ever been associated with metamorphic rocks. It only says that *now* no fossils are, as a rule, to be found in them. As, however, this term is also applied to the lowest rocks in the great series ranging from below upwards, or from within outwards, in the earth's crust—a series to be considered in the succeeding chapters—the name metamorphic is, upon the whole, the best.

By metamorphic rocks, then, we mean rocks, originally sedimentary, which have, by the action of heat and other agencies beneath the surface, acquired a crystalline structure.

B.—(1) The metamorphic rocks have all the characteristics of aqueous, sedimentary rocks more or less clearly shown, except that they do not now, as a rule, contain fossils. Sand, pebbles, ripple marks (p. 218) are met with amongst them. In Fig. 53 ripple marks upon a piece of sandstone are shown. They are the stone forms of the markings seen upon a sandy shore after the tide has gone down. In many metamorphic rocks similar marks, generally more or less obliterated by the forces that have metamorphosed the rocks, are met with.

Again, a regular alternation of successive beds is often seen among these rocks, telling of successive deposits from solution or suspension in water. In Fig. 54 is shown a diagram, copied from Prof. Geikie, of beds of metamorphic rock as they are met with in the Scotch Highlands. *g* is gneiss; *a* is a set of aqueous rocks, sandstones, conglomerates, breccias overlying *g* unconformably; *q l* are beds of quartzose rocks and crystalline limestone, both metamorphic, overlying *a* unconformably; *s* are quartz schists and mica schists, overlying *q l* conformably.

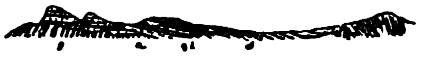


Fig. 54.

The metamorphic rocks, true to their intermediate character between the aqueous and the plutonic, have generally no fossils, resembling in this the latter, but never present any veins, as plutonic rocks do.

(2) All the metamorphic rocks are silicates and acid silicates (p. 84). They contain from 42 to 75 per cent. of silica (SiO_2); they all contain aluminium (Al), magnesium (Mg), iron (Fe), calcium (Ca), in the above quantitative order, and all but talc-schist contain small quantities of potassium (K) and sodium (Na).

C.—The metamorphic rocks are met with in connection with sedimentary rocks of all ages. There appears not to have been any time in the geological history of the earth at which aqueous fossil-bearing strata might not be subject to metamorphosis and turned into crystalline, azoic rocks.

Speaking generally, the succession of the metamorphic rocks in point of time has been from gneiss, the oldest generally, through the quartzose rocks, the schists, and the crystalline limestones to clay-slate, the youngest, generally. Here it is well to note, once for all, that in geology the name of any group of rocks or of any system is, as a rule, taken from the most characteristic rock of the system. But it is of vital importance that the student should not imagine that this naming-rock is the only one present in the group or system it names. Thus, in the sentence with which this paragraph begins, it must be understood that "gneiss," the oldest metamorphic rock, does not occur alone. It is associated with other rocks, but dominates them in quantity at first. In the groups known as quartzose, schists, crystalline limestones, clay-slates, again, each of these rocks predominates over others, including often gneiss, with which it is associated. In like fashion, when, later, we come to speak of the coal measures, e.g., we shall only mean a series of rocks in which coal is the dominant rock.

Fig. 55.

The metamorphic rocks may occur (as shown in Fig. 54) in alternate layers, or at times in huge, monotonous masses of the same kind of rock extending over vast areas (Fig. 55).

In working out the detail distribution of the metamorphic rocks, the plan given on p. 82 (Table VII.) will be used, as usual; but henceforth only the letters and numbers in it will, in order to save time, be employed. The student must be depended upon to remember that 1 stands for Europe; 1 *a* for the British Isles; 1 *a* i. for England; 1 *a* ii. for Wales; 1 *a* iii. for Scotland; 1 *a* iv. for Ireland; 1 *b* for the Continent; that 2 and 3 stand for Asia and Africa; 4 for America; 4 *a*, South; 4 *b*, North; 5 for Oceania; 5 *a*, Australia; 5 *b*, Polynesia.

1 *a* i.—The granite bosses of Cornwall and Devonshire in connection with the old red sandstone and the coal measures, have undergone metamorphosis.

In South Staffordshire (coal metamorphosed).
High Teesdale (limestones).
Skiddaw (slate).

1 *a* ii. — Plas Newydd, Anglesea (limestone and shale).

1 *a* iii. — In the south-western counties (arenaceous rocks and shale).

The Scotch coalfields, generally (coal).
Ayrshire and New Cumnock, specially (coal).
Isle of Arran (red sandstone).
Bishopbriggs, near Glasgow (sandstone). See Fig. 48, p. 83.
Camp's Quarry, near Edinburgh (limestone).
Fife (coal).
All the Highland district, occupying more than half of Scotland and an area of some 16,000 square miles. The crystalline metamorphic rocks here are the northernmost of the three great parallel rock series that run across Scotland from south-west to north-east.

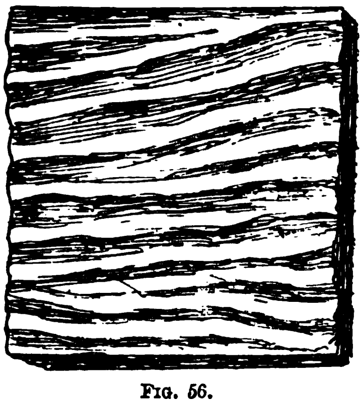


Fig. 56.

1. *a* iv.—The series of metamorphosed rocks just mentioned reappear in the north-east of Ireland, notably in county Antrim and in Rathlin Island, just off the north-east corner of Antrim (limestone).

1 *b*. Greece.—Campiglia, in Tuscany (dolomite).

The French Pyrenees (slate).

In France itself, Mount St. Michel, in Le Puy (granite); Commentry, in the Allier (coal); Gergovia, in Auvergne (limestone); Brittany (slate); Eastern Vosges (slate); the Ardennes.

In Germany, Sulzbach, in the Upper Palatinate of Bavaria (coal); Oberellenbach, in Lower Hesse (sandstone); Ettingshausen, in the Vogelsgebirge (Bird Mountains) of Hesse (coal); Meissner, in Hesse Cassel (coal); Wildenstein, near Büdingen, Upper Hesse (sandstone); Johnsdorf, near Zittau, Saxony (sandstone); the Brocken and Ramberg, in the Hartz Mountains (sandstone, &c.).

In Austria. Schöberle, near Kriebitz, Bohemia (sandstone); east and south-east of Botzen in the Tyrol (limestone); Fünfkirchen in Hungary (coal).

In Norway. The Christiania district (limestones, shales, slates, sands).

2. In the Punjab.

4 *b*. The coast of California; the Sierra Nevada; the Green mountains of Vermont; Albany, New Hampshire.

D.—As to the palæontology of the metamorphic rocks, it has already been noted that they are, almost without exception, destitute of fossils now. But as they were once upon a time sedimentary rocks, we have reason to believe that they did, originally, contain vegetable and animal remains. These have, however, been destroyed by the igneous changes produced by the intrusion or overflowing of igneous rocks, or by the chemical changes that have taken place within the metamorphic rocks themselves. In many cases we find the sedimentary fossil-bearing rocks passing directly into their metamorphosed, azoic forms. And in Norway, in the Christiania district, the remains of the fossils in the undoubtedly metamorphic rocks have not been wholly obliterated.

E.—As to the origin of the metamorphic rocks, they are all sedimentary in the first instance. And almost all of them have been formed by deposit upon the floors of seas.

As to the changes they have undergone, the chief agents appear to have been (1) heat, (2) chemical action, (3) pressure.

(1) The heat may have been communicated to the rocks by (*a*) the direct contact of igneous rocks in a molten state, (*b*) the direct contact of hot water, (*c*) the direct contact of steam and other hot gases, (*d*) the transmission of heat through rocks from indirect sources of heat, (*e*) the generation of heat by the crushing of masses of rock as the crust of the earth cools. These four groups of phenomena are often classed under the head "hydrothermal action." ὕδωρ (hudor), water; θερμος (thermos), heat.

(2) Chemical action. Very active chemical compounds are constantly at work within the crust of the earth, and must produce considerable metamorphic effects upon rocks already forming part of that crust. Carbon dioxide plays its part in hypogene as well as in epigene actions (p. 352, 375). The powerful acid known as hydrogen fluoride, or hydrofluoric acid (HF), also does much work in the metamorphosis of rocks. It acts especially upon the silicate minerals. Salts of the metals of the alkalies—i.e., of potassium and sodium especially, and of calcium, are also very active, especially when, under certain chemical conditions, the caustic compounds, potash (KHO), or soda (NaHO), or lime (CaO) are set free from them to act upon the rocks and metamorphose these. In this connection it must not be forgotten that under the great pressure existing within the earth's crust, gaseous compounds are dissolved in much greater quantities than under the ordinary pressure of the air. Add to all these direct actions of chemical substances upon rocks, the innumerable inter-actions between different chemical bodies in the crust occurring at high temperature and under great pressure, and it is evident that there is an immense amount of chemical action going on that must result in great rock changes.

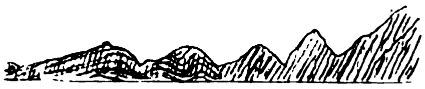


Fig. 57.

(3) Pressure. Quite apart from its indirect effects in raising the temperature (see 1 *d* above), and in facilitating solution of gases and chemical action, pressure acts directly in the metamorphosis of rocks. The steady contraction of the crust of the earth, and the increase of local pressure due to other causes, produce great alterations in the internal molecular structure of rocks.

The general result of these agencies is the conversion of sedimentary rocks into metamorphic. The special results are the formation of crystals, the destruction of the contained fossils, coloration of the rocks by igneous action (not to be confused with coloration due to iron oxides); decoloration, especially where hot volcanic gases turn lavas into white clays, as in the suffioni or vapour springs of Tuscany, hardening or induration; coking in the case of coals; marmorosis (*marmor*, marble) in the case of limestone; the production of new crystalline minerals (garnets, apatite, &c.), the production of foliation in the case of gneiss and of cleavage in the case of clay-slate. Only the two last of these require any further notice, and this they will have under the heads of Gneiss and Clay-slate respectively.

F.—These, as far as the direct uses of the individual metamorphic rocks are concerned, will be better considered in connection with each rock. The indirect products may be noted here. These are asbestos (p. 26), graphite or plumbago or blacklead (p. 519, last Vol.), steam coal, meerschaum, steatite (p. 26), precious stones, such as the diamond, garnet, beryl, ores of iron, lead, copper, silver, &c.

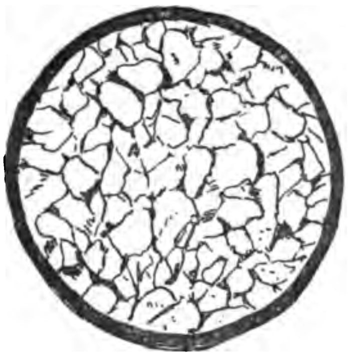


Fig. 58.

After this description of the metamorphic rocks generally, each of them can be described in particular briefly.

Gneiss.

A.—The name is of German origin, and was given by the German miners to the granitoid schists found in the earliest strata.

B.—(1) Gneiss is stratified granite. See Figs. 55 and 56. It is a hard, tough rock in which the lines of stratification are generally curved and bent or foliated. It is never tabular, like basalt. The crystals in it are indistinct and broken.

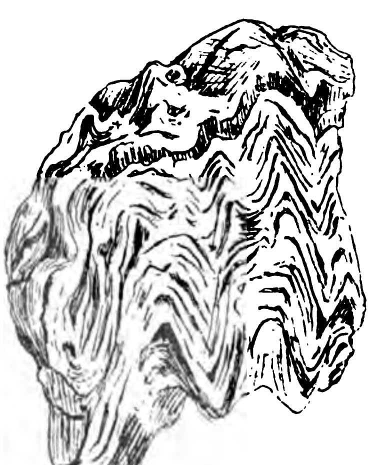


Fig. 59.

The foliation of gneiss is of great importance. On p. 218 something was said about this geological term. There we saw that in a foliated rock the plates or laminæ into which the rock can be split are not all of the same nature, but are of different composition. A glance at Fig. 56 will help the student to understand this, but not, of course, properly. That can only be as the result of the observation of an actual specimen of foliated gneiss. The foliation generally follows the lines of stratification. It may be accompanied, if the rocks have been subject to lateral pressure, by contortion. See Fig. 57.

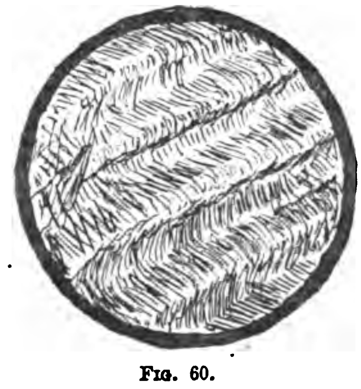


Fig. 60.

(2) Gneiss consists, like granite, essentially of quartz, felspar, and mica. In Fig. 56 the broad, white veins are of orthoclase felspar with, now and again, a grain of the other two minerals; the dark bands are of grey quartz and black mica.

C.—All that has been said of the distribution of the metamorphic rocks generally holds of gneiss. The rock occurs in huge masses wherever the older formations come to the surface, and is especially associated with granite.

D. and E.—See above.

F.—Gneiss is not a very handsome building stone, but it is used for piers and breakwaters.

Quartzose Rocks.

Of these, the most important are quartzite, mica-schist, hornblende schist, talc schist.

Quartzite.

A.—Named quartzite or quartz or quartz rock from its mineralogical composition.

B.—(1) A granular, generally white, or occasionally reddish rock, with a lustrous fracture. The granular appearance is due to the fact that it consists of quartz in small crystals. See Fig. 58. The stratification is better marked in quartzite than in gneiss. The alternate layers are often easily seen, and certain fossil markings may be met with.

(2) Of nearly pure quartz.

C.—In thin or thick beds, with the schists mentioned next, and sometimes in masses many thousands of feet thick.

D.—See above.

E.—Quartzite was clearly a nearly pure quartz sand originally. It has been metamorphosed by pressure, and the cementing together of the quartz grains by a silicious cement, probably formed by the action of very hot water upon the quartz itself. As to the origin or "How" of the quartzose rocks, two opposing views have been, and are, held. Werner's, that they have been thrown down from solution in a universal ocean; Hutton's, that they are sedimentary rocks deposited from a state, not of solution, but of suspension, and afterwards metamorphosed by hypogene heat. Probably, as is often the case with two opposed theories, both are true.

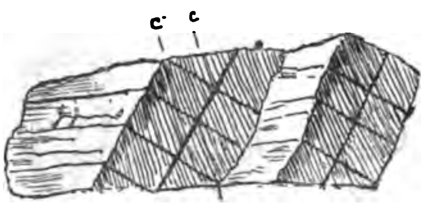


Fig. 61.

F.—Quartzite is much quarried for pottery work, where it is used for the purpose of grinding the calcined flints. As it is of the same chemical nature as flint (SiO_2), any admixture of the grinding rock (with the rock ground does not spoil the latter for pottery work.

Mica-Schist.

A.—Schist is derived from σχισμα (schisma), a splitting. It is applied to rocks that, with a foliated structure, are fissile (p. 218) into thin, irregular plates, but do not split up by cleavage (see also p. 218 and below). Mica-schist, because mica occurs in it.

B.—(1) Mica-schist is led up to from quartzite by a transition form, quartz-schist. Mica-schist itself (see Figs. 59 and 60), is slaty, and presents waved plates or laminæ (foliation), often, as in both the rocks figured, much contorted. Fig. 60 is a section of mica-schist seen under the microscope.

(2) Quartz and mica, each well marked off from the other.

C.—Mica-schist is, next to gneiss, the most abundant of metamorphic rocks. For its distribution, see above.

D.—Metamorphosed sandstones (the quartz) with interleaved fine layers of mud (the mica).

E.—See above.

F.—Used to some extent in the North of Scotland as a building material.

Hornblende Schist.

A.—A schist (*v.s.*) containing hornblende.

B.—(1) Black or dark-green.

(2) Of hornblende, felspar, and quartz or mica.

C.—Associated with gneiss.

D.—*v.s.*

E.—Probably metamorphosed volcanic rocks, lava, or tuff. Tuff, or tufa, is a porous vesicular rock. τοφος (tophos), porous.

Talc Schist.

A.—Containing talc.

B (1)—White or greenish, with a soapy feel; (2) Talc, with quartz and felspar.

C—Not very abundant.

1 *b*.—In the Alps (Mont Blanc and Monte Rosa), the Apennines, and the Ural Mountains.

D. and E.—See above.

F.—Potstone, the lapis ollaris (oily stone) of the ancients is a massive form of talc schist. It is used in Northern Italy in the making of pots and vases.

Clay-slate.

A.—This rock is clay that has been turned into slate.

B.—(1) Hard, fine-grained, bluish, fissile.

It is in this rock that we meet with the very important phenomenon of cleavage. Clay-slate is not foliated, but (p. 218) it splits along lines that do not coincide with the lines of original deposit, as in the case of foliation and lamination. In Fig. 61 a series of clay-slate rocks is shown. J. J. are the exposed faces of joints (Fig. 15, p. 217); SS are the lines of stratification; CC are planes of cleavage.

(2) Aluminium silicate ($Al_2 3SiO_3$).

C. and D.—See above.

E.—Denudation of felspathic rocks and transport to tranquil seas of deposit; consolidation of the soft clay of the felspar; heat pressure; chemical action, hardening, crystallising, metamorphosing: lateral pressure causing the arrangement of the rock particles in planes perpendicular to the plane of compression, and hence "cleavage."

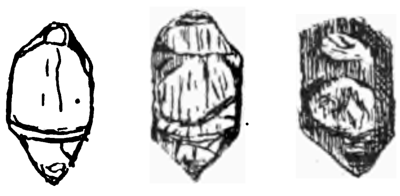


Fig. 62.

F.—Clay-slate is used for roofs, writing slates, and pencils, and for vases, chimneys, cisterns. Associated with it, in Cornwall, Cumberland, and Wales, are ores of tin, copper, and lead.

Crystalline Limestone.

A.—Limestone that has assumed a crystalline character. Sometimes it is called primary or metamorphic limestone and, rarely, hypogene limestone (see above).

B.—(1) White crystalline, granular, saccharoid, (saccharum, sugar); ειδος (eidos), resemblance. (2) Of calcium carbonate ($CaCO_3$).

C.—See above. In Norway, Sweden, and Scotland crystalline limestone is sparingly developed. In Italy, in the Alps, and notably at Carrara, this marble rock is abundant.

D.—See above.

E.—Formed by the metamorphosis of ordinary compact limestone.

F.—Marble for ornaments and sculpture. If is also quarried for mortars and manures.

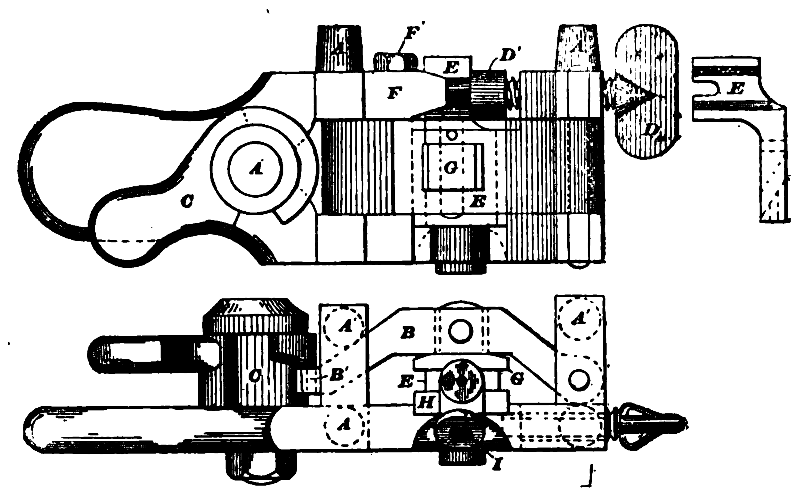
Serpentine.

A.—On p. 26 it was pointed out that this rock received its name from its motley colour—like that of a serpent's skin.

B.—(1) Serpentine is not crystallised, but is granular and compact. (2) It is a magnesium silicate combined with water—$MgSiO_3$, H_2O. The colour is due to hæmatite.

C.—See above. For special developments of it, the student should note 1 *a* i., the Lizard, Cornwall; 1 *a* iii., the great dyke that cuts through the red sandstone at Forfarshire; and 1 *a* iv., Connemara.

E.—See above.



D.—Serpentine is metamorphised olivine, a magnesium and iron silicate occurring in basalt. In Fig. 62 the metamorphosis of the pale, transparent, crystalline olivine into the dark, opaque, non-crystalline serpentine is shown.

F.—Used in the making of small ornaments, such as vases and jars.

DRILL JIGS.*

THERE are two reasons why drill jigs are designed. First, more accurate and uniform sizes and positions of holes are desired, and second, a greater production is required, or a smaller cost for a known or predetermined production. Both these requirements are easily filled if the comparison is to be with hand-work or to poor existing jigs. But always to get the desired results where a new jig is needed to replace an old one is not so easy a problem. Yet there are certain rules to be observed in designing jigs that may direct the inexperienced to more correct results than would be obtainable did he not know them. These rules I have found to be good in practice; but possibly there are other rules that are as good, and which I should be glad to know.

The piece to be operated on should have its seat and stops permanently attached to the frame or body of the jig, and not to an attachable or movable part of the jig. This frame is the part that stands on the table of the drill-press; and no matter how many positions or elevations this frame may take on this table, the feet that support it should be permanently attached to it. The observance of this rule will insure the piece being properly placed on the table of the drill-press.

The bushings for guiding the drills should also be permanent parts of this frame, and not attachable or movable elements, because the seats and stops must be in constant and rigid connection and relation to the drill bushings, otherwise there will be no certainty of effect. For if one bushing be in the frame and another in the clamp or other movable part, the relation of these bushings may depend on the size of the piece and on the care of the operator who places it in position, and there will be no uniform results possible.

A drill jig should drill every hole in a piece at one setting. If it be possible to always observe this rule, the proper relation of any one hole to the others will be always maintained; but this effect will fail if there be a re-setting, no matter how carefully it be re-set, or whether such re-setting be made in one jig or in many. Of course, if there be mechanical difficulties in the jig that cannot be overcome, that ends it; but if it be a question of drill spindles, it is better to use two or more drill-presses, or even to change the drills in the spindles.

The seat and stops in a drill jig must be made so that they may easily be cleaned; all the cuttings, dust, oil, and dirt must quickly and certainly be removed, and these points must be where they can be quickly inspected for cleanliness.

The clamps, screws, and other means to fasten the piece into the jig must be designed and made to be so nearly instant in their action to fasten and release the piece that it is as quickly handled in this respect as possible. These clamps, &c., should, as nearly as possible, oppose in direct line the thrust of the drill. In this, as in all operations, the piece should be held in relation to the three dimensions of space—width, length, and thickness—rigidly, and much more rigidly than the calculations show as safe.

The jig should be made, if possible, so that the drill shall enter the most important holes from their most particular ends.

Where a jig and its piece weigh more than fifty pounds, the jig should be made "skeleton" as far as practicable. The expense of a steel forging is sometimes paid for in a few days in the difference in amount of work done in a light jig easily handled, in excess of that done in a clumsy, heavy one that is frequently called a "man-killer."

Where a piece has one or more holes in it that consume considerable time in drilling them, two drill jigs should be made, and while the automatic drilling feed is at work in one jig the other may be emptied, cleaned, and refilled.

To determine whether a piece should be drilled first or not is quite simple. If the surfaces on a piece are further spread than the holes in length and width, and are more nearly coincident with the outlines in these dimensions, so that the piece will, when machined on these surfaces, lie flat on them, then make these surfaces first. But if the holes are further spread, large and long enough to do the work, then drill first. In either case, when the results of a first or other operation are used as positioning points to do an important subsequent operation from, then all other important subsequent operations of any kind should be done from the same points. This will assist harmony of results in the finished work in reference to standards.

The bushings in drill jigs should not be shorter in length of holes than the diameter of the drills, and they should not be longer than three diameters. When a bushing is too short, it reduces by wear the size of the drill near the point, and soon it will not "clear," but will bind and break. When a bushing is too long it chokes the drill with cuttings and dust, and this binds also. A bushing should not touch the piece, but be away so far that the lips of the drill are entirely clear when the point of the drill is on the surface of the piece. This will help to avoid choking in cast-iron, and prevent possibility of the corner of the lip being chafed in the bushing, and these corners from cutting the bushing. Bushings should fit drills as close as practicable, but, unfortunately, that is not as close as desirable. Dust, chips, and expansions require more room than one not familiar with jigs on practical paying work would imagine. I have often made drill jigs that trangress these rules, as all will have to do; but, if it is possible, I make them on these principles, and I expect no serious dissent from them. In this sketch is shown a jig made in 1879, and which was still in use in 1888.

The frame A is of machinery steel, and should be well case-hardened, to prevent mutilation from the careless use of drills. It will be seen that the feet A' and all the bushings are rigidly attached to this frame. The clamp B is of tool steel, and the end B' is hardened. When the clamp B is released from the cam C it should fall out when the frame is turned upside down, and should turn on its hinge clear of the piece E. When the clamp B is turned back, the piece is alone held to its stop F by the wing screw D, which has a loose cap D' on its point. The seat or bolster H fits the lower shape of the piece E, and determines its position when the shoe G in the clamp B forces it downward. The stop F, which fits the working part of the piece E, is made so that it can be replaced when worn. It is hard tool steel, rigidly fixed to A by the screw F' and two dowel pins. When this jig is turned to drill the angular hole I, it is laid in a V block of proper inclination. This jig is made on correct principles; and while it teaches but little directly, it should suggest much. I do not know who designed it. I added the piece F to facilitate repairs. It has always been considered by mechanics as one of the first jigs ever made that filled the bill.

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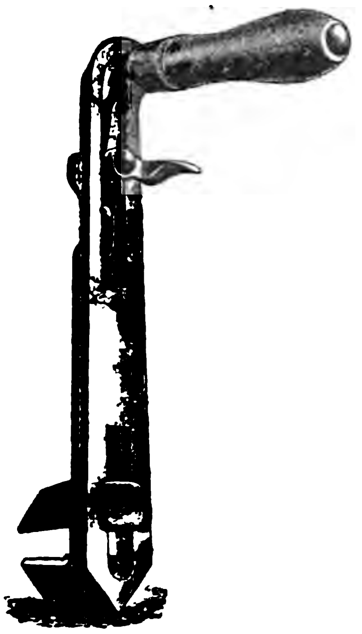
* By A. D. Pentz, in the *American Machinist*.

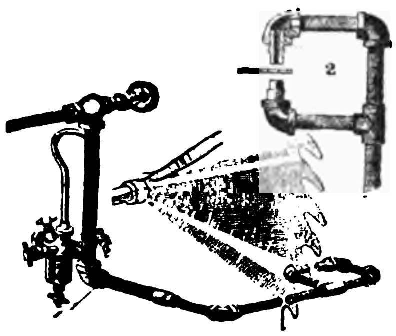
CHAMPION CARRIAGE-WRENCH.

THE annexed engraving represents what is called the champion carriage-wrench, made by the Goodall Company, of Antrim, New Hampshire. It is described by the manufacturers as the simplest, easiest to operate, and best carriage-wrench ever invented. It fits any size nut, and there are no screws or thumb-nuts to adjust. A simple pressure of the fingers opens the jaw. The handle being at right angles with the body of the wrench, forms a crank when adjusted to the nut, allowing of its being turned off in the easiest and quickest way with one hand, and, in cold weather, with mittens on. The nut is held firmly in the jaws, preventing the possibility of its falling in the dust, which often occurs with all other wrenches, no danger of soiling the hands, no time lost in adjusting screws.



DEVICE FOR CLEANING WOOD-SAWS.

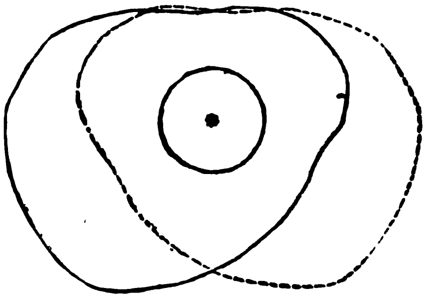
IN the device shown in the illustration the gummy matter accumulating upon the saw is removed by steam emitted in contact with the teeth, while the saw is running in the lumber, Fig. 1 showing the application of the improvement, while Fig. 2 is an enlarged view of the nozzles and pipe connection. The invention has been patented by Mr. Thadious V. Elliott, Nichols, S.C. A pipe from a steam boiler, adapted to supply steam and water of condensation, or hot water, is connected by means of a valve with a vertical pipe, a lateral and horizontal extension from which connects with two nozzles whose apertures are adjacent to opposite sides of the saw, near its cutting edge. The nozzles are in the form of threaded hollow plugs, which screw into elbows of the supply pipes, being adjustably held to be readily moved toward or from the saw blade. To facilitate the cleaning of the saw, a lubricator of approved form is connected with the vertical pipe, as shown in Fig. 1, the oil passing from the lubricator to mix with the steam or water carried to the nozzles. The openings in the nozzles are preferably conical, so that the cleaning mixture is ejected with considerable force against the sides of the saw.—*Scientific American.*



A PHOTOGRAPHIC VIEW AND THE HUMAN EYE.

I SHOULD like to draw a comparison between a photographic view and the field of vision of the human eye. The dotted lines in the figure represent the limits of the field of vision of the right eye as projected on the interior of a hemispherical surface; the continuous line, that of the left eye, and the central circle the limits of a photographic picture—i.e., 45°, all taken from the same point, the centre of the spherical surface, the camera in the one case, and the eye of the observer in the other case, being exactly opposite the fixation point, as represented by the star. We see at a glance how limited in extent is the photograph as compared with the field of either eye, and further, as the writers told us, how the upper and lower halves of the field of vision differ in size and shape.

In contrast with extent of surface, however, we find that the photograph has an immense advantage over the eye in the definition of eccentric objects, which are practically as clearly figured as those directly in the centre. That this is far from being the case with the eye may be easily shown by fixedly regarding, at a distance of about 12in., any one letter of a word in this page, when it will be found that, at most, two letters on either side can be recognised. It follows from this that any drawing represents the aggregate of an enormous number of separate observations by the artist of different portions of his study, for if he were to endeavour to draw only what he saw when fixedly regarding one part of his study, let us say a life-sized portrait, the result would be one waistcoat button as natural as life, and the rest chaos; but he would have the satisfaction of having faithfully rendered what he saw. All the cases of distortion mentioned by the ingenious writers occur only in the single fixation observations, and hence can have no bearing in any kind of drawing.—A. HILL GRIFFITH, M.D., in *Photography.*



PHOTOGRAPHY ON A BLACK GROUND.

IT is now very long ago that our readers, says *La Nature*, learned to know, through the qualified pen of Mr. A. Londe, always on the alert for photographic novelties, the varied effects that may be obtained, either from an artistic or a simply amusing point of view, by the use of what is called the Russian background. But more than one amateur assuredly will have met with the difficulty of obtaining (aside from a special installation) the necessary perfections in backgrounds or screens, especially since the fashion has turned to the bust portrait degraded upon black. So our readers will doubtless thank him who, in these very pages, was one of the first to recommend the magnesium flash light for pointing out a process within the reach of everyone for executing the most extraordinary combinations that the imagination could suggest, without complicated accessories, and by a simple, judicious use of artificial light.

In the first place, what is blacker than a window open at night on the darkness? The flash light permits of making any exposure whatever in front of it, and the black of the background will certainly rival that of the first studios of the Boulevard.

It will be said that this is not a very practical method in cold-in-the-head weather! Let us close the window, then, without insisting, and let us open the door. One has always, even in the winter of 1891, a door for opening in his house. A little back of the embrasure let us place the model face to the apparatus, and then let us flash the light at at the side, as he sits for the artistic effect. A deep shadow projecting itself behind the sitter will furnish us with the desired black ground. Black, I say, whatever be the real colour of the said ground, and whatever be the lights burning in one or the other room. Black, that is to say, inactinic for gelatino-bromide, although visible to our eyes.

For there is a prejudice against which I cannot too much protest; it is useless, even in order to operate *upon* black, to condemn one's self to operate *in* black. The magnesium light alone counts from an actinic standpoint; and all the light furnished by the candles, kerosene lamps, gas, or even incandescent lamps that may exist in a room would require, in order to give however slight an impression of the surrounding objects upon a photographic plate, so long an exposure, so great a fraction of an hour, that it may be absolutely disregarded during the largest openings of the objective in the kind of operation that we are to occupy ourselves with. Even when there are directly in the field one or more of those sources of light with which we are content for domestic purposes, but which, as white as they appear to us, are nevertheless really yellow or red and contain few violet rays, what will happen? They will pose simply with their surrounding, the image of which is so slightly veiled, even for the nearest objects, that it is a chance if we find a trace of it where these objects, through some polished surface, have performed the function of reflectors and not of simple diffusers. As for the image of the flame, that will be perfectly defined, with all of its details. At the worst, if the exposure has been of an exaggerated length, it will be found surrounded on the negative with an aureola, or halo, due solely to the reflecting action of the glass employed as a support, and which has nothing in common with what is called the veil, any more than it has with that other accident that occurs with a still further prolonged exposure, and which consists in the reversal of the image, become positive upon the negative.

It is, therefore, useless (and I repeat it earnestly, on account of the contrary belief of so many professionals) to make night in order to photograph night, and to believe that one is obliged, for example, to represent a drawing-room without chandelier and a dinner without candles. To return to what occupies us, leaving all undisturbedly lighted, let us be anxious only lest our background shall receive at second hand too great a number of magnesium rays diffused through the part of the room where we cannot entirely prevent the reflection of the flash from penetrating. For that, the utilisation of the leaf of the door, open on the side of the sitter opposite the flash, will have the double advantage of arresting, on the passage, the greater portion of the rays that tend to enter the dark room, and of sending them back to the side of the sitter, who, without that, would run the risk of being too deeply shaded. It is possible, even, by placing the sitter and light geometrically in a right line with the edges of the jamb and the open leaf, to prevent any direct ray from entering the room. After this the darkness of it will be certainly comparable to that employed by Mr. Marey for his remarkable photochronographic studies on locomotion, that is say, the most perfect that has been realised up to the present.

Since now, without trouble and expense, we are here possessors of an ideal background, nothing remains but to utilise it in order to derive from it all that it is capable of giving us.

To commence, would you like to try one of those simple, degraded blacks which so well bring out light clothing? It will suffice, after making the exposure as indicated above, to operate according to the classic method by putting into the camera a shutter containing an aperture which allows of the passage of only that part of the image that it is desired shall reach the plate.

Does the operation seem to be somewhat delicate, and does the regulation seem tedious by the light of the candles? Or does the apparatus refuse to allow of the introduction of the shutter? Here is how it always will be possible and easy to operate: Take some sort of a dark fabric and, throwing it over the back of two chairs a slight distance apart, in front of the sitter, regulate the curvature of the falling fold in such a way as to conceal the sitter up to the shoulders from your eye, placed against the objective. Then flash the light in front of this screen in such a way that the face seen from the apparatus, receiving no direct ray, shall remain black for the objective. There will be thus obtained upon the plate a bust entirely detached from a dark ground and degraded toward the bottom, where the edge of the veil will have become so much the lighter and softer in proportion, as it will have been less perfectly in focus, that is to say, nearer the apparatus.

There is no need of adding that on reversing the process—that is to say, on substituting white for black, light for shadow, and a sheet (or, better, on account of the folds, indented cardboard) for the drapery—it is possible to obtain directly upon the negative the ordinary degraded white that it takes so much trouble to obtain in printing photograph by photograph. So it is to be wagered that, having got a liking for it through an easy success, you would not wish to stop there, but would feel inclined to apply the method to the realisation of some of those tempting trifles to which attention has so many times been called in this journal.

Take, for example, the charming photo. bust of Mr. Gravet. Who has not, after making a negative, been confronted by the too sensible difference between the blacks of the profiling and the accessory draperies? Now, by the use of our background, the risk would be much lessened; but to succeed almost to a certainty, one has only to proceed as follows:—A first exposure on a shadow ground is made with the pedestal, the position of which must be accurately marked on the ground-glass. Then a second exposure of the model in half-length degraded upon black, so regulated that the soft lights of the bust on the ground-glass are lost over the pedestal—an operation that is reduced to a simple control if advantage is taken of the fact that, this time, there is nothing to prevent the pedestal from being left in place in front of the model, since it must, in definitive, be hidden by the veil.

Upon the negative we will find the image of the pedestal separated from the bust by a degraded zone, a few lines of which, through a broad after-touch, it will suffice to arrest and make more marked, in order to obtain a result which will not only have suppressed the faults of the profile, but also and especially its stiffness, &c., in the cut-out parts of the living bust.

Remark that it would have been perfectly allowable for us at the first exposure (that of the pedestal) to take at the same time, around the pedestal, any group whatever of persons or objects filling all the parts of the black field that it was not necessary to reserve for the bust itself. And then, instead of the effect of a solitary and somewhat conventional bust, the trick of which is easily divined, we obtain family pictures which are very puzzling through the presence, in a second living edition, of the person all entire from head to foot, a fraction of which, statufied, attracts in the first place one's whole attention.

The system of double exposures, thus understood, may, moreover, with a little additional complication, lead us to applications in other ways, original without being much more difficult, by combining changes of distance of the apparatus between each of the operations. Let us suppose, for example, that, having placed the apparatus so near the model that the focusing throws out of the plate the frame of the door or window whose opening serves us as a black background, we have taken the image of a large head, the neck of which occupies on the ground-glass a position marked in advance with pieces of gummed paper.

There is nothing to prevent us from afterward moving our apparatus back to the maximum distance where the reduced image, No. 2, of the door will embrace on the ground-glass the large image, No. 1, of the head. Let us then place across or in front of the door a fully set table, with a large centre piece so arranged that its edge shall coincide, in definitive, with the neck of the decapitated person. By way of parsley (but rather to secure adjustment and suppress the line of junction of the two images than to improve the aspect of the service), let us place in the bowl a crumpled white napkin, in a slightly emergent puff. It will only remain for us to place around this new sort of a dish a few astonished guests, or among them, of course in the front row, the possessor of this so well-mounted head; and, provided that we have well-regulated things and avoided superpositions, we shall obtain a picture of photo-auto-megalanthropophagy, which will not fail to puzzle the cleverest persons if they are not acquainted with the artifice.

It is useless to point out all the variants of which this idea is susceptible; the man with a big head, the gigantic hunter, St. Denis carrying his head, will be but a play. But one difficulty will present itself if it be desired to operate in the opposite manner—that is to say, to give the principal details of the picture extremely reduced dimensions and not more exaggerated ones—to represent, for example, a large man in contemplation before his statuette, or a small man looking at himself grow, or a cook making a *sauté* of heads over a stove, a juggler playing with a ball, &c. It will be seen that it is easy to vary the subjects.

It becomes, then, almost impossible, on moving the apparatus back in order to obtain the small image, to eliminate the neighbouring objects from the field, especially the door-frame; and it was only after uselessly attempting to get around the obstacle by all the means known that, having decided to submit the question to calculation, I was fortunate enough to deduce therefrom an absolutely general method, including the preceding particular case, and permitting of responding, with security, to the most fanciful ideas.

MUSICAL INSTRUMENTS: THEIR CONSTRUCTION AND CAPABILITIES.—VI.*

I WILL defer the next illustration from Don Riano's book, in order to continue with these finger-stops, which evidently remained in use in portable organs after balanced keys had been employed. An instance of them may be seen in our own National Gallery in an altar-piece by Orcagna, the date of which is given in the catalogue as A.D. 1357. The order of these stops is not clear, but seems to be chromatic, and the sharps are of the same colour as the naturals, not contrasted as afterwards became the custom. Another instance of such an instrument is found in a beautiful female figure representing Music, depicted in a fresco, attributed to Taddeo Gaddi, and preserved in the Spanish chapel of Santa Maria Novella, Florence. She is represented as singing, while touching with her third finger one of these stops. There are two rows of stops, as in Orcagna's altar-piece; and that the back and upper one is chromatic I entertain no doubt. It is true that the back row appears to have as many stops as the front one, as may be seen in Mr. Timothy Cole's woodcut of the figure in the *Century Magazine*, March, 1889. This artist has since favoured me with a photograph of the painting, to prove the accuracy of his engraving; so it may be assumed either that Taddeo Gaddi has not cared to be exact, or that some of the finger-stops were dummies. Fifteenth century illustrations of similar stops may be seen in *portatifs*, depicted by Memling in paintings preserved in the hospital of St. John, at Bruges. The accuracy of these delineations is unquestionable, as is also the complete chromatic order of the stops. One of these representations of a *portatif* is in a painting in the famous shrine of St. Ursula; the other and larger in the "Marriage of St. Catherine." The latter is dated 1479, but the instruments represented may have been already old when the painter selected them for delineation. I now return to Don Riano's next illustration of a *portatif*, which is different. It is copied from a fresco, an altar-piece in the Cistercian Monastery of Nuestra Senora de Piedra, Aragon, and is dated 1390. Here is shown a *portatif* with three rows of pipes and balanced white natural keys, with one square chromatic key let in. Assuming that the treble of the instrument terminates at A, which occurs in fifteenth century positive organs, and recognising the necessity in the plain song of a B flat for transposition, we cannot be wrong in regarding this square key as that note. If there is another B flat an octave lower, which, according to Guido's scale, was likely to be the case, the hand of the player covers it. Virdung, in 1511, figures a diatonic keyboard with two B flats; but this drawing is not altogether to be relied upon as an exact representation. There were such keyboards, no doubt, only of an older fashion. Fra Angelico, who was painting in the first half of the fifteenth century, represents *portatifs* with keyboards, and, in one important instance, a dubious indication of incidental upper keys. I think, however, it is proved that full chromatic keyboards were in contemporary use with diatonic ones, including B flat, which was reckoned a diatonic note in the fourteenth and fifteenth centuries.

With regard to the keyboards of large church organs, I cannot do better than briefly summarise the information on them, supplied by Prætorius in the second volume, "De Organographia," of his great work entitled "Syntagma Musicum," and published at Wolffenbüttel, A.D. 1618. It was completed by the Theatrum Instrumentorum seu Sciagraphia, that is to say, the illustrative plates, A.D. 1620.

I will pass by what he says about the earliest organs in churches, because he is not speaking from personal knowledge, to start with the famous old Halberstadt organ with which he was familiar. This organ was built, according to inscriptions upon it, in A.D. 1361, and renovated in A.D. 1495. Whatever happened in this renovation, we shall find that the manual keyboards and compass of keys were undisturbed, and that probably the pedal keyboard was original; but as to this doubt may be allowed. The compass of the two highest keyboards was the same, and exactly that of the ancient Greek scale of fourteen natural notes, extending from B natural in the bass clef—"hypate hypaton"—to A in the treble clef—"nete hyperbolæon"—thus proving that the church-organ keyboard was a scholastic conception in the first instance; and we shall find it, although afterwards only partially, for some time adhered to, and with Pythagorean, which was a non-harmonic tuning. The fifteenth natural key in that conception was the B flat near middle C, which belonged to the conjunct tetrachord, "trite synnemenon." But the necessities of the transposition of the plain song to accommodate voices—for which we have the authority of Arnold Schlick, who published his book in the same year as Virdung, A.D. 1511—had brought about the intercalation of the chromatic keys, or "ficti" as they were then called—feigned notes; and consequently the restricted compass of the Halberstadt organ was, I have no doubt about it, originally chromatic. The lowest manual was a bass keyboard from an approximately 32ft. B natural to 16ft. C. The highest was for the mixture, various pipes of different but related pitches sounding together when a key was put down, without any attempt to sort them into various registers. In fact, the first essay in this direction is here seen, in the speaking-pipes in the front of the organ, the "Principal," as it was called, being on the second or intermediate keyboard apart from the mixture, and on the third or bass manual connected with the large deep bass pipes in the side towers. This principal was a 4ft. stop, the measure of an English principal of the present day; and it is curious that this old German tradition has really been maintained in England while it has not in Germany, where the 8ft. foundation register is now the principal. We call the 8ft. foundation stops diapasons—that is to say, octaves below our principal, diapason being the Greek equivalent for octave. I can hardly accept the explanation which derives this name from an organ-builder's rule, inasmuch as, though called diapason, his rule would serve to measure any pipe in any register. I believe the third keyboard pipes were originally used for drones, and to keep such notes continuously sounding was how pedals first came into use. We call a drone now a pedal point, and composers use it, especially for the tonic or dominant, with great effect. The Halberstadt pedals were for bass notes to the mixtures, and were mixture notes themselves, although without the highest rows of pipes. We may consider the pipes in the side towers were also upon the pedals; but as to this the text is not clear. If the usually received statement, that pedals were invented by Bernhard, organist to the Doge of Venice, in A.D. 1470, then the Halberstadt pedals were no older than the renovation; but I think we may safely follow the suggestion of Prætorius that pedals had been long in use in Germany, and were only introduced by Bernhard at that date into Italy. They were not generally adopted in other parts of Italy, or in England either, until the present century. The compass of the Halberstadt pedals was only an octave: B natural, C, C sharp, D, D sharp, E, F, F sharp, G, G sharp, A, and B flat. We learn from Schlick that B flat had been the highest pedal key, and some inconvenience had been caused to organists by changing this note to B natural.

Now, the Halberstadt keys were very wide. On the two upper keyboards 4in. from centre to centre of each key, with chromatic keys 2in. wide, placed 2¼in. above the diatonic. The keys of the two discant manuals were rounded, but in the bass keyboard they were square. I am indebted to Dr. Hopkins for these measurements, which are given in his valuable article upon the organ in Sir George Grove's dictionary, and, I presume, are founded upon Prætorius's text and drawings. There could be, with this keyboard, no question of stretching an octave with the extended hand, or even more than a major third, and what we call fingering was entirely out of the question. The organist used the side of his clenched hand to depress the keys.

I will now briefly show, from Prætorius, the gradual upward extension of compass; but for a long while the B natural in the bass clef remained the starting note, according, as I have said, to the old Greek scale. It would appear that the pitch of the renovated Halberstadt organ was about a tone above our medium pitch of C, 528 double vibrations a second; but the pre-Reformation B natural was a fourth higher than this Halberstadt pitch, as was the case in the old Magdeburg organ, which was still remaining in Prætorius's time. We have seen that the Halberstadt organ had no higher key than the old Greek A in the treble clef. Prætorius describes the keyboard of the church-organ of St. Egidius, at Brunswick, the date of which was A.D. 1456, as permitting the stretch of a fifth, instead of a major third, as at Halberstadt. He gives a drawing, but, unfortunately, not the compass of the Brunswick keyboard; but he does of another organ of the same period, that of St. Salvator, at Vienna. In this the manual compass extended to C in the treble clef; the pedals as at Halberstadt. An undated organ at Minden, with keys 2¼in. wide, according to Prætorius's own measurement, had the same compass, pedal and manual, as this Venetian organ. The next quoted by him was the organ of St. Sebald, at Nuremberg. Here the pedals went down to the lower A of the bass clef, the "Greek proslambanomenos," with B flat also added; but the manual kept to the normal B natural, ascending, however, to treble clef D. Another by the same builder, Heinrich Traxdorff, was in the Church of Our Lady at Nuremberg, without pedals, and only ascending in the manual to the Halberstadt A; but he introduced the octave register in the St. Sebald organ and, presumably, in this, in addition to the already separated principal, the mixture remaining as the Hintersatz or Back organ. A further extension was made by Krebs and Mülner in the organ at Mildenberg, where the manual was advanced to the higher F of the treble clef, the lowest bass key still remaining B natural but the pedal starting from A, and from thence to the A above, a chromatic octave. We are now nearing the period of a great change in the organ keyboard, when Conrad Rotenbürger built, about A.D. 1475, the great organ at Bamberg, with similar compass, but to change it eighteen years later—that is, in A.D. 1493—to the "long measure" in the bass, for the pedals F, G, A, B flat, and then from B natural, chromatically, to the B flat above the bass clef, altogether an octave and a fourth; and for the manuals from the same F below the bass clef to A above the treble, three octaves and a third. The width of the keys was gradually being lessened until, when Cranz, in A.D. 1499, built the great organ of St. Blaise, at Brunswick, the octave was only the width of nine keys of Prætorius's time, when the octave had come to be comfortably grasped, as it has remained ever since, by an average hand. I ought here to state the compass of a modern German organ, and will take that of the great organ of Ulm, built by Walcker of Ludwigsburg, and accounted one of the finest German instruments. The manual keyboards, three in number, go from C below the bass clef to F above the treble, 54 notes, and the pedals from the octave lower C to D in the bass clef, 27 notes. Large organs built in this country exceed this compass. Messrs. Hill's Sydney organ has five octaves, from C to C, on all five manuals 61 notes, and pedals from C to F, 30 notes.

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* By A. J. Hipkins, F.S.A. Extracted from a series of Cantor Lectures before the Society of Arts.

From the end of the fifteenth century the drone bass notes, as tonics or dominants to an octave system, appear to have got the better of the scholastic tetrachordal idea of the scale. Where the long measure, as it may be called, to the low F was not carried out on the keyboard, it was, in fact, as far as possible by substitution of pipes. The B natural key served no longer for that note, but for the G below it, the C sharp key doing duty for A, and the D sharp, when not retained for E flat, for B natural; but as this was hardly a drone note, B flat was often preferred. This was the short measure—for 300 years the well-known "short octave." In Italy the short octave has remained quite up to the present time, but generally with E for the apparently lowest key, which really sounds C, as F sharp sounds D and G sharp E; neither of these chromatics being good drone notes. Long drone pipes may be observed in pictures in which are represented the old *portatifs*, or processional organs, as in the Orcagna altar-piece and the Spanish fourteenth century miniature I have mentioned. I can give many examples. And, in the Cæcilia panel by the Van Eycks, painted for the Church of St. Bavon, Ghent, but now at Berlin, a positive or small chapel organ is painted in the most realistic manner, and the lowest note, D, has a special key situated below the keyboard at the left-hand side, while above this key there is a latch the only possible use for which could have been to fix a drone. Perhaps the deep drones came later into large church organs on account of the greater cost of the deep bass pipes.

The chief advocate for the extended introduction of the swell-box in this country is Mr. G. A. Audsley, who has not only urged it on logical grounds in his treatise on "Concert, Church, and Chamber Organs," published in the columns of the ENGLISH MECHANIC (1886-88), and his recent lectures on the "Swell in the Organ," but has practically proved the great advantages to be secured by the multiplication of expressive departments in the organ. About twenty-five years ago he schemed and constructed his own chamber-organ, which was when finished, and still remains, for its size, the most flexible and expressive pipe-organ existing. This can easily be understood when it is known that out of its nineteen speaking-stops fifteen are rendered expressive by being inclosed in swell-boxes. The two expressive divisions of the great organ, on the lower clavier, are inclosed in two independent swell-boxes; the only stop here uninclosed being the *principale grande* (open diapason 8ft.) The upper or choir manual being entirely expressive, the range of expressive effects and *nuances* secured by these means is remarkable, while the tone qualities of the stop remain unaffected. Mr. Audsley also advocates inclosing a portion of the pedal-organ to make the bass also expressive. Amongst organ builders of the present time, Mr. Roosevelt, of New York, makes the greatest use of the swell-box. For instance, in his organ recently erected in the Auditorium at Chicago, he has, out of its eighty-six manual-speaking stops, rendered seventy-nine expressive by inclosing them in five separate swell-boxes.

The solo organ is quite modern. Its introduction is attributed to the late Cavaillé-Coll in France, and Mr. Hill in this country. The intention of the solo organ is to supply certain effective reed stops on exceptionally heavy wind. The pedal-organ is the general bass to the whole instrument. In the largest instruments the 16-foot diapason and other stops are doubled by 32-foot open metal and reed stops; and Messrs. Hill and Son, in their great Sydney organ, have actually introduced a 64-foot reed, the harmonics of which blend in the general effect.

In the 17th century, and perhaps the 16th, an interesting offshoot of the organ, was the regal, a complete reed stop taken from it and used as a separate instrument for accompaniment in convents and elsewhere. These beating reed instruments are now very scarce. I believe I possess the only large Regal in this country; it is an almost portable Vox Humana. The regal might have been regarded as the prototype of the harmonium, had there not been an unbridged gap between the discontinuance of the regal, which became entirely forgotten, and the invention of the harmonium and its congeners, which did not happen until the present century had come in.

The pianofore was invented by Cristofori, of Padua, in the first years of the eighteenth century, to satisfy the desire for a stringed clavier that should combine the expressiveness of the clavichord with the effectiveness of the harpsichord; it was, at first a sufficiently facile intrument, and contained those principles of resonance—resistance to strain and suppleness of key action that still characterises it. Cristofori solved three important problems, the first of which was to counteract the strain of thicker strings necessary to withstand the impact of hammers. The second, allied to the first, was to compensate for the weakness caused by the opening between the tuning-pin block—technically, "wrest-plank"—and the soundboard, imperative for the hammers to rise to the strings. The third was the mechanical control of the rebound of the hammer from the strings—technically, "escapement"—so that the hammer should not block against the strings and prevent vibration. All this he did, and more, for he invented the check, or movable rest for the hammer-tail, the simplest expedient to preserve the position of the hammer for a repeated blow—technically, "repetition."

The domestic upright piano is now restricted to the various modifications invented with the instrument about 1800, by Isaac Hawkins, and improved some sixty years since by Robert Wornum, the general merits of which have caused it to be, in these latter days, employed in every piano-making country.

The structure of smaller pianos is, in principle, the same as the concert grand. I have, in this lecture, preferred to deal with the general principles of piano construction, rather than to touch upon debateable points, which would take too long to discuss and could hardly be settled, inasmuch as piano making, like all other musical instrument making, is an art, and cannot be brought down to the level of mere mechanical manufacture. I think those who play the piano should have some acquaintance with those general principles, including that of sympathetic vibration, which the player controls with the pedals, a natural Æolian charm and prerogative of the instrument, divined by Beethoven, but the true use of which we owe to Chopin. I believe, if consideration were given to those principles more than it is, the unreasonable demands some players make upon this singularly responsive instrument might be reduced, and to the advantage of the cultivation of a feeling for tone which is incumbent upon wind and other stringed instrument players, but is too frequently disregarded by those who play the piano.

THE BLUE OF THE HEAVENS.*

WHY is the sky blue? It may be thought that a subject so continually open to observation must long ere this have been explained by natural philosophy. But such is not the case. It is just the commonest phenomena in the present day that are still awaiting explanation—such as thunderstorms, the northern lights, the zodiacal light, the causes of storms, the formation of hailstones, and many kindred subjects, under which category we may perhaps class the blue of the heavens. Natural philosophy has succeeded in discovering the laws of heat, light, and electricity, and the stupendous discoveries in those domains are only equalled by their enormous practical application.

But we must not allow ourselves to be dazzled by such triumphs, for much yet remains to be done in the domain of natural science, and perhaps the most important: the solution of many natural phenomena as they actually present themselves to us in nature. It may astonish you that this has not already been done; the difficulty, however, lies in the anterior complications which have been the causes of the phenomena, and which prevent the unreserved application of the known laws of the so-called natural forces—in this case of light—to their solution. A fresh and persistent course of investigation is needed to the understanding of those anterior complications, in order to bring them into relation with known laws, by which alone the phenomena can be explained. The difficulties of such an explanation will be made clearer to you when you consider with me the investigations necessary to the explanation of the blue of the heavens.

Let us first keep in view the facts. On a fine cloudless day the sky appears to us blue. This blue, according to the conditions of the atmosphere, is subject to many gradations. The clearer the air, the deeper the blue appears to us. On the other hand, the more the air is charged with dust, mist, or rain, the paler the blue, until, with a cloudy sky, be the cloud covering ever so thin, it shades off quite into white. It is also known that the blue is deeper close to the zenith, while in the horizon, when the sun is high in the heavens, the colour is whitish—at times, dazzlingly white. In like manner observations seem to have determined that the blue is of a fuller deeper hue in warm Southern climates than in cold Northerly ones; that it also has a deeper blue when viewed from the heights of mountains; and, again, as a rule, is bluer in the interior of continents than on the coasts. All these properties must find their explanation in a theory of the blue of the heavens, if it lay claim to be a true one.

The earliest attempt to explain the blue of the heavens, it appears, dates from Leonardo da Vinci, who advanced the following theory: Light before dark seems blue, and the greater the contrast between light and darkness the more intense is the blue.* He then applies this theory to atmosphere: the blue of the atmosphere is caused by the density of the illumined aërial bodies, which exist between the earth and the darkness of space. Atmosphere in itself is colourless: the greater the darkness behind it the finer the blue it will assume. Hence dark mountains in the far distance appear of a bluish tint, while those on which the sun is shining are seen more in their own colours.†

Who does not here instinctively recall Goethe's proposition: "To the production of colour two things are necessary—light and darkness, brightness and shadow, or to make use of the general formula, light and no light. Light generates a colour we call yellow; *darkness generates one we designate blue.*"‡ Although, undoubtedly, Goethe here adopts Leonardo da Vinci's view, yet his general conception of the origin of colour—physically the most incorrect theory of colour that was ever evolved—is not to be imputed to his great predecessor. Besides, Goethe has developed Da Vinci's conception in his own way. He commences his explanation of natural colour, more particularly atmospheric, by phenomena viewed through gross media. The undoubted established fact, interpreted by Goethe in his own way, is as follows: If a bright object be viewed through a turbid medium, it appears yellow to red; if, however, a darker object be viewed through the same medium, a blue colour appears. We shall see later that this fact does really serve to explain the blue of the heavens. Goethe, however, while he rightly conceives the atmosphere to be a turbid medium, by his above-given principles goes beyond Leonardo da Vinci. He says: "If the darkness of infinite space be observed through an atmosphere of vapour illumined by daylight, the blue colour appears. Upon lofty mountains, by day, the sky is an intense blue, because there is only a thin mist floating between them and the darkness of space. No sooner does one descend to the valleys beneath than the blue becomes paler, until in certain districts, as the mist increases, we find it shades off into a bluish white.§ Upon the blue tint of distant mountains his opinion is the same as Da Vinci's.

It now seems undoubted that a colour thus generated must be purely subjective, and therefore only conceivable as the effect of contrast of a faint light against the dark firmament of space, for, according to the views of Goethe and Da Vinci, the light which comes to us from the illumined atmosphere is really white, and the dark background alone makes it blue; but how is it then that objects seen before sunrise and after sunset, which only receive light from the blue sky, show a bluish tint, as the great master Leonardo da Vinci correctly teaches? How explain, as Goethe with

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[*] A lecture delivered by DR. J. M. PERNTER to the Association for Promotion of Scientific Knowledge in Vienna. (Vereines zur Verbreitung Naturwissenschatliches Kenntnisse in Wien).

[*] Trattato della Pittura, cxiii.

[†] Ebenda, cli.

[‡] Entwurf einer Farbenlehre: didaktischer Theil Einleitung.

[§] Entwurf einer Farbenlehre: didaktischer Theil, 155, 156.

equal justice remarks, that "in the camera obscura the blue sky is distinctly shown on the white paper beside every other material colour"? (A.A.O. 152) The darkness of space certainly emits no rays, so that if the rays proceeding from the illumined atmosphere be white, it is impossible that they should colour objects of a bluish hue, or produce blue in a camera obscura. This seems quite out of the question.

Muncke* has attempted to establish the subjective theory of the blue of the heavens by a different method. His view is that it arises from the same cause as do blue shadows, and explains it by the following observations. "When towards sundown in winter the shadows of trees are cast upon snow, the snow takes the peculiar and distinctive shade of the blue of the sky. The faint reflected light from the snow in shadow, as opposed to the stronger reflected light from the illumined snow, produces this colour from palest to deepest shades." Apart from the fact that the observation of the relative intensity of colour under these conditions is open to doubt, this solution clearly tends to show that the light from the sky is so faint as to produce, as does all very faint light, the impression of blue.

This view has been adapted at much cost of skill and knowledge by Nichol† to the explanation of the blue of the heavens. He too affirms it to be a purely subjective colour. Every faint light seems blue to us. The explanation of this fact lies in the formation of our eyes, which are known to possess nerve filaments sensitive to three several colours—red, green, and violet. All three filaments are jointly excited by every kind of light, but in different degrees, and the colour we see is the resultant effect of these excitations. Even by white light these different nerve filaments are variously affected. The "violet filaments" especially are very sensitive to faint light, whilst the red and green, on the contrary, remain almost totally unaffected. Hence *the fainter the reflected light from the sky, the bluer will it appear*. Thus, these explanations are based upon the faintness of the light reflected from the sky. But they are not tenable.

You will yourselves have repeatedly had occasion to observe that this light from the sky is by no means so faint. The light we get in summer after sundown is but reflected; but the sky remains perfectly light for a long time, even in the east, sufficiently so for us to read the smallest type or follow any occupation, while the sky continues to be of a deep blue. Further, you will not have failed to notice that on fine, clear days the sky looks blue even in close proximity to the sun, although its brightness, even on averting the dazzling sunlight, can scarce be borne. This proves, without a doubt, that every theory which takes as its basis that the blue of the heavens is to be ascribed to the faintness of the light it reflects, is incautious. Besides which, it is contrary to observation to ascribe *so full and brilliant a blue* as that of the sky in its most perfect development to the faintness of the light impression. A *very faint* white light does certainly give the impression of blue; but never the full radiating blue of a clear sky.

A decisive experiment was made upon this by Pickering,‡ who compared in a photometer with white paper, the light from the sky with direct modified sunlight. The image of the sky was viewed at once in a mirror, but he had to turn the polarimeter until he had obtained an equal degree of light upon the illumined paper of sky and modified sunlight. He then found the image of the sky decidedly bluer, as long as he observed the modified sunlight on the white paper. He next took a bluish paper, the image of the sky still remaining bluer than the equally bright light of the sun upon bluish paper. It was only on employing a decidedly sky-blue paper that he succeeded in obtaining with equal intensities of light similar colours from the paper on which the modified sunlight was projected, and that on which was the reflected image of the sky. This proves that the mere lessening of the sun's light to the same degree as the diffused light of the sky is not sufficient to cause the reflected sunlight to appear blue, and that consequently the reflected light from the sky does not appear blue on account of its lesser brilliancy, but because the sky, in reality, reflects blue light.

We must therefore consider as futile all attempts to describe the blue of the heavens as a subjective colour. Of the several experimental attempts to classify it as an objective colour, we will first take the simplest. It is, in fact, very easy to assume in an off-hand way that air appears blue to us because it is blue; just as a blue glass looks blue to us because it is blue; *id est*, only transmits blue rays; and, moreover, possesses to an excessively high degree the power of radiating blue. This view was taken by the great natural philosopher, Euler,§ and many others with him, and revived in somewhat modified form by Chappuis.* Chappuis supposes that ozone is blue, and has, indeed, proved it to be so when viewed in sufficiently thick strata. This solution, however, seems perfectly untenable. We are well acquainted with coloured and transparent bodies, and know that they manifest the same colour, whether seen by reflected or transmitted light. It would seem, therefore, utterly incredible that the sun, when seen direct through the whole atmospere, should not also look blue to us, in the sense of a blue glass—at any rate, when it is low, and its light passes through such an enormous column of air before it reaches us. And even if sunlight be accounted too intense to be so strongly absorbed as to appear blue, yet moon and stars should decidedly be blue, or of a bluish tint.

(*To be concluded.*)

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* Gehler's Physikalisches Wörterbuch, 1825. Artikel: Atmosphäre der Erde, p. 104.

† Philosophical Magazine, 5th series, Vol. VIII, p. 425, and Zeitschrift für Meteorologie, 1880, p. 102.

‡ Zeitschrift für Meteorologie, Bd. 20, 1885, p. 154.

§ Gehler's Physikalisches Wörterbuch, Bd. I, p. 502.

* Comptes Rendus, 1880, Bd. 95, p. 522.

USEFUL AND SCIENTIFIC NOTES.

The modes of fishing for oysters are as various as the modes of rearing and eating. At Minorca the fisherman simply dives to a depth of 70ft., with a weight in one hand to carry him down. With the other hand he picks up as many oysters as he can carry, and brings them up to the boat.

Lantern Slides.—The Fry Manufacturing Co. have issued a little manual on "Lantern Slides: How to Make Them," by A. R. Dresser, which will be useful to all who desire to prepare their own slides upon gelatino-bromide plates. The "manual" is one in Fry's photographic series, and is filled with really practical matter. Anyone ought to be able to make lantern slides by following Mr. Dresser's directions.

Printing Without Silver.—Prepare the following solutions:—(1) Acetate of lead, 150grm.; acetic acid, 2½c.c.; water, 450c.c. (2) Potassium iodide, 150grm.; water, 450c.c. (3) Salammoniac, 250grm.; water to make a saturated solution. Float the paper for five minutes on a bath of (1), and then dry; next float on (2), and again allow to dry. The paper is sensitive to light. An exposure of four seconds in the printing-frame suffices to print out, but in diffused light the time may be varied to a minute. The image appears green upon a yellow ground. The paper should be slightly moistened before printing. The image is fixed in a bath of (3), and when finished is said to be of blue-violet colour. Half an hour's washing completes.

Philip's Patent Revolving Orrery.—Under this title Messrs. G. Philip and Son, of 32, Fleet-street, are introducing the patented invention of Mr. J. C. Parvin for indicating the position of a planet, the moon, or a fixed star, and for telling at what hour they will rise, south, and set. It will indicate the phases of the moon, and when eclipses will take place. This simple invention, in principle, is exactly the same as Philip's revolving planisphere; but only the stars forming the zodiacal belt are indicated on the circular disc, within which the motions of all the planets are performed; above this are mounted two brass fingers divided into degrees, and carrying pointers running in a slot. Both fingers and pointers can be set to any desired position, and made to revolve across the horizon with the card. It should be useful to many students of astronomy, as well as to teachers.

Fecundity of Sea Fish.—Dr. Wemyss Fulton contributes a paper on this subject in Part III. of the "Annual Report of the Fishery Board for Scotland" of 1890, wherein he states that the fecundity of over a hundred specimens of fish, comprising thirty-nine species, has been determined. The degree of fertility varies to an extraordinary extent among certain fishes, and according to the sizes of the individual. The ling produces a greater number of eggs than any other fish, twenty to thirty millions being an ordinary average among medium-sized and large specimens. On the other hand, the pipe-fish brings forth each season only a few hundreds, the eggs being taken charge of by the male, which carries them about in a compartment situate on its under surface. The cod produces from two or three to seven or eight millions of eggs, the haddock from two or three hundred thousand to nearly a million, the saithe from four or five to seven or eight millions, the torak or tusk from about one to two or three millions. In the herring the number ranges from about twenty to about fifty thousand, the average for sixteen specimens examined being over thirty thousand, showing a considerably greater fecundity than has been generally supposed. Among flat-fish the most fertile is the turbot, with from three or four to nine or ten million eggs, and the least so the long rough dab, which produces from about thirty to sixty thousand. In proportion to its size, the flounder produces more eggs than any other fish, the number ranging from over five hundred thousand to about one and a-half million eggs. The common or English sole is also very fertile.

SCIENTIFIC NEWS.

THE position of Wolf's comet at Berlin midnight on October 19 will be, according to the ephemeris of Herr Thraen, R.A. 4h. 40m. 27·92s. N. Dec. 4° 19′ 38·1″. It will then be at its maximum brightness, or 12·1, as compared with unity at time of rediscovery. The map given in the "Astronomical Notes" last week shows the position of the comet throughout this month.

Herr G. Witt, of the Urania Observatory, Berlin, obtained an observation of Encke's comet on September 4. He describes it as bright, diffused, without any perceptible trace of nucleus. The perihelion passage is on October 18th, but before then the comet will have moved into the southern hemisphere. Its position, according to Dr. Backlund's ephemeris for Berlin midnight will be on October 1, R.A. 10h. 43m. 3s., N.P.D. 74° 14′.

Two more small planets were discovered by M. Charlois, of Nice, on the nights of Sept. 8th and 11th. They will rank as 317 and 318 in the general list, assuming that 312 is really a discovery, and not one of those minor planets previously entered in the list. No. 301 has been named Bavaria. It was discovered by Dr. J. Palisa, of Vienna, on Nov. 16, 1890.

In this month's *Knowledge* there are some reproductions of photographs, taken by Dr. Max Wolf, of Heidelberg, of that part of the Milky Way about Alpha Cygni. The value of photography is well shown by these plates, as it is doubtful if any human eye could detect the stars, even with a more powerful telescope.

One of the oldest shipbuilders—the oldest on the Clyde—and one of the few remaining who remembered the growth of the iron and steel part of the business, is dead at the age of seventy-six. Mr. John McMillan, of Dumbarton, played a very important part in making the Clyde the great ship-building district it is.

The death is announced of Prof. William Ferrel, a distinguished American scientist, who, after graduating, became assistant in the office of the "American Ephemeris and Nautical Almanac," which post he held for ten years. Subsequently, until 1882, he held a special appointment in the United Statas Coast Survey, for the discussion of the tidal observations. In 1882 he was made assistant, with the rank of professor, in the Signal Service Bureau, where he remained until October, 1886, when he retired to Kansas City. Mr. Ferrel invented the maxima and minima tide-predicting machine, which is now used by the American Coast Survey. He received honorary elections to Austrian, English, and German meteorological societies, and in 1868 was elected to membership in the National Academy of Sciences. Prof. Ferrel was a native of the state of Pennsylvania, and was born in 1817.

M. Wilken, who, although comparatively a young man, was well known as an ethnologist, is dead. He was a Government official in the Dutch East Indies, where he made good use of his opportunities until he reached his forty-fourth year.

The secretary of the Lisbon Royal Academy of Sciences, Prof. J. M. L. Coelho, died last August, and the society now officially announce the fact. He was 66.

A distinguished ornithologist has been lost by the death of August von Pelzeln, custos of the Imperial Museum, Vienna.

The autumn meeting of the Iron and Steel Institute will be held in London on Oct. 6 and 7, The programme, which has just been issued to the members of the institute, intimates that the first day's meeting will take place at the Royal Arsenal, Woolwich, when two papers will be submitted, the first by the Director-General of Ordnance Factories, Dr. W. Anderson, F.R.S., "On the Constitution of the Royal Ordnance Factories," and the second by Capt. Holden, R.A., Proof Officer, Woolwich, "On the Measuring Instruments used in the Proof of Guns and Ammunition at the Royal Arsenal." After the morning meeting, the members will be conducted over the manufacturing departments of the arsenal, and will be entertained at luncheon by the president of the institute, Sir Frederick Abel, K.C.B. After lunch other departments of the arsenal will be visited, and the members will then assemble at the Proof Butts to witness the firing of quick-firing and machine-guns, experiments with smokeless powder, &c. On the following day the institute will resume its sittings at the Institution of Civil Engineers in Westminster, when a number of papers will be read, including one by Sir Henry Bessemer, F.R.S., "On the Manufacture of Continuous Sheets of Malleable Iron and Steel, direct from Fluid Metal," and another by the Director of Naval Construction, Mr. W. H. White, C.B., "On Illustrations of Progress in Material for Shipbuilding and Engineering in the Royal Naval Exhibition."

An exhibition held under the auspices of the Photographic Society of Great Britain, was opened this week at 5A, Pall Mall East, and will remain open until Nov. 12.

At the Royal Victoria Hall on Oct. 6 Prof. T. Hudson Beare will lecture on "The Steam-engine," with experiments; on Oct. 13 the Rev. Canon Browne will discourse on "The Invasion of England and Battle of Hastings," with illustrations from the Bayeux tapestry; on Oct. 20 the lecture will be on "Flowers and their Helpers," by Mr. J. R. Green; and on Oct. 27 the Rev. E. Hill will deliver a discourse on the Channel Islands.

At the Congress of German Naturalists and Physicians held last week at Halle, Prof. Anfrecht, of Magdeburg, spoke of the value of Koch's tuberculin as a remedy for tuberculosis, especially in the initial stages; and further averred that it retarded the progress of the disease even in the period of excavation. His remarks were to a certain extent endorsed by Prof. Weber, of Halle.

Malta honey is said to be noted for its purity and delicate flavour, which is attributed to the bees feeding on, or, rather, "gathering" from, the "sulla" a species of clover extensively grown in the islands known as "Malta." It is estimated that to collect 1lb. of honey from clover 62,000 heads of clover must be deprived of nectar, and 3,750,000 visits must be made by the bees.

At a recent meeting of the Paris Academy of Sciences M. Rommier read a paper on a somewhat similar subject—the yeast of wine—the bouquet, or aroma, of the wine made from grapes of the same species but grown in different districts being quite distinct. The characteristic bouquet seems to be due to the district, and wine from shifted vines or cuttings does not necessarily possess the special flavour of the original when planted in other districts. It is known that the best wines are produced from grapes raised on volcanic soils.

Some years ago Prof. Rein planted in the Frankfort botanical garden some of the trees from which it is stated the Japanese obtain their lacquer or varnish. The tree is known to botanists as the Rhus vernix, and it appears there are now 34 healthy trees, some 30ft. high. Prof. Rein has taken sap from a few of the trees, and sent it to Japan for trial by native artists. It is, however, almost useless for Europeans to attempt to compete with the Japanese in their line, but the lacquer, if it can be made from trees grown in Europe, may be used for other purposes than varnishing wood. The Rhus Coriaria, or varnish-tree, grows in many parts of what may be termed the Mediterranean district, and its juice is known for its deleterious, or injurious, properties, and has consequently been let alone. The Japanese, however, seem to understand it, and it is certain they make a beautiful lacquer or varnish from the juice of their trees; but they keep the processes secret.

It is stated that in some parts of Australia the olive-tree thrives; and as olives are valuable either preserved or for their oil, another industry worth studying is open to our Antipodean cousins.

California is turning its attention to the study of botany. Fruit grows there in abundance, and it has been thought advisable to start a botanical club, which has been duly instituted under the presidency of Dr. H. W. Harkness.

To the Paris Academy of Sciences M. Paquelin has presented a paper on a rather curious phenomenon. It seems that if a mixture of hydrocarbon vapour and air is led over a specially-arranged platinum apparatus or wire the metal is heated almost to fusion-point, yet it remains luminous if plunged into water. Such an experiment will naturally attract much attention.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

JUPITER — THE TELESCOPE — TELESCOPES AND TROOPSHIPS—SPACE OF FOUR DIMENSIONS—THE HARVEST MOON — GEOGRAPHICAL TABLES—LATITUDES AND LONGITUDES OF THE PERIHELIA OF THE PLANETS, AND THEIR DISTANCES FROM THE SUN—THE STUDY OF ASTRONOMY—THE VENOM OF THE TOAD — STONEHENGE — VENUS ON THE NIGHT OF APRIL 12, 1782—OBJECT-GLASSES FOR CELESTIAL AND TERRESTRIAL OBSERVATION—MICROSCOPIC OPTICS.

[32762.]—I do not know whether the fault lies with the engraver, or printer, or both; but I am sorry to say that I fail to recognise anything like an accurate reproduction of my sketch of Jupiter on p. 89. Imprimis, I drew the Great Southern Belt of practically equal width throughout. In the next place, the shadow of Satellite II. followed it as an intensely black circular spot. In the third place, the Northern Equatorial belt was distinctly darker than the Southern one; and, fourthly, the planet was shaded right up to its North Pole. [Mr. Stanley Williams will see from this, written, of course, a week before his letter (32737), on p. 111, appeared, that the engraving which he so righteously criticises in no legitimate sense whatever represents my original drawing. Perhaps the latter got rubbed out in the post.]

Apropos of Jupiter, there is nothing whatever remarkable in the observation made by Mr. Middleton, and described by him in letter 32708, p. 90. He appears to be the possessor of a good instrument; but anyone who owns one of equal excellence may observe transits—at all events, of the shadows—of Jupiter's satellites on any fairly decent night when they occur.

I am writing this in a locality where I have no access to back numbers of the ENGLISH MECHANIC, and hence shall feel obliged to "Wega" (letter 32713, p. 91) if he will be good enough to refer me to the volume and page on which I stated "that to see the companion to Polaris with a 2¾in. telescope a power of 200 would be necessary," in order that I may verify so remarkable a statement on my return home. Perhaps, too, at the same time, he will give a similar reference to the place where my assertion appears that for a finder you *must* have a positive eyepiece. There can be no doubt whatever that you *ought* to have one—a fact which may be gathered from the examination of the finders of the telescopes in the first dozen observatories you enter at random; as presumably their makers know their business. Of course, a negative eyepiece may be used, with its imperfect focussing of the fiducial wires. Savages shave with flint flakes—but I prefer razors myself.

I congratulate Captain Battersby (letter 32714, p. 91) on having got his telescope safely out to Barbados. Telescopes do bear an amazing amount of knocking about. I have myself been on board of a "trooper" in company with more than one astronomical telescope, and although we have, as the sailors say, "made very bad weather," been nearly on our beam-ends, and had our baths and other impedimenta shot bodily out of our cabins into the messroom, and had many pounds' worth of china and glass smashed to atoms, the telescopes, somehow, escaped intact. They seem to bear a charmed life. In connection with the fungoid growth on the inside of the lenses of the objective, I think that if Captain Battersby will repeat the application of spirits of wine on fine cotton-wool, and rub hard enough, he will get them out. Cotton-wool is hardly a material that will affect the figure of his object-glass.

If Mr. Grey (letter 32719, p. 92) carries out to its logical conclusion his curious hypothesis that a thing must—or may—exist because it "is distinctly shadowed forth by mathematical equations," then we must not confine ourselves to "space" of four dimensions, or of five or six; but must land ourselves in the preposterous notion that "space" of *n* dimensions is a conceivable entity. It is a gross solecism and abuse of language to apply any word with such an extremely definite connotation as that of "space" to such an intellectual vagary as this. I do not think that Mr. Grey will suspect me of being one of those who decry mathematics. My protest is against their misuse, and against the assumption that symbols, pure and simple, must *ex necessitate* have entities corresponding with them. Speculations on space of *n* dimensions appear to me to be strictly cognate with the mediæval discussion of the schoolmen as to how many angels could stand on the point of a needle.

If Mr. Garside (query 75317, p. 97) can beg, buy, or borrow a celestial globe, he will be able to clear up what puzzles him in connection with the Harvest Moon much better than he could from any diagram, and, notably, from such a one as he asks for. In fact, a very little attention may enable him to understand the matter without any diagram at all. When the moon is in that part of her orbit which makes the least angle with the horizon, she rises for some nights running at nearly the same time. Now this part of her orbit lies in the neighbourhood of the so-called First Point of Aries, and as, of course, the moon traverses it at every lunation, this phenomenon of her rising at nearly the same hour for a few nights happens regularly once a month. But the moon is full when she is in the opposite side of the heavens to the sun, and as the sun is only in Libra (180° from Aries) at the date of the autumnal equinox, it is only at that time that she can be full in Aries. We notice the *full* moon rising at nearly the same time for three or four consecutive nights, but pay no attention to it doing so when it is only a crescent. There is no mystery in the matter, nor does the harvest moon differ from any other moon save in being full in a particular part of the sky.

Mr. Collins (query 75320, p. 97) will find a table at the end of Loomis's "Practical Astronomy," giving the length in feet, and decimals, both of a degree of the meridian and parallel, for every 10′ from the Equator to the Pole.

Being far away from my own (or any other) books, I cannot answer Mr. Moor's query (75338) on p. 98 at present; but will see on my return home what data are available for giving him the co-ordinates of the planets' perihelia. But I can say offhand—and without any book at all—that, calling the earth's mean distance from the sun 1, that of Venus is most decidedly *not* ·38709, &c., but ·72333 or thereabouts, for I will not trust my memory to more, if to as many, decimal places.

I think that if "Duffer" (query 75349, p. 98) will procure Prof. Young's masterly "General Astronomy," and carefully read it through, he will have obtained as comprehensive a view of the science as he will ever be likely to gather from any single book. If now he wishes to enter into the subject of practical and spherical astronomy, Loomis's "Practical Astronomy" will supply him with an admirable manual. He will, of course, need a good volume of logarithms: perhaps Bruhns's is the best. To acquire a knowledge of the face of the sky, nothing will help him more than Proctor's "Star Atlas." Cottam's is very beautiful, but is confined to stars visible only in these latitudes. As a work of instruction and reference in viewing the heavenly bodies, it would be difficult to surpass Denning's "Telescopic Work for Starlight Evenings." Finally a "cheap" telescope, means in an overwhelming majority of cases, a "nasty" one. A first-class 3in. telescope, is worth half a dozen low-priced 4in. ones, so that "Duffer" will find it the falsest of false economy to buy an instrument by any one but a leading maker. By the time that my querist has mastered Young, Denning (or Webb's "Celestial Objects for Common Telescopes"), and Loomis, he will be in a position to decide for himself what branch of astronomy he would most like to pursue, and the best method for him to adopt in pursuing it. I may add, for his information, that £16 ought to provide him with a telescope and all the books I have mentioned.

I was rather surprised to gather from your "Scientific News" on p. 110, that the venomous, or rather, irritant nature of the secretion of a toad's skin, has recently been the subject of discussion, inasmuch as I imagined that this peculiar property has been a matter of common knowledge or experience with every country-bred dog from time immemorial. Nothing is more curious than to note how a dog will avoid a toad; as if, perchance, in his puppyhood he should foolishly bite at one, the profuse salivation and foaming at the mouth referred to by Dr. Guthrie supervenes at once. I do not remember to have noticed the vomiting. But my point is that the irritant character of the cuticular secretion of the toad seems to have been treated either as a new discovery or as a matter for discussion; whereas it has, so far as I know, always been familiar to everyone who has been brought into contact with toads at all.

The very suggestive letter (32756) of Mr. Erskine Scott, on p. 114, deserves more consideration than I can give to it here; but on my return to my books I will calculate the azimuth of the point of sunrise at Stonehenge for various epochs. In order to utilise such calculations, however, it will be essential to know the precise bearing of the monolith from the so-called "altar-stone," and perhaps Mr. Bacon may be able to obtain this either by the aid of a prismatic compass, or (should he possess it) a theodolite.

As will be gathered from what I have said above, I am away from all my books and means of reference, so cannot possibly reply to query 75354, p. 118. If, however, Mr. Munro can get hold of the *Nautical Almanac* for 1782, he can at once find out for himself whether Venus was, or was not, an evening star. By the bye, I forget, though, in what year the publication of our National Ephemeris commenced.

In reply to query 75391, p. 119, Mr. Strother can, of course, use the object-glass of his transit instrument in another tube for ordinary astronomical purposes—always assuming that it is a good one, and defines clearly and sharply without any fringe of colour. He must by no means remove either of the lenses, the object of the third one being to correct what is known as the secondary spectrum, and to render the combination more purely achromatic. There is no difference whatever between a marine and a land telescope, each consisting of an achromatic object-glass, with a four-lens erecting eyepiece. No optician, as a rule, takes as much pains with the objective of one of these hand telescopes that he does with one constructed for astronomical purposes, and hence they are generally not very satisfactory when used on the heavenly bodies with a Huyghenian eyepiece. The Jones's flourished at the beginning of the present century, and were well-known opticians. In the days of my youth I possessed a small transit-circle, or rather, altazimuth, of their make. It was a very nice little instrument.

"A. F. C." (query 75402, p. 119) will find a reply to his question above.

If we suppose that the images formed in the focus of "Tyro's" microscopic objectives are, as he says, magnified 21, 41, and 81 times respectively, then as a lens of 1in. in focus is popularly supposed to magnify 10 diameters, one (equivalent to his 2in. and 1in. eyepiece) of 1·33in. in focal length would magnify 7·5; so we say, 7·5 × 21, 7·5 × 41, and 7·5 into 81, which we shall find will come out 157·5, 307·5, and 607·5 respectively. No two English makers construct their A, B, and C eyepieces of the same focus. So that the concluding part of "Tyro's" query is unanswerable.

A Fellow of the Royal Astronomical Society.

JUPITER.

[32763.]—There is a clerical error in my letter (32734, p. 111), which it may be as well to correct. The dark streak in the S. hemisphere of Jupiter was first seen by Mr. Williams on June 1, 1889, and not on June 1, 1891, as stated.

The period of rotation, 9h. 55m. 18·3s., which I gave for this marking, corresponds very nearly with that derived from other features in the same hemisphere, and there is no doubt that this rate represents the motion of a current operating over a considerable extent of S. latitude. Various observers have determined rotation periods differing very slightly from that of the conspicuous streak now visible, and it may be interesting to quote these:—

h. m. s.		
9 55 17·6	Schröter.	A break in a dark streak, lat. 20° S.
9 55 20	Lohse.	Dark streak, lat 30° S.
9 55 17·2	Schmidt.	A marking S. of the great S. belt.
9 55 23	Trouvelot.	Grey belt S. of red spot.
9 55 15	Trouvelot.	Great grey spot in same zone as last.
9 55 21·6	Williams.	White spot in lat. 30° S.
9 55 11·8	Williams.	Dark spot ditto.
9 55 17·8	Williams.	Ditto ditto.
9 55 17·9	Denning.	Short belt in ditto.
9 55 18·2	Denning.	Bright spot in ditto.

The mean of the 10 values is 9h. 55m. 18s.

Bristol. **W. F. Denning.**

THE AUGUST PERSEIDS.

[32764.]—All who are interested in meteor radiants will thank Mr. Booth for his researches on the subject and the publication of them in your columns. They certainly go a considerable distance towards proving a shifting of the radiant, but they can hardly be reconciled with previous observations, unless the radiant varies from year to year, as well as from day to day. Mr. Denning finds a shifting in Declination as well as in Right Ascension, whereas Mr. Booth found the Declination constant throughout his observations. In 1878 Mr. Denning found a radiant of 32° + 53° from a rich shower of 53 meteors on the 30th of July, and could hardly have been mistaken in the case of so fine a shower; while Mr. Sherwen now finds 28° + 57½° for the same date—a very considerable variance. It is to be noted, too, that concurrently with this fine shower from 32° + 53° at the end of July, 1878, Mr. Denning noticed another from 43° + 58°, very near the principal August radiant. Meteors from near this point were also observed at the end of July by Heis, and Heis traced a large number of meteors observed near the 10th of August to a radiant within 3° of that observed by Messrs. Booth and Sherwen at the end of last July. The whole question requires further discussion, and I hope some of the mathematicians who take an interest in the subject will inquire what physical connection among the various meteors would produce such a shifting as appears to have been observed. Whether the various observed radiants belong to the same shower or not, will depend in a great measure on this connection.

Dublin, Sept. 26. **W. H. S. Monck.**

[32765.]—In reply to Mr. Booth's letter (32741), the position and radiants given by me were obtained by the naked eye during the progress of the shower or showers; and, as I was watching the phenomena for upwards of two hours, I do not think I was mistaken. The three radiants were *fairly* in line with one another, and were all well marked. The shower to the left was, no doubt, from the well-known radiant near β Camelopardus (vide "Chambers," p. 766). I can only say I endeavoured to give the facts and positions as accurately as possible, and if they do not conform to theory, why, let theory conform to them. I do not see why eye-charting at the time should not be as accurate as pencil-charting afterwards. I eschew the question of the shifting of the Perseid radiant, as being at present altogether beyond my depth; and I would not presume to force new wine into old bottles until better informed. Meantime, I accept the fact, and have no doubt it will, in due course, receive a satisfactory explanation.

Dublin, Sept. 26. **W. H. Milligan.**

THE CANALS ON MARS.

[32766.]—Les correspondants de "l'E.M." qui, essayant de démolir les résultats de M. Schiaparelli, sont animés du désir de faire mieux qu'un aussi grand observateur, ambition que l'on trouvera peut-être très-louable devraient se montrer mieux au courant des travaux de l'astronome Italien. L'un d'eux, par exemple, n'est pas capable d'identifier la carte de M. Schiaparelli avec celle de M. Green; c'est cet excellent ami de la vérité qui s'appelle "F.R.A.S." Il est à plaindre, car, si la passion ne l'aveuglait pas, il reconnaîtrait que la carte de M. Schiaparelli est presque une photographie de Mars et renferme avec un peu plus de netteté, il est vrai, tout ce qu'on voit dans celle de M. Green, avec quelques petites choses en plus par dessus le marché. L'autre correspondant ignore que M. Schiaparelli a vu les lacs doubles, et il n'a jamais en tout les yeux qu'un seul dessin de cet astronome. Malgré cela, il n'est plus permis, d'après ces messieurs, de rien de doubler; partout où il-y-a déboublement il-y-a illusion, diplopée, astigmatisme, aréomanie, ou quelquechose de pareil! On frémit en pensant que peut-être, dans un avenir prochain, ils étendront leurs conclusions aux étoiles doubles et démontreront ainsi l'inanité des immenses travaux exécutés depuis nombre d'années dans cette branche de la science par quelques hallucinés. **Dr. F. Terby.**

THE DOUBLE LAKES OF MARS.

[32767.]—Since writing my last letter, I have seen several drawings by Prof. Schiaparelli, showing the famous "double lakes" of Mars. The markings to which this pompous name has been given are nothing but *a mere widening of the canals themselves*, and being part and parcel thereof, duplicate according to the same optical law. The new conundrum of Mr. Williams can be satisfactorily explained by what I said in my last letter.

Antwerp, Sept. 26. **H. Schleusner.**

WOLF'S COMET.

[32768.]—I think that Mr. T. Moon, of Hatfield, Doncaster, who "could just get a glimpse" of Wolf's Comet in a finder of less than 1in. aperture, possesses such an extraordinary instrument that he owes to the maker thereof and observers generally that he should publish the name of the former, on the principle of "Palmam qui meruit ferat." Fired with emulation of his achievement, I endeavoured to "get a glimpse" of the comet in my finder, a very good one of 1½in. aperture, at 1 o'clock yesterday morning, and failed utterly, although I brought θ^1 and θ^2 Tauri, near which it was situate, behind one of the wires, to obviate their glare. At 11 p.m. the comet formed nearly an equilateral triangle with these two stars, θ^1 being then a little the nearer to it.

At 12 θ^2 was just about as much the nearer, and at 1 a.m. the three appeared as an inverted isosceles triangle, the base about two-thirds the length of the sides. Last night at 11, the comet and two 6-mag. stars (80 and 81, I think), presented an inverted resemblance to the arrangement of α, β, and γ Arietis, in a low-power field taken roughly.

I have observed a manifest nucleus from my first sight of the comet in Triangulum, and, like "F.R.A.S.," I fail to realise the stated increase of brilliancy, very faint in a 4in. refractor. I now sign my name, of which I gave only the initials last week.

Sept. 29. **J. Bartlett.**

TELESCOPES AND TROOPSHIPS, &c.

[32769.]—Allow me to suggest to Captain Battersby that what he takes for a fungoid growth between his lenses is nothing more than Newton's rings, caused by imperfect contact of the two surfaces. **Sm.**

ICE AGES.

[32770.]—The two writers hereon, in p. 112, might consider, seeing the present atmosphere on earth is equivalent to about 29·8in. of mercury, what if, in the glacial times, it were only equivalent to 27in. or 26in. As there seems to have been less water than now, by some 15 or 16 million cubic miles, I can suppose this was not the only fluid that fell, but some air accompanied it. A penny pamphlet, published by Reeves, 185, Fleet-street, on "Huxley's Mendacity" about Noah's Flood, may explain the event, and how the glacial age suddenly ended. **E. L. G.**

THEOSOPHY.

[32771.]—"Sigma's" remarks *re* theosophy in your issue of Sept. 25 do not take one very far. I do not think any theosophist would allow his philosophy to stand or fall by the pamphlet whereon "Sigma" bases his remarks. The æther of the theosophist is in no sense the ether of science. For that matter, the ether of science is itself an hypothesis, and no scientific speculation appears able to assign to ether a structure that can explain its properties. Dr. Lodge's suggestion as to the ethereal medium of thought is not new, for Dr. Richardson propounded a similar hypothesis many years ago. But if we assume an "ether" that is capable of being the medium for the transmission of thought, or rather of mental pictures, and assign to it various layers or degrees of sublimation according as it registers mental pictures, emotions, concepts, and even entirely spiritual ideation in exact correspondence with the various planes of human subjective action, I think we have the idea of the æther of the theosophist in its various degrees. And if the registration and transmission of thought-pictures thereon is not an absurdity, then neither is the registration of the higher degrees of mental and spiritual action.

Sept. 27. **Ferndale.**

DIALLING AND HOROLOGY.

[32772.]—"C. H. T.," some weeks ago, asked for a few names of writers on the subject of dialling. The following list may be of some service. It is arrranged alphabetically, and not according to date of publication:—

Blagrave's "Art of Dyalling," 1682.
Brown's "Horologiographia," London, 1671.
Collin's "Geometrical Dyalling," London, 1659.
Desagulier's "Treatise on Gnomonics," Oxford, 1712.
"Universal Dyalling," by G. S., London, 1657.
Fale's "Horologiographia," London, 1593.
Foster's "Elliptical or Azimuthal Horologiographia," 1654.
Good's "Art of Shadows or Universal Dialling," London, 1711.
Leadbeater's "Mechanic Dialling," London, 1737.
Leybourn's "Art of Dialling," London, 1702.
Lyon's "Treatise on Reflecting Dialling," London, 1658.
"Mechanic Dialling, or The Art of Shadows," manuscript, no date.
Moxon's "Mechanic Exercises Applied to the Art of Dialling," London, 1703.
Sargue's "Universal Way of Dialling," London, 1659.
Stirrup's "Horometria," London, 1652.
Wells's "Young Gentleman's Dialling," London, 1725.
Wells's "Sciographia, or Art of Shadows," London, 1635.

As the querist appears to be interested in the subject, I have made the list as full as the sources of my information allow; but he will probably find it a difficult matter to obtain any of the books mentioned. A new edition of Mrs. Gatty's "Book of Sundials" was published in 1889, and this will, no doubt, be as good as any he may obtain. Chambers's "Encyclopædia" has a very good article on dialling, and if "C. H. T." has access to the *Horological Journal*, he may there also find scraps of information, especially in the earlier volumes. The subject, no doubt, is interesting; but in these days of the ubiquitous pocket-watch it cannot be of any great importance. And, for my part, I should like rather to see some eminent practical man, like the late "Second's Practical Watchmaker," contributing a series of articles on the higher branches of the kindred art of horology. This would benefit a larger class of readers, and be of more general interest. It is to be regretted that there is not now that interest taken in the subject which was so conspicuous in the pages of "Ours" when "Cosmopolitan," "Alfojoe," and a host of others were regular contributors. The splendid articles on Chime-Clock Making which have recently appeared are an indication, I hope, of a revival of general interest in matters horological, and although primarily addressed to amateurs, have been, I make no doubt, read with interest by all readers who are members of the trade. We shall hope that the "E. M.," after so many years' silence, will again have its pages devoted to this as well as the other mechanical arts. **Spring Detent.**

HINTS FOR BELL-HANGERS, ETC.

[32773.]—I don't know what our friends, Mr. Bottone and Mr. Allsop, will say to it; but I fancy our American friend, whom you quote last week on p. 108, is exhibiting his want of real knowledge for the benefit of mankind. How on earth can it make the bell ring better than before? Surely rather quite the contrary. It is placing an obstruction in the way, seeing the coil is to be a little less in resistance than the bell coils. Quite one half would be lost, and if the bell would only ring weak before this was added, it would not ring at all after. I never before saw such an idea as this. No doubt someone will be trying it, but, of course, it will be an utter failure. I should strongly advise our friend not to write any more than he knows. Never mind whether it is from Chicago or not, as such is misleading to those who know no better.

South Retford, Notts. **Alfred Jackson.**

A NEW GAS-STOVE.

[32774.]—This "new" stove is nothing more than a kind of Bunsen burner. It possesses no superiority in warming the room over an ordinary gas-jet, since it does not alter the volume of gas burnt. The amount of heat produced is the same whether it be used or not, and the products of combustion are unchanged. **Sm.**

[32775.]—It would be a simple matter to prove that such an arrangement as your correspondent refers to in letter 32754, p. 114, is worse than useless for heating a room. An atmospheric burner heating a mass of metal is, when placed in the position of a lighting burner, matter in the wrong place, as the convected heat produced rises to the ceiling and remains there. To speak about the "intense heat" produced is nonsense. As a matter of fact, the temperature of an illuminating flame is beyond comparison higher than that of any atmospheric burner. In the zone between the transparent and white parts of a common gas-burner the temperature is close on—and in some burners exceeds—the fusing point of platinum; and I have myself repeatedly fused fine platinum wires in a common gas-jet. The temperature of a good atmospheric burner, unaided by air under pressure, very slightly exceeds a clear red—the fusing point of copper. A proportion of the heat from a lighting burner is radiant heat, which flies in all directions, giving a very appreciable amount downwards at a considerable distance below the flame. If air is mixed with the gas before burning, the radiant heat disappears, and all the heat rises to where it is not wanted.

The total quantity of heat from any gas-burner of any kind, lighting-jet, atmospheric burner, blowpipe, or oxyhydrogen-jet is, in every case, absolutely the same for the same gas consumption. This is a natural law which never varies, and the want of knowledge of this law has caused enormous waste of time and money of would-be inventors, who ignore chemical facts and try to invent the impossible.

The reason why different forms and systems of burners are used is, that each form is especially suited to obtain the best results for certain specific purposes; the object being to divert as large a proportion of the energy with as little waste as possible to one use.

The products of combustion from any gas fire are quite as objectionable as those from a coke fire, and a good chimney is as necessary for one as for the other. No doubt the absence of a proper flue to the gas fire is the cause of "Householder's" complaint. **Thos. Fletcher.**

BREATHING OF A LOCOMOTIVE.

[32776.]—The breathing of a locomotive, that is to say, the number of puffs given by a railway engine during its journey depends upon the circumferences of its driving-wheels and their speed. No matter what the rate of speed may be, for every round of the driving-wheels, a locomotive will give four puffs, two out of each cylinder, the cylinder being double. The size of the driving-wheels vary, some being 18ft., 19ft., 20ft., and even 24ft. in circumference, although they are generally made of about 20ft. The express speed varies from 54 to 58 miles an hour. Taking the average circumference of the driving-wheels to be 20ft., and the speed per hour 50 miles, a locomotive at an express speed will give off per minute 52, 1,000 puffs per hour, the wheel revolving 13,200 times in 60 minutes, giving 1,056 puffs per mile. Therefore, an express going from London to Liverpool, a distance of 201¼ miles, will throw out 213,048 puffs before arriving at its destination. During the tourist season of 1888 the journey from London to Edinburgh was accomplished in less than eight hours, the distance being 2,001 miles, going a speed throughout of 50 miles an hour. A locomotive of an express train from London to Edinburgh, subject to the above conditions, will give 423,456 puffs. **A. H. Small.**

70, Seymour-street, Hyde Park, London, W.

OHM'S FORMULA.

[32777.]—I am obliged to these gentlemen (letters 32747 and 32748, p. 113) for their replies, though the second appears to have misunderstood my meaning. I am aware (as per Colenso and others) that $4 \div \frac{1}{2} = 8$, and not 4; but, presuming the 4 to be divided represented, say, oranges, I should consider the 8 stood for 8 *half* oranges, not whole ones.

I see now, however, that were the quotient in electrical calculations to be of the same character as the divisor, no reduction of the res. would appear to increase the current, as we know it does; for adopting the orange method, and lessening the resistance to $\frac{1}{10}$th, would still give us only 4 ampères; thus $\frac{4}{\frac{1}{10}} = 40$ tenths—i.e., 4—instead of 40 ampères, the true amount. Mr. Benjamin's letter gave me an opportunity of asking a question upon which theoretically I could not previously satisfy myself, though practically I knew I must be wrong. Ha! I accepted the recognised calculation without endeavouring to understand it, I should not have troubled "ours" with my query. **B. Harcourt.**

OPIUM IN INDIA.

[32778.]—Your correspondent, S. E. Peal, writing from Asam, denies that Englishmen "have taught the natives of India the use of drink and opium." The former question I leave to others; as to the latter, I should be glad to be allowed a few words of reply.

If the denial simply means that opium was known and abused in India before English rule was established there, no doubt Mr. Peal is quite right. But the charge against the British rulers of India of having greatly extended the evil by their policy is one that rests on high official authority. Mr. Henry St. George Tucker, who was for a long time one of the directors of the East India Company, and chairman of the Board of Directors in 1834, and again in 1847, in a note handed in by him to the Court of Directors, wrote as follows:—

"Ever since I had the honour of being a member of this Court I have uniformly and steadily opposed the encouragement given to the extension of the manufacture of opium; but of late years we have pushed it to the utmost height . . . . We contracted burdensome treaties with the Rajpoot States to introduce and extend the cultivation of the poppy. We introduced the article into our own districts, where it had not been cultivated before, or where the cultivation had been abandoned, and we gave our revenue officers an interest in extending the cultivation in preference to other produce much more valuable and deserving of encouragement. Finally, we established retail shops, which brought it to every man's door."

In Lower Burma, according to the evidence of Mr. Hind, assistant commissioner for that province, as quoted by Dr. George Smith before the Parliamentary Committe on Indian Finance in 1871—"Prior to the introduction of British rule in Arakan, the punishment for using opium was death. The people were hard-working, sober, and simple-minded. Unfortunately, one of the earliest measures of our administration was the introduction of the Abkari (the name given to the department which manages the revenue from drink, opium, and other poisonous drugs) rules by the Bengal Board of Revenue. Mr. Hind, who had passed the greater part of his long life amongst the people of Arakan, described the progress of demoralisation. Organised efforts were made by Bengal agents (i.e., agents licensed by the Government from Bengal) to introduce the use of the drug, and to create a taste for it amongst the rising generation. The general plan was to open a shop with a few cakes of opium, and to invite the young men and distribute it gratuitously. Then, when the taste was established, the opium was sold at a low rate. Finally, as it spread throughout the neighbourhood the price was raised, and large profits ensued." Mr. Hind "saw a fine, healthy generation of strong men succeeded by a rising generation of haggard opium smokers and eaters."

I could give further testimony from official sources to the same effect, showing what has been the opium policy initiated by the East India Company, and followed up by the Queen's Government in India to this day; but these are probably as much as you can find room for. In conclusion, I will only add that we do not charge the Government of India, as a whole, with "desiring to raise the revenue" by demoralising the people. We do not profess to pry into motives, and are sure that many members of the Government are incapable of wilfully designing anything of the kind. But we arraign the policy which has had the lamentable effect of spreading the opium vice throughout our Indian Empire, as well as in China and elsewhere, as an immoral policy—*contra bonos mores*—opposed to those good and just laws which God has laid down, and which are written in every heart.

Joseph G. Alexander, Secretary.

Society for the Suppression of the Opium Trade.
Offices, Broadway Chambers, Westminster, S.W.

WASTED FOOD.

[32779.]—Our querist should read a "Fungus Foray," in the *Yorkshire Weekly Post* of Sept. 26, 1891, and he should join the Yorks Naturalists' Union, where he would enjoy the great advantage of seeing specimens gathered, and hearing a leading mycologist describe their qualities.

Collect all species, and preserve them in separate glass bottles of alcohol; get them named by experts. Label them with names and numbers, to tally with a book recording locality, and all other particulars—i.e., if you be enthusiastic in this obscure branch of botany. **Eos.**

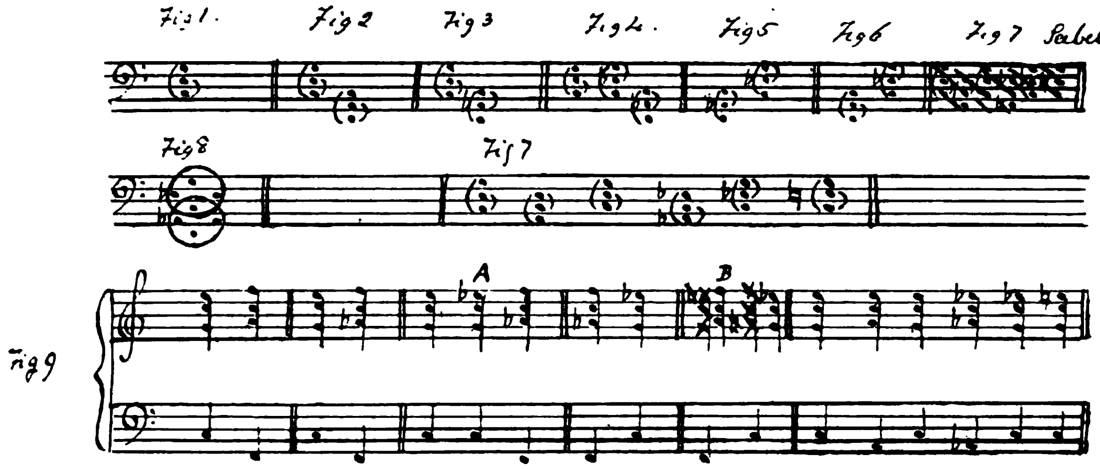
SMALL GAS-ENGINES AND ELECTRIC LIGHTING.

[32780.]—Is it not practicable for a small and simple gas-engine to be produced at a cost of £5 or £6, that would work a dynamo capable of lighting five or six lamps of 16c.p.? There would be an immense sale for such an article, as tenants of small houses could then have it in the cellar and light their rooms at a total cost of £10, which outlay hundreds of people would not object to. **W. P.**

HINTS FOR EXPERIMENTALISTS.

[32781.]—It occurs to me that some plan might be invented by which photographic pictures could be obtained from the mechanical action of light; as, for instance, by employing that agent to regulate the deposition of a powder, or of a condensible vapour, on a flat surface within an exhausted vessel. I am not yet sufficiently familiar with Prof. Crookes's experiments to speak positively; but I believe that the manifestations of radiant energy he discovered were common to gases at high and low pressure, though masked in the former case by the effects of air currents, and perhaps otherwise modified. What would be the effect of radiation on solid particles suspended in a gas or on an insoluble powder—carbon, for instance—suspended in vitriol in an exhausted vessel? Would the suspended particles, in any of these cases, be attracted or repelled by light? If so, I suggest that experiments should be tried with a vessel having a flat glass bottom, the image of some object being projected upon the glass, so as to decide whether the vaporised or suspended particles would settle in various degrees upon the more and less illuminated portions of the plate. I do not know that the form of this experiment might not be modified with advantage. For instance, the suspension of a powder in olive-oil, at several atmospheres pressure, might be a more favourable condition. The attempt might also be made to produce a coloured image, through the selective action of the different rays of light upon a mixture of various coloured powders, during a prolonged period of subsidence. It might be found that the lower layer of powder, i.e., the layer most readily deposited, would be so diversified as to interpret the colours of the projected image by a design in pigments.

Again, suppose a coloured image to be projected on a lampblacked or other surface in an exhausted vessel. This surface would convert the various rays of light into molecular disturbance of the residual gas; and the extent of the disturbance at different portions of the surface would, I suppose, be proportional to the intensity and colour of the impinging light. Now if this lampblacked surface were the cross section of a bundle of glass-covered platinum wires, and if this bundle of wires, fused into the glass envelope of the exhausted vessel, constituted an electro-negative pole, then disturbance of the residual gas near the surface would result also, from the passage of an electric current through it. These two disturbances, each normal to the "sensitive surface," must interfere with one another, and I should think it not unlikely that the cause of the disturbance would, in turn, be reacted on;—that the relations between absorption and



reflection of light at the surface would be modified by the passage of an electric current, and that the incidence of light of a particular colour and intensity upon any given wire of the bundle, would affect the electric resistance between that wire and the main body of the residual gas. It is obvious that any successful experiments in this direction would have an important bearing on the subject of photo-telegraphy. A. D.

THE PRINCIPLES OF HARMONY.

[32782.]—The celebrated theorist, M. Félis, studied, it is said, upwards of eight hundred works on this subject. The present writer, not having the like acquaintance with the literature of music, is unable to trace definitely to its source the germ of the principles here expounded. These are to be found, in part, in the writings of Moritz Hauptmann and W. W. Parkinson. The works referred to are not intelligible to all readers, the first being couched in obscure Hegelian phraseology, the second presenting, for the most part, a mass of vulgar fractions. To Parkinson, however, belongs the merit of a harmonic notation of remarkable clearness, by means of which the most complicated combinations of sounds are exhibited in orderly form, and their pitches and progressive tendencies determined. As the development of the theory and the notation proceed simultaneously, so may they best be described together.

An inductive science is based on experiment, from which the principles are inferred; the remote consequences of these are reasoned out in an orderly way and experimentally tested. The agreement of these experiments with the results of the reasoning is the test of the truth of the inferred principles. Commencing the preliminary experiments, it is assumed that the reader has a general knowledge of the names of the intervals and the keys of a musical instrument, such as a pianoforte, or otherwise the investigation would be far too protracted. At the same time, it is only for shortness, not as presupposing any theory, that this knowledge is assumed, or the results would be invalidated through the circular reasoning involved.

If a given note be sounded together with all others successively, say the note C and the successive notes of the chromatic scale, it will be found that certain combinations only are in repose, the others being dissonant. The concords with C are found to be the following:—E flat, E, F, G, A flat, A, and the octave C. It will be observed that on a piano these intervals are only approximately in tune; that the notes only stand for or do duty for truly consonant intervals. The octaves, however, are, or should be, in perfect tune. The pitch of C being given, or known, the rates of vibration of the others can be measured, and the ratio of the intervals known once for all. They are as follows:—The minor third, $\frac{6}{5}$; major third, $\frac{5}{4}$; fourth, $\frac{4}{3}$; fifth, $\frac{3}{2}$; minor sixth, $\frac{8}{5}$; major sixth, $\frac{5}{3}$; octave, 2. These numerical ratios are useful as gauges of pitch, not as an explanation of consonance, for if it be said "the mind delights in sounds whose ratios are of a simple nature," the question at once arises: Why does the mind rejoice in such sounds? The real explanation will be found to be of a much simpler nature, but must not be forestalled.

If the above sounds be compared with the octave *c*, they will give the same interval in the reverse order, and as there is a peculiar sameness of character in a note and its octave, we may for the present regard the fourth and the two sixths as "inversions" of the fifth and the third, and direct our attention more closely to these latter. The interval of fifth has a perfectly definite character, which no extraneous notes can obliterate; the two sounds are heard as "root" and fifth beyond possibility of confusion, as contrasted, though consonant, elements of the interval.

The major third, by itself, and considered independently of key, appears equally immediately intelligible; the two notes, however, seem rather in agreement than contrasted, the interval having a restfulness and completeness wanting in the bare fifth. With the minor third the case is different: it has no repose, it is not intelligible until the mind supplies the major third above or below to give it a meaning. If no key has been previously suggested, it is taken to mean the major third and the fifth of a root a fifth below its highest note. It can only be understood when "mediated" by a third note sounded or mentally suggested. Thus there are only two concords immediately intelligible—the fifth and the major third.

The mental effect of the major triad can now be referred to a mental, not numerical, analysis of its intervals; the triad C, E, G, meaning that C has a major third and a fifth. These relations are perfectly compatible with the concord of E and G, and perfect harmony is the result.

Let this chord be denoted as in Fig. 1; where thirds, in perfect tune, stand on contiguous spaces, and fifths on spaces next but one to each other. (The relations of fifths and major thirds are denoted in these diagrams by ties.) We may suppose a pianoforte with a special mechanism, by means of which the tuning of one note tunes all the octaves of that note at the same time.. Then, to tune the notes of Fig. 1 will tune all the C's, E's, and G's on the instrument. The simplest progression, or change of chord, consists in displaying a note in new relationships; the note C, having been declared as the lowest note of a fifth, may now be made the highest note of another fifth. The root is, of course, F, and, removing the subject of our proposition from C to F, we may now postulate that F has a major third and a fifth. The progression will be denoted as in Fig. 2. The progression may now be reversed, C again assuming the character of root. We may, however, instead of changing the subject C to F, retain the C under a totally new light. Instead of positing that C has a major third and a fifth, we may show C *to be* a major third and a fifth, Fig. 3. First it *had*, now it *is*. This may be considered as a passive aspect of C, instead of the previous active character of the note. Fig. 4 illustrates the effect of the avoidance of the obvious; the previous proposition, C is active, then passive, being much more direct than the present one—viz., C is active, then G is passive; thirdly, C becomes passive. The terms "active" and "passive" are not here used from any partiality for metaphor; but to state concisely what has just been explained at length.

The progression of the last two chords is unexceptionable. First, G is a major third and a fifth, determining C; next C assumes the like character. The reverse of this progression, Fig. 5, unlike the reverse of Fig. 3, is not unconditionally good. The first proposition that C is a major third and a fifth, does not contain or suggest the sound G, to make its assumption of the same character reasonable. When, however, the harmony has first progressed from this chord as a position of rest, there can be no objection to its resumption. The progression, Fig. 6, or its reverse, is quite out of reason. It first asserts that F has a major third and a fifth; then that G, an unconnected note, is a major third and a fifth. The progressions, Fig. 7, hardly require comment—they are closely-connected chords with plainly discernible meanings. The sounds thus far used are the whole of the concords of C, and with C only are they all in agreement. The Fig. 8 (Parkinson's) well shows the peculiar predominating position of C in these chords.

From its central position, and seeing that it governs the pitches of no less than six sounds, its presiding influence might be inferred; it is the tonic of the system.

Something should now be said as to the progression of the individual parts. In the foregoing progressions there is no need for the C to move, as it forms a part of every chord. When, as in Fig. 7, two parts remain stationary, it suffices that the third part move diatonically; and, when two parts move, that they both move diatonically. They are not bound thus to move; but that is the simplest and most obvious motion. In addition, each chord can be accompanied in the bass with its root, and the balance of the parts is best maintained when the bass moves in a contrary direction to the upper parts. Should the bass, however, move in the same direction as an upper part, all fifths and octaves so formed are exceptions to the prohibited list of the composers. Fig. 9 illustrates the chords of the previous diagrams. At A the bad progression of Fig. 4 causes the chromatic E-flat to rise to F; and at B, corresponding to Fig. 6, we have the sequence of minor sixths, equivalent to major thirds, between A F and G E-flat. It must be observed that though the double determination as having or being at once a major third and a fifth, resides, in the minor triad, in the fifth, yet the root only loses one of its elements of character, that of having a major third. It yet has a fifth, and in the major the fifth *is* a fifth, so that whichever of the two sounds has a double determination, the other still retains one. Thus the bass does not change from root to fifth with the mode, as a false analogy might suggest.

The other notes being all in tune with C, some of them—to wit, A flat, A, E flat, E—are much purer than the equal temperament of a piano admits; on this instrument the major thirds are very sharp, and the minor thirds correspondingly flat, whence it follows also that the step from A flat to A, E flat to E, is much too great. The tempered fifth is much more perfect than the tempered thirds—indeed, their want of truth is hardly perceived. In the theory of harmony there can be no question of temperament: that is a necessary inconvenience which has to be tolerated in certain classes of instruments, and the relations of the different combinations of sounds must be gleaned from the true sounds, not from their approximate substitutes. Respecting the measurement of the intervals as far as these chords furnish them, it is easy to calculate that there are four different melodic steps now determined; the *major tone*, $\frac{9}{8}$, from F to G; the *minor tone*, $\frac{10}{9}$, from E flat to F, and from G to A; the *diatonic semitone*, $\frac{16}{15}$, from E to F, and G to A flat; and the *chromatic semitone*, $\frac{25}{24}$, from E flat to E, and from A flat to A. It is of more importance to recognise that there is a difference between these two species of tones and semitones, and to bear in mind that they must not be confounded, than to know precisely what that difference is as measured by the ratios of the vibrations. The ear knows the true from the false by the felt relationships of the sounds, not by reference to the numerical ratios of the pitches of the several notes.

Although the central tone of this system is named the tonic, it will further be shown that these chords do not perfectly define the key; the chord known as the dominant has yet to be considered before this can be done. Meanwhile, it may be convenient to state that the chords already given are named as follows:—Those on C are the major and minor tonic chords; those on F the major and minor subdominants; the minor chord on A the relative minor tonic. This last is connected with the major chords of the tonic and sub-dominant; and it is convenient, though unusual, to name the major chord on A flat the chord of the relative major tonic, to complete the analogy. The completion of the key will be explained in the next paper on this subject.

Arts Club, Manchester. R. L. Phillip.

(*To be continued.*)

LIGHTNING.

[32783.]—Your correspondent, "F.R.A.S." has kindly noticed my paper on the above; I beg to thank him through your columns. The cases which he cites, of an electric storm, are quite explicable by considering them as caused by an ascending current; but, in my opinion, as impossible from a descending "stroke of lightning." The first time my attention was drawn towards the effect of ascending currents was about forty years since, when a church near Cork was seriously damaged in a storm, accompanied by a severe fall of hail, in a westerly gale. I was on a committee appointed by a local scientific society to visit and report on the accident, which bore some remarkable features. The tower and spire were built of cut limestone; about half of the latter was blown off, the stones were scattered about, but a large portion fell into the body of the church, and the extreme top stone was found in a field about 100 yards away. The portion of the spire which remained, about 12ft. high, was burst open from the platform of the tower to the place where the upper portion had stood, showing a gap nearly wide enough for a boy to climb up; and it appeared as if there was not a stone removed in order to make the gap, simply an opening out of the stonework. The walls at the base of the tower showed evident signs of an upward force, some of the larger stones were thrown out of their places and completely turned over. These effects were at that time, as, indeed, they would be by many even now, attributed to the church being "struck by lightning," and there the mystery would remain unsolved; but now that electrical currents and resistances are better understood, it appears to me simply a case of the discharge of a current of great volume, passed by the tower as the best conductor it could find, and meeting the resistance of the diminished size of the spire, became sufficiently heated so as to cause decomposition of the water, and probably the lime in the mortar, the instantaneous explosion of which would be quite sufficient to produce the above effects. About the same time, a large old mansion in the town of Youghal was "struck" (I use the term for convenience); in the upper story there was a long passage, with a cross wall, in which was an arched doorway. The lady who resided there heard a drip of water at this doorway, and was placing a small basin to catch it when the event took place, and the drop of water was propelled with such force that it knocked a small round hole, as if made by a rifle bullet, in the bottom of the basin; at the same time, a bell-wire close to the doorway was deflagrated, leaving a broad band of gloriously-clouded colouring on the lime-washed walls. In this case, the insufficiency of the wire to convey the current caused its destruction, and is a good example of the intense heat so instantaneously created; and the accident to the basin indicated a downward return current. A similar accident to a tree as that related by "F.R.A.S." occurred to an old elm at my brother's residence near Waterford, in the autumn of 1887: two holes were blown up at the root of the tree, and the bark stripped off for 16ft. high by 20in. wide, and scattered over the lawn for a distance of over 50 yards. The roots of this tree must have extended over fully an acre of ground, and formed the conductors to concentrate the current on to the base of the tree, where the soft inner bark and the sap gave the resistance, caused the heat that decomposed and exploded the water, so producing the catastrophe; and this leads me to believe that the cause of persons being injured or killed when taking shelter under trees is, that they form a joint conductor with the tree, and probably give more resistance, and so suffer. In my previous letter I mentioned some other cases; but I fancy that the above are sufficient for my present purpose. Since writing the above I have received the "E.M." for the 25th, and have to thank "Sigma" for his remarks. The object of my writing is not, even were I able, to "gild the refined gold" of our electrical professors, but merely to put the problem into a popular form, and to show what I consider the true cause of such accidents, and that their being the direct effect of lightning is a false idea.

London, Sept. 25. **Rob. J. Lecky.**

SCIENTIFIC (?) ADVERTISING.

[32784.]—Permit me to say that the remarks of your correspondent who signs himself "A Fellow of the Royal Astronomical Society" in letter 32706, on page 89, respecting the action of the council of the Royal Astronomical Society and one of its officials, which can only refer to me, are untrue. In these remarks we have a fine example of scientific slandering. **A. A. Common.**

63, Eaton-rise, Ealing, W.

GEOLOGY FOR STUDENTS.

[32785.]—Dr. E. Aveling states, on p. 83, col. 1, under Syenites, "No syenite occurs in England."

"Wordsworth's Guide to the English Lakes," 1842, p. 94, under Buttermere, speaking of Scale Force, "From this point it is a mile to the force, which is one clear fall of 160ft. between two vast perpendicular walls of syenite," &c.

"Jenkinson's Tourist Guide to the English Lakes," 1882, p. 62, under Buttermere, says: "Hemmed in by high perpendicular rocks of syenite."

"Black's Guide to the Lakes," 1883, under "The Geology of the Lakes," p. 242, says: "The area of the syenitic rocks is considerable."

I shall be greatly obliged if Dr. Aveling will state of what the rocks above mentioned really are composed. **G. F. S.**

BICYCLE TIRES.

[32786.]—This arrangement for air tires appears to me to possess some advantages. A sufficient number of hollow balls are arranged round wheel, and kept in position by a band of leather, or india-rubber (or both combined), such bands to have holes stamped along both edges, say half an inch apart, the iron tire of wheel to be drilled at both edges with corresponding holes. These holes are for lacing the bands firmly into position by long leather laces. Many variations of the above will suggest themselves. **Marlow.**

PNEUMATIC TIRES.—HINTS FOR EXPERIMENTALISTS.

[32787.]—This question (see letter 32715) has been pretty thoroughly threshed out. The Quadrant Cycle Co. about three years ago brought out a wheel which had two rims, one concentric with the other, the inner one being connected with the spokes in the usual manner (direct), the outer being attached in the usual manner by means of a series of coil (helical) springs to the inner rim. They were not a success, owing to the lateral play introduced, and also to the instability of the outer rim and tire, these being of the ordinary solid type; and I believe they have given up making them. Now, if this idea was introduced into a pneumatic-shod wheel, the evils would be compounded, these having, in common with cushion tires, a chronic tendency to side-slip owing to the tire appearing to be insufficiently supported at the sides. Again, "A. D." proposes filling the tire with water. Now this seems to me, for many reasons, perfectly impracticable—first, on account of the weight, which would be a great deal more than a solid of the same diameter in decent quality rubber; secondly, you would lose the elasticity of the compressed air, as water is incompressible, and the air under compression is acted upon to a greater extent than the point actually in contact with the road, the wheel being insulated or suspended in the elastic medium. The difficulty seems to be best met by the "Clincher" rim and tire, the outer covering, or band, being moulded with a fine canvas ply or fabric sandwiched between the layers of rubber, making it nearly uncuttable by the ordinary débris of the road—broken lemonade-bottles, &c. But if, by chance, it should be punctured, it can readily be repaired in a few minutes, the tire being made in two parts and fixed into the rim by the pressure of the air inside the inflated tube. The "Boothroyd" tire, again, is as nearly an approach to the safety of a solid as possible, the compound of rubber and canvas being exceedingly tough against cutting, and at the same time being resilient as the original Dunlop pneumatic. This tire can be repaired by plugging the hole with a small piece of rubber smeared with solution, its construction being the same as a thin cushion with canvas moulded into it to give the necessary resistance to the air compression, and being attached to the rim by cement. There are several competitors in the market for public favour, but these two are, undoubtedly, far and away the best. I think the idea of separating the tire into sections has been tried, with small results, by reason of the difficulty in keeping the chambers air-tight and in not being able to re-inflate them. One of the methods employed was filling a long canvas and rubber casing with hollow indiarubber balls, and protecting by lacing a leather cover over all. The strain upon the rubber has been found to be greater practically by localising it to a small space, just where the weight of machine and rider comes, and, the rubber being stretched and the pores opened, loss of air soon takes place. Should like to hear some other correspondents' opinions. **Chas. S. Beal.**

At the time when Gmelin and Guimet were disputing as to the priority of discovery of artificial ultramarine, the chemist to the Royal Porcelain Manufactory of Meissen, Köttig, independently discovered a method of manufacture of that substance. The *Journal* of the Society of Chemical Industry says that in the spring of 1828 this chemist, whose claims have not been fully recognised, was engaged in an attempt to make a lead-free fusible glass, using for this purpose a mixture of sodium silicate and pure clay, and after strongly heating the same, observed that a blue-coloured substance was produced in small amount. He continued his experiments now with the object of discovering a suitable method of manufacturing the blue substance, and found that he could regularly produce it from a mixture of sodium sulphate, silica, charcoal, and clay. Subsequently, however, he modified the composition of this mixture, and selected soda crystals, kaolin, powdered brimstone, and charcoal as the best materials.

REPLIES TO QUERIES.

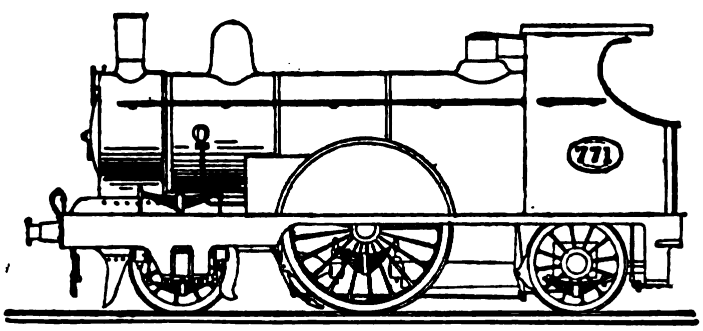
**** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[74338.]—**Child-Marriage in India.**—I have read the short paragraphs in the "E. M." about the subject, and I would advise the correspondents of the "E. M." not to indulge in such matters in a paper devoted to science. Such subjects as the social customs of any nation are not likely to be fairly discussed in this paper, nor are there any benefits to be derived from the vague and often incorrect information obtained second-hand. How difficult it is for foreigners to judge of the social and religious matters of the Indians will be evident from the single fact that they suppose the Hindus to be idolaters, i.e., worshippers of the idols or images as deities, whereas nothing can be more glaringly untrue. Even Oriental scholars of England, almost spending their whole lifetime on the religion of the Hindus, can yet fall into the error of supposing that the Mahábhárata preceded the Rámáyan. Unless a foreigner can breathe the atmosphere of a Hindu household, his comments on the Hindu life are, in nine cases out of ten, erroneous. It is the spirit of the Hindu life into which a foreigner can hardly enter, and without that spirit everything appears anomalous, and perhaps barbarous too. It would have been well if such important religious customs as the Hindu marriage system were left alone. Social changes, to be of real service, are to be effected from within; besides, there are enough subjects in India having nothing to do with the Hindu religion, for the right exercise of philanthropy. Think of the dumb millions of India who do not even know what a full meal a day means, meagre as their meals are. Think of the opium dens and excise laws under which the people are groaning. The number is legion, yet they are happy and contented. Notwithstanding their hard lot, they furnish an example worthy to be imitated. Dr. Birdwood has truly said:—"Europe has still to learn to taste of some of that content and happiness in life which is to be still found in the pagan East." Surely there is danger in disturbing such a social equilibrium. **Arya.**

[74855.]—**Thames Steamboats.**—I hope the following particulars (some of which I have only just obtained) are in time to be of use to the querist. The *Clacton Belle* was built in 1890, and is 250ft. by 26ft. 6in. She has two navy boilers working under forced draught up to 110lb. Engines diagonal compound surface condensing, cylinders about 28in. and 52in. by 60in., working at about 50 revs. per minute. The *Lord of the Isles* was built in 1877, and had new boilers about 1885. She is 246ft. by 24ft., and has two haystack boilers with four furnaces each, working pressure about 45lb. Engines diagonal oscillating, cylinders 46in. by 66in. **London River.**

[75000.]—**American Organ.**—I note the remarks made on p. 115 to this query, and also to another query of the same title on p. 116. The remarks about springs are on a par with those about filing reeds. Proper American-organ pallet springs can be bought, as I stated before, at a shilling a set, and if more than one set of springs are used, the touch is bound to be somewhat heavy; but if the pallets bed well over the mortise-holes, one spring to each pallet will suffice, and there is no need to use any other kind of pallet-springs than those that can be purchased at a shilling a set. With regard to the matter of filing reeds to pitch, how can the reeds be filed to pitch without filing off the milling? Unless the smaller reeds of the 4ft. treble are filed down to the right thickness, the reeds will not speak well. Has my critic ever seen a reed after it has been voiced and tuned? If not, he can buy a whole set of reeds voiced and tuned for 10s. 6d., and will then be convinced of the truth of my statement. **Practical Organ Builder.**

[75050.]—**G.E.R. Engines.**—In reply to "G.," I beg to send a sketch of No. 771, and the following particulars of the new class of "single" express locomotives on the Great Eastern Railway. Principal dimensions: The cylinders are 18in. diam. by 24in. stroke; steam ports 1ft. 3in. by 1⅜in.; exhaust ports 1ft. 3in. by 3¼in.; the centres of the cylinders are 2ft. apart; the piston rods are 3in. diam; one slide-bar for each cross-head above piston rods; the ordinary link motion is used, and the slide valves are placed below the cylinders; the driving wheels (single) are 7ft. diam.; the leading and trailing wheels are 4ft. diam.; the leading wheels have outside and inside bearings, the driving and trailing wheels inside bearings only; the wheel base is 16ft. 6in.; the centres of leading and driving wheels are 7ft. 9in. apart, and centres of driving and trailing 8ft. 9in.; the distance between the frames is 4ft. 1⅜in.; the boiler is constructed of steel, the plates are ½in. thick; length of barrel 10ft., diam. 4ft. 3in. (inside); centre from rails 7ft. 6in.; the firebox casing is 6ft. long, 4ft. 0½in. wide at bottom, and 7ft. in height. The



firebox (copper) is 5ft. $3\frac{7}{8}$in. long (inside) at bottom, 3ft. $4\frac{1}{2}$in. wide (inside) at bottom, and 5ft. $7\frac{1}{2}$in. in depth. There are 256 brass tubes 10ft. 4in. long between tube-plates and $1\frac{3}{8}$ diam. (outside). Heating surface of tubes, 1124·96sq.ft.; heating surface of firebox, 105·5sq.ft.; total, 1230·46sq.ft. The grate area is 17·9sq.ft. The engines weigh, when empty, 36tons 15cwt. 1qr. On leading wheels, 12tons 5cwt.; on driving wheels, 14tons 15cwt. 1qr.; on trailing wheels, 9tons 15cwt. Weight when in working order, 40tons 3cwt. 2qr. On leading wheels, 13tons 5cwt. 2qr.; on driving wheels, 16tons 2cwt. 2qr.; on trailing wheels, 10tons 15cwt. 2qr. The top of the funnel is 12ft. 11in. from rails. The engines are fitted with the Gresham sand-blast, and their boilers are fed by two No. 8 Gresham and Craven's injectors. The first locomotive of this class was built in 1889, No. 789. It is slightly different to the new ones in appearance—viz., the steam domes are now placed close to the funnel, the sand-boxes are fitted on the side of the driving-wheel splashers, and the brake blocks are placed in front instead of behind the driving-wheels. The tenders of these locomotives are of the usual G.E. type. The six wheels are 4ft. diameter. Centre of first pair to second 6ft. 6in., and centre of second to third 5ft. 6in. Length of tender frames 18ft. 3in. Capacity of tank 2,755 gallons. Weight, empty, 16tons 6cwt. 2qrs; weight full, 32tons 18cwt. 3qrs. I am unable to give dimensions of the new 5ft. 8in. 4-coupled tender engines.

JAMES F. VICKERY.

[75079.]—**Silvering Glass.**—The replies of "R. S. P." and Clark and Montigue in No. 1379 afford what is too common—minute details for part of the process, and no details for other parts. Will "R. S. P." kindly define the strength of his "perfectly pure solution of silver nitrate," and "ammonia solution"? and your other correspondents, in like manner, state the strengths respectively of their "caustic soda solution," "water and KHO," and why their caution, "Do not use too much copper," after defining its exact weight to the third decimal in grammes? D. J. R.

[75120.]—**Harmony.**—I am much obliged to the various correspondents who have so kindly answered my query, and more particularly to Mr. D. G. Jones are my thanks due, for I have learned more from his lucid reply than from the perusal of any treatise on harmony that I have yet seen. I am quite aware that there is no short-cut to the knowledge of harmony, but I must say that I think that a simpler method might be used for teaching it than is the case at present. The works on this subject are not practical enough, and I am at a loss to see how the theory taught by them can be put into practice. I find that, as our able correspondent says, with three chords—viz., that of the tonic, the dominant, and sub-dominant, I am able to add the accompaniment to simple songs in a major key, and by flattening the third of tonic I can harmonise in the minor. But I can only find which are the right chords to play by ear. Surely there should be some rule to guide one in the choice of the chords, and in the order in which they should be played. I am told that another chord is useful for key of C—viz., F sharp, C, D, and F sharp; but what its relation to the other three chords is I do not quite understand, nor have I discovered when to use it. I should also like to know when all the notes of the chord should be played all together, as in last bar of example given by Mr. Jones, and when in triplets, as in the other bars. I shall be pleased to avail myself of Mr. Jones's offer, and will advertise my address next week.

DO RE MI.

[75122.]—**Epilepsy.**—The theory and basis (and what led up to the discovery, elaboration, &c., of the same by the illustrious Hahnemann), of homœopathy, is required to be examined and studied before its materia medica can be appreciated, or even understood. Either of the publishers of British homœopathic works—Gould, 59, Moorgate-street, E.C., or Leath, 5, St. Paul's-churchyard, E.C.—would inform the two querists as to what are the books best calculated for the above end. The "Cyclopædia of Drug Pathogenesy," edited by Dr. Hughes, of Brighton, and Dr. Dake, of America—i.e., "The Materia Medica of the Future," issued by the British Homœopathic Society, is obtainable from Messrs. Gould, the publishers, and contains, amongst several hundreds of other drugs, the best description of the pathogenetic actions of bromine and of its salts; but as £3 3s. may deter some querists from purchasing it, this work can, I conclude, be perused at the British Museum; while the courteous secretary of the Great Ormond-street Hospital would, no doubt, oblige Mr. Stanley and other querists with admission for the above object into the hospital's library. Upon the receipt of a letter from him, giving therein evidence that he (Mr. Stanley) has studied the subject of homœopathy, then I will reply to any questions he may think fit to put, and by post. The following may serve as an inducement for the study of homœopathy to many of the younger readers of "Ours":—In the summer of 1866 I was residing on the northern border of the Forest of Dean, on the edge of Guy's Hospital Estates, the sole management of which was, early in the present century, vested in the hands of a Hereford lawyer, one of my ancestors. My medical *penchant* soon become known amongst the villagers, one of whom, a small freeholder, asked me to come and see his wife (55), who was seriously ill. I found her set up in bed, and writhing in great agony: the room was full of young women, which prevented me asking several questions (I was young and sensitive then); but her agony, the state of her pulse, dry heat of hand (just like a hot brick), flushed face, rapid full pulse, laboured rapid breathing, staring wild aspect, &c., was sufficient to indicate *à la materia medica de la homœopathie* by causative (and, therefore, curative) actions. Aconite, as the remedy, two or three drops of which, each containing $\frac{1}{10000}$th part of a drop of the crude tincture, I added to a teacup of water, well mixed it, gave her a teaspoonful dose, and directed her to be given a teaspoonful every ten minutes until relieved. I then left the house, promising to come again when sent for, and thought no more about the case. I afterwards found that before I had gone out of sight she had filled two small chamber utensils with urine, all passing or voiding of which had been stopped some days, hence her agony and other symptoms, all of which were due to tincture of digitalis, which she had received for so-called heart-disease at Hereford Infirmary some days previously. Now upon reference to the "Cyclopædia of Drug Pathogenesy" Digitalis will be seen to stand prominently forward in its actions on the urinary sphere, and just as illustrated in this poor woman's condition. Then upon reference therein to aconite, this drug also acts on the same sphere; but it also antidotes those self-same morbific results of digitalis, hence its (aconite's) marvellous almost instantaneous curative success in the present instance, in which the *totality* only of the objective (i.e., what I saw) symptoms gave me the clue to the remedy. In the September issue of the *Homœopathic World* (6d., obtainable at Gould's, Leath's, &c.), the article "Homœopathy: its Principles and Law Treated from the Scientific Point of View" may enable the laity of "Ours" generally the better to understand and to appreciate the significance as to drug action of the above recital. (I hope this may close the epilepsy item.)

THE LYDNEY DISPENSER.

[75126.]—**Locomotive Bed-plate.**—Will not the diagrams given by "J. H." suit this querist, or what special feature does he require? He can easily scale out what he requires from the numerous diagrams given in the volumes issued in the last four years' say. NEMO.

[75127.]—**Casting in Cuttle Fish.**—Metal is purified by melting in a cupel of bone-ash or cuttle-fish, but gold rings, brooches, &c., are cast in moulds of plaster of Paris or of iron. T. L. C.

[75132.]—**Upright Writing.**—Any penman, with the exercise of a little determination, can write an upright hand, or one sloping backwards or forwards, without altering the position of his hand on the paper. Much nonsense has recently been written about upright caligraphy, as if there were any importance in the exact position of the body. The person writing should do so "at ease"—that is all that is required; but he should write plainly, especially his signature. NUN. DOR.

[75133.]—**Terrestrial Eyepiece.**—I think there is much information on this subject in back volumes, and perhaps the somewhat similar query on same page may lead to a reply suitable to the inquirer. If not, an optical instrument-maker could supply him with the eyepiece for very much less than he could possibly make it. H. G.

[75139.]—**Triple-Expansion Engines.**—"Don Cesar" asks what amount of power is lost through back-pressure in a triple-expansion engine. The answer is, None at all. It might be worked out by some so that it could be "proved" the engine gave no power at all, which was one of the stumbling-blocks when the "simple compound" was introduced. L. M.

[75141.]—**Self-righting Lifeboat.**—I suppose that Greathead, of South Shields, has the best claim to the invention of the self-righting lifeboat in 1789, especially as he received a grant from Parliament and sundry testimonials.

NUN. DOR.

[75144.]—**Gilding on Glass.**—The best way is probably to use gold size and apply the leaf when the size is tacky; but is it necessary to burnish the leaf? Will it not do to apply it to the back of the glass? At any rate, there are several methods described in back volumes, and necessarily much depends on the skill of the operator. T. L.

[75152.]—**Gas-Engine.**—Something depends on the quality of the gas, but as a rule one of gas to nine of air does. Exploded gas is of no use except as a diluent. R.

[75155.]—**Solder.**—Querist asks whether bottle capsules are pure tin. They are more nearly pure lead, but mixed with tin will, no doubt, make very good solder—that is, if cleaned from the colouring often placed on them, which would, however, most likely be burned off in the melting. NUN. DOR.

[75158.]—**Incubators.**—I shall probably send in a few letters on the construction of incubators before long, as I find those numbers of the "E. M." which contain descriptions are out of print; but there is no hurry, as it won't do to hatch the chicks much before January. INCUBANS.

[75168.]—**Oil Test.**—The rough and ready test as to the lubricating qualities of oil is to place a little in a phial and invert the bottle, taking note of the time the oil occupies in running down the sides to join the bulk. If the film falls quickly it is a thin oil, though it may be very suitable for such work as you require. The "test" is Prof. Thurston's, in which a spindle is weighted and run in bearings, notes being taken of the temperature. I am not sure, but I think Bailey and Co., of Salford, make an oil-tester of the kind which is very useful to those who have much machinery.

NUN. DOR.

[75239.]—**Astro. Telescopes.**—Many thanks to A. Gadd and "F.R.A.S." for their kind replies. I had already tried Berthon's method of measuring the power on the Gregorian, and made it 128, which agrees almost exactly with the calculated power by the methods given. I was a little out in my measurements, as suggested by Mr. Gadd, but this only slightly affected the result. H. WAKE.

[75254.]—**Space of Four Dimensions.**—I "Har" has access to periodical literature, he wil find much information on this subject in an articl on "Imaginary Geometry and the Truth o Axioms," in the *Fortnightly Review*, Aug. 1, 1874 by G. H. Lewes; also in his book, "Problems o Life and Mind," the article being a discussio which treats of original writings by Helmholtz Jevons, and others, the former eminent philosophe writing in *The Academy*, Vol. i. p. 128, and Vol. iii p. 52, and the others in *Nature*, Vol. iv. p. 481, an Vol. i. p. 238, and Vol. v. p. 202. The works o Lobatschewsky have been translated into French b M. Houël. VEHMGERICHT.

[75265.]—**Piano Pedals.**—If the querist will l me know the kind of pedal action he wants—whether a separate combination or simply pedal on keys—I will at once send a description of on plan for the benefit of those of the readers o "Ours" who are interested in the subject.

PRACTICAL ORGAN BUILDER.

[75269.]—**Harmonium.**—The American har monium reeds mentioned are simply American organ reeds with holes drilled to receive screws and can be had from most dealers in organ fitting The couplers I use for harmoniums are also th ordinary American-organ octave couplers, sold at 5 Stubbins, near Manchester. SCHOFIELD.

[75273.]—**American Organ.**—Will "Organon" kindly say who is the maker of these splendidly finished reeds he speaks of? I am sure it woul be a great boon to tuners to know this! If the can be had, as he says, without requiring filing, o what use is it to employ tuners? "Organon" must be one of the Mahatma's tribe (p. 96) him self if he can get some of the higher notes of 4ft pitch to speak without filing them down. Als how is it that American-tuned reeds have th milling marks filed off? I would refer him to bac vols. of "E.M.," where "Elève" and Matthews advise this treatment. I am afraid that "Organon" is about half a century behind time when he advises making pallet-springs (query 75000, p. 71), as they certainly can be bought for 1s. per set, and good springs at that.

Stubbins, near Manchester. J. SCHOFIELD.

[75276.] — **Carbonising Wool.** — Am much obliged to "Sea-Side" for his answer, and will be glad to receive full particulars, with cost, &c., in answer to my query, as I wish to try it, if not too expensive. FIBRE

[75315.]—**Small Self-starting Electro-motor.** —I have some of these; they will work with a single dry cell; they are used for clockwork.

E. R. DALE, A.I.E.E.

[75318.]—**Raising Water.**—"Waterloo" has omitted one most important item in the scanty data he gives—viz., whether his pond is supplied by a stream of water or not, for, unless it is, it is difficult to know how he will obtain motive power for raising water to his farmyard. It would be necessary also to know the quantity of water discharged by this stream in a given time, and what fall is available to work the water-wheel or turbine. I should think (always provided that there is a stream available) that he could not do better than put up an hydraulic ram. He will be able to get full particulars by writing to some of the makers of hydraulic machinery. I think that a "ram" would be more suitable than a water-wheel driving a pump, as probably it would cost less, and certainly would be less expensive to fix, and would require less attention. FOGHORN.

[75319.]—**Motion.**—On a plane or flat surface the two balls would reach the earth at the same instant; but on a level surface, like that of a calm lake, the projected ball would be the last to touch the earth. J. T. M.

[75319.]—**Motion — Errata.**—The formulæ I gave in my reply to this query (p. 117) have been very considerably misprinted. Perhaps the comp. will do better this time.

$$S = \tfrac{1}{2}gt^2$$

$$T = \sqrt{\frac{2\,S}{g}}$$

WM. JOHN GREY, F.C.S.,

Newcastle-on-Tyne. Analytical Chemist.

[75329.]—**Dental Composition.**—One kind is made by melting beeswax and stirring in plaster of Paris with sufficient bole to give a red colour. When cool the mass is ready for use, and may be softened in hot water, some of which is absorbed and causes the plaster to set. H. EBBAGE.

[75333.]—**Fishing Nets.**—Black catechu, commonly called cutch, is the material used for tanning fishing nets. It is soluble in boiling water.

H. EBBAGE.

[75333.]—**Fishing Nets.**—Only in India have I seen fishermen's nets made of cotton, being an abundant and cheap material, but very perishable. However, there are so many indigenous barks, berries, and roots of a glutinous and astringent nature, that the nets and lines are rendered fairly durable, and fish blood is also used by the sea-fishers for the same purpose. In England hemp has always been employed as the textile for net twines till recently; but "Irish flax" is now coming into use where lightness, strength, and durability are of importance. The wholesale price varies from 1s. 6d. to 3s. 8d. per lb. weight. The usual preparation as a preservative is decoction of oak bark, or catechu. Lately, when I was staying in the Hebrides, my "ghillie" (a Crofter fisherman) brought to my notice the tuberous roots of a prevalent weed employed in the island from time immemorial for the above purposes, and also in their rude herbalistic medicine. It appears to me rich in tannic acid, the requisite principle needful to their requirements. EOS.

[75337.] — **Dynamo (defective).** — To MR. BOTTONE. — Well made, this dynamo should magnetise steel as well, or better than, a battery. The reason of your little current is, too much wire on field-magnets; take off 2½lb., and then report results. S. BOTTONE.

[75340.]—**Chemical.**—As two molecules or 168 grains of sodium bicarbonate are neutralised by one molecule or 150 grains of tartaric acid, and evolve two molecules or 88 grains of carbonic acid gas, it follows that 1oz. or 437·5 grains of the bicarbonate will require 390·5 of tartaric acid, and yield 229·2 grains of CO_2. A pint of this gas at 30in. bar. and 60° Fahr. weighs 16·36 grains; therefore 299·2 grains will measure 13·4 pints. J. T. M.

[75341.]—**Battery for Incandescing Wire.** —To MR. BOTTONE.—For short experiments, at long intervals, the battery (chromic acid) is the better. If the effects are required frequently, the dynamo is more suitable, as it would be always ready, and avoid the mess and trouble of mounting and dismounting. A full description of the way of making such a dynamo, will be found in the ENGLISH MECHANIC for 1883, under the heading of "The Dynamo: How Made and How Used," or if you cannot refer to back numbers, see my advertisement in Sale Column. The only difference in make, to suit your case, is to wind the armature and field magnets throughout with No. 12, and couple up in shunt instead of series. S. BOTTONE.

[75343.]—**Induction Coil.**—Have a core 13in. long, 1in. diameter, of No. 18 soft iron wire. Primary, two layers No. 16. The best kind of battery is six cells, quart size, chromic acid. Leclanchés are no good for coil work. Condenser, 150 sheets of tinfoil interleaved with paraffined bank-post, sheets 6in. by 8in. S. BOTTONE.

[75344.]—**Electrical.**—Four layers too many; No. 16 too large. Use two layers No. 20.

S. BOTTONE.

[75358.]—**Testing Manganese.**—You must get a chemist to do this for you. The usual way is to dissolve in hydrochloric acid and estimate the amount of chlorine expelled. SM.

[75360.]—**Gilding Solution.**—Proportion of cyanide about right. You will get the best results with about 18 grains of fine gold to the pint of solution. You can use your Daniell cells connected for quantity; but a weakly-charged Bunsen is the best for gilding.

Brighton. T. C. SMITH.

[75361.] — **Series-wound Dynamo.** — The resistance of armature coils should bear to that of the F.M. coils the same proportion as 1 to ⅔. Hence the resistance of 130 yards of No. 20 being, say, 2·68 ohms, that of the field-magnets should be 1·78 ohm. Now, three strands each 60 yards in length would have a resistance of only $\frac{60}{3}$ yards, or ·403 ohm. This would be at least four times too small, besides not giving sufficient ampère-turns. Two strands of No. 20, each 170 yards in length, would do it very nearly exactly, since the resistance of 170 yards No. 20 = 3·48, and half this (the wire being doubled) is 1·74 ohm. For the sake of neatness, you might lay 85 yards on each magnet of single wire, and then couple up both limbs in parallel. S. BOTTONE.

[75362.]—**Accumulators.**—To MR. BOTTONE.— Assuming that the lights are to be kept going when the dynamo, through any cause, fails to give the due amount of current, the number of cells must be such as to give the voltage required by the lamps. Hence the number must be the same as though the lamps were fed exclusively from the cells. It is no disadvantage to use lamps of high voltage, because they take proportionately less current in ampères; so that exactly the same number of cells (arranged in parallel to give the larger ampèrage) would be needed to run the low-voltage lamps.

S. BOTTONE.

[75364.]—**Covering Copper Strips with Indiarubber**—is best done by painting with a solution made by dissolving pure rubber in carbon bisulphide.

Brighton. T. C. SMITH.

[75365.]—**Tractive Resistance on Inclines.** —The power needed to move a weight up an inclined plane is proportional to the sine of the angle of inclination, which sine is equal to the height of the plane divided by its length. To put this in another way, let h = height of plane, l = length, w = weight, and p = power; then $l : h :: w : p$. In small gradients we may assume without sensible error that the length of the plane is equal to the base (b), and we get—$b : h :: w : p$. Thus, for a rise of 1 in 100 the extra pull due to the incline is 22·4 per ton, which is a considerable addition to the ordinary train resistance, even at a high speed. Hence engines usually feel banks very severely, a small rise making a very great difference in the speed. The following equation may perhaps be interesting to the querist:—Let W = weight of train (including engine) in tons, v = velocity of train in miles per hour, m = gradient, and P = horse-power of locomotive; then—

$$\frac{12{,}0284\,Wv + 88\,Wv^3}{3{,}762{,}000} + \frac{197{,}120\,Wv}{33{,}000\,m} = P$$

From this formula v can be calculated when the other quantities are known. Of course, if the pull needed be greater than the adhesion of the engine to the rails, the train cannot climb the ascent. There is a tolerably steep incline from the N. E. R. railway shops at Gateshead, down to the old Carlisle line. It is now used as a coal-line, and it is very interesting to watch three engines getting a coal-train up the incline. A small stretch of the imagination would enable one to fancy that the locomotives had some consciousness of the great exertions they were making.

WM. JOHN GREY, F.C.S.,

Newcastle-on-Tyne. Analytical Chemist.

[75367.] — **Slotting Metal.**—Slotting cutters, used for slotting fine screw-heads, &c., would answer your purpose. A cutter $\frac{1}{20}$in. thick can be obtained (finer still, if desired) and mounted on an arbor, and run between centres, and the work fed up to it by hand or by slide-rest. S. H. C.

[75369.]—**Brazing and Soldering.**—You can get ample temperature by the use of a blowpipe. Whether you get sufficient heat depends upon the magnitude of the work. SM.

[75369.]—**Brazing and Soldering**—can be done with a good gas blowpipe. Few other tools are required except a foot-blower, charcoal or coke (according to size of work), and a few pairs of tongs. You can get all hints you want from back numbers of the "E.M."

Brighton. T. C. SMITH.

[75369.]—**Brazing and Soldering.**—A few tools will be required, also a little material to work with; a good, stout copper bit, some killed spirit, which is muriatic acid with zinc added in small pieces until it will take no more, and some solder. For brazing on a small scale, a blowpipe, charcoal block, and some powdered borax, also some granulated brass. If you get a small forge, you would be able to braze on a larger scale, as you have already got the gas. E. J. W.

[75369.] — **Brazing and Soldering.** — "S. R. H." gives no idea as to what sort of work he intends soldering; but assuming it to be all kinds, perhaps the following hints gleaned from experience will be of some use to him. As to tools, they are not very numerous; for soft soldering two or three copper bits will be required—one large one for thick work, and one or two small ones for small work; also a spirit brush, which is made out of a tube, with some bristles squeezed in one end, or a piece of cane hammered out at one end answers very well; a jam-jar to contain chloride of zinc, and small bottle with large neck to contain rosin dissolved in spirits of wine. For soldering bright brass-work, which would be discoloured with the chloride of zinc or spirits, the heat necessary for soldering or brazing small articles can be obtained with a blowpipe, but for large work a hearth is best. A blowpipe is used only where a very neat joint is wanted, in such as the bottom of a small tube, or when two pieces of metal are to be united and a soldering-iron would knock them out of place. The spirits are made by dropping into a jar containing hydrocloric acid some pieces of scrap zinc, until all chemical action ceases, when it is diluted with half water. This is used as a flux for soldering tin, copper, brass, and iron. The iron should be pickled, or rubbed over with the neat acid first; and cast iron should be first tinned, using salammoniac as a flux, before the solder will stick to the iron. To solder zinc, use neat acid as a flux. Where a strong joint is wanted in brass, copper, or iron, then it is brazed, which is done in the following manner:—The two joints are firmly bound with iron wire or dovetailed together, then some powdered borax is mixed with water to form a paste, into which is mixed some brass filings, and applied to the joint, and the whole is heated until the brass flows; but in the case of a dovetailed joint it will not require to be bound with iron wire, but may be bound with brass, which will flow into the joint on being heated. To braze brass as above, spelter or silver solder must be used instead of brass, which can be got at most metal warehouses. To make neat joints with soft solder, the iron must be nicely tinned and kept so, which may be done by dipping into the spirits each time of drawing from fire; also, all joints should be thoroughly cleaned by being scraped, and the best scraper for the purpose is made out of a triangular file being ground to a point on its three edges, a tool with which as a fitter you may be familiar. Any other information you may require, I shall be pleased to give.

H. ROBINSON.

[75371.]—**Gas-Furnace Casing.**—Fireclay or fireclay mixed with asbestos fibre.

Brighton. T. C. SMITH.

[75372.]—**Fireclay.**—Mix with water, and use as soon as convenient. It won't "set" like plaster or cement, but should be carefully dried, as it shrinks, and is liable to crack.

Brighton. T. C. SMITH.

[75372.]—**Fireclay.**—I have been using this material for many years, and find that to allow it to soak for a few hours before using it—say, put it in soak over night and use next morning—by doing this, it stands against the heat longer than if used immediately it is mixed. E. J. W.

[75373.]—**Moulding Gas-Carbon.**—Mix with treacle, press into shapes required, and bake.

Brighton. T. C. SMITH.

[75373.]—**Moulding Gas-Carbon.**—The best carbons are cut out of the "retort scurf" itself. Moulded carbons are made by mixing the powdered graphite with sufficient tar or syrup to make a stiff paste, compressing in moulds under a pressure of two or three tons to the square inch, baking at a bright red heat in close vessels, again soaking in syrup, again baking, and so on, until the desired compactness and hardness have been attained.

S. BOTTONE.

[75373.]—**Moulding Gas-Carbon.**—Mix with ¼ ground wood charcoal. Make into a paste with treacle or tar. Inclose tightly in a mould, and heat to redness under a layer of sand. Sm.

[75377.]—**Blower for Gas Generator.**—The easiest possible way of filling the holder is your present one—to draw it up. If the stoppage is an objection, have a second holder to go on working whilst the first is pulled up. Any mechanical blower will require more labour to produce the same effect. 999.

[75378.] -**Dynamo.**—Yes; provided you do not reach the saturation point of the field magnets. S. Bottone.

[75379.]—**Accumulators.**—The best I have seen yet is one recently patented by Sillery, of Wrexham. Staffs.

[75379.]—**Accumulators.**—1. The E.P.S. 2. The method of making and the composition of the paste is fully given in my book, "Electrical Instrument-Making for Amateurs," the only difference being that the plates are cast with perforations in them. Each square foot of positive lead surface in a cell will give six ampère hours. Hence, a cell having seven positive plates in it (not counting the negatives) will give 42 ampère hours. S. Bottone.

[75379.]—**Accumulators.**—The latest type consists of the E.P.S. plates; but you cannot make these, since they are covered by a patent. Essentially, accumulator plates consist of perforated lead, spread with a paste of red lead and sulphuric acid. The time the plates retain their charge will depend on the care bestowed on the insulation of the cells when constructing. Instructions for making these cells have been given so frequently that I must refer to back numbers for further information. F. Askew.

[75380.]—**Microphone.**—On page 77 of the present volume of the "E.M.," Mr. Allsop gave an admirable description of a microphone, and to this I should advise you to refer. A diaphragm with granule carbon between ferrotype plates is covered by the "Hunnings" patent. F. Askew.

[75381.]—**Electric-Light Economy.**—Direct from dynamo, of course. Sm.

[75381.] — **Electric Light Economy.** — A certain amount of energy is lost with all accumulators, which varies with the efficiency of the cells; it is therefore cheaper to light direct from dynamo.
Brighton. T. C. Smith.

[75381.]—**Electric-Light Economy.** — Much cheaper to light direct. The use of the accumulator is to steady the light. This can also be done by having a heavy balance-wheel on shaft of dynamo. The accumulator is also convenient when the light is wanted at times when the engine is not running. S. Bottone.

[75381.]—**Electric-Light Economy.**—By accumulators you lose a certain percentage of power; but this is generally more than counterbalanced by steadiness of light, lengthened life of lamps, &c.; but, again, accumulators are costly in the first place. If you have an engine with sensitive governors, you may drive direct; but gas-engines seldom run steady enough for this, and therefore you will, no doubt, find it better to charge accumulators, even if you do lose power. F. Askew.

[75382.] — **Constant Battery.** — "Sufferer" desires an impossibility. He cannot get a powerful current with no wear of elements. Sm.

[75382.] — **Constant Battery.** — Bunsens or bichromates are a trouble to keep in order, the elements having to be raised from the liquid after use, while the former cells have to be taken to pieces and washed after every application. You would find Leclanchés answer your purpose better than any, these requiring no attention for at least a year. To regulate the current, you could arrange a varying resistance, or, better still, a cell selector, by which you could obtain current from 5, 10, 15, 20, or 25 cells if this latter be the total number of cells employed. F. Askew.

[75386.]—**Electric Sores.**—The sores on the body are not caused by electricity at all, there being so little as to be inappreciable; they are due to the irritant effects of the metallic salts. The copper specially is injurious to some skins. I have a neighbour of mine, who wore a much-advertised and be-puffed belt, that had six large open wounds under the six copper discs. S. Bottone.

[75386.]—**Sores caused by Electric Belts.**—Unless a belt consists of a dry compress, it always has the above disadvantage. I have little faith in these appliances myself, and until it can be proved to me that a current flows through the affected part and can act on the "tissues," I never shall believe that any real benefit can thereby be derived. F. Askew.

[75387.]—**Electro-Plating.**—The addition of sulphuric acid to a solution of mercuric nitrate has given a precipitate of mercury sulphate. The action of zinc has precipitated metallic mercury in a state of fine division. There is nothing wrong in this. It is all according to chemical laws; but what connection there is between these phenomena and electro-plating I fail to see. Sm.

[75387.]—**Electro-Plating.**—The best quicking solution is made as follows:—For each gallon of solution dissolve 1oz. of mercury in nitric acid; after it is dissolved add a small quantity of water and precipitate with cyanide; well wash and drain precipitate and dissolve with a strong solution of cyanide; a moderate excess of cyanide should then be added, and the water added to make one gallon for each ounce of mercury. I should strongly advise "D. H." to have nothing to do with "quick"; it is quite unnecessary if the work is properly prepared.
Brighton. T. C. Smith.

[75388.]—**Edison's Phonograph Motor.**—To Mr. Bottone.—This is fully described and illustrated in the "E.M." for Sept. 18. If you write to me privately, I can answer the trade questions: I may not in these pages. S. Bottone.

[75389.]—**Refining Gold.**—Your simplest way is to melt up the gold with some copper, about half its weight. Cast into an ingot, roll out into a ribbon, roll into a coil, and heat it with strongish nitric acid. The copper is dissolved and the gold is left. Melt the residue, and cast into a convenient shape. Sm.

[75389.]—**Refining Gold.**—Melt your gold with about equal weight of silver, granulate, and put in dilute nitric acid (1 acid, 2 water); apply gentle heat until there is no further chemical action. The fine gold will be found as a red mass at bottom of the vessel. It should be well washed with hot water, dried, and run into a button, when it may be rolled or cast into anode.
Brighton. T. C. Smith.

[75390.] — **Judson's Cell.** — Wash the cells thoroughly and charge with a solution of ammonium chloride, 1½oz. to 1 pint of water. F. Askew.

[75390.]—**Judson's Cell.** — Begin by soaking your cell for several days in clean water to remove every particle of soluble saline matter. Dry carefully in a gentle oven. Melt off the lead collar by means of a blowpipe flame. Cast a fresh collar on. Paint the outside with several layers of pitch. Fill in the sides of the perforated carbon plates (if there are any) with small lumps of manganese dioxide. If there are none, envelop your zinc in a bit of canvas, and pack the dioxide, mixed with crushed carbon, in the cell, between the carbon cylinder and zinc rod. Charge with the usual sal-ammoniac solution. S. Bottone.

[75392.]—**Fireworks.**—The following give good results: — Brilliant red fire: Strontium nitrate, 10oz.; potassium chlorate, 3oz.; pure sulphur, 2oz.; fine shellac, 1oz.; fine charcoal, ¼oz. Brilliant green fire: Barium nitrate, 12oz.; potassium chlorate, 5oz.; pure sulphur, 2oz.; fine shellac, 1oz.; mercurous chloride, 1oz.; fine charcoal, ¼oz. Amateur.

[75392.]—**Fireworks.**—Red fire: Clorate potash 10 parts by weight, nitrate strontian 80, sulphur 26, charcoal 6. Green fire: Sulphur 20, chlorate potash 33, nitrate baryta 80. All to be dried and finely powdered. Of course you know they must not be ground in a mortar together, lest you get an explosion. Mix after they are ground. Staffs.

[75392]—**Fireworks.**—The following will be found good colours if used in cases 1½in. diameter. Mix well and keep dry. Bright red:—Strontia nitrate 4½oz., potassium chlorate 1oz., pure sulphur 1oz., fine shellac ½oz., fine charcoal 1dr. Rich green:—Barium nitrate 5oz., potassium chlorate 1½oz., pure sulphur 1oz , fine shellac ½oz., mercurous chloride ½oz., fine charcoal ¼oz. Rocket.

[75392.]—**Fireworks.**—There are several formula for green fire. If the fire be intended to illuminate buildings, the colour should be of a rich tint; and on the other hand, when for lighting up trees and avenues, the depth of colour can be slightly sacrificed so as to give place to a greater intensity of illuminating power. The foliage of the surrounding scene supplying any deficiency in colour effect if the place be well illuminated. The richer the fire the greater the expense. You must also remember that what you gain in intensity of colour you lose in illuminating power. I give you three compositions, leaving it with you to judge which will suit your purpose best:—Pale green: Barium nitrate 8oz., potassium chlorate 3oz., pure sulphur 1½oz., fine shellac ½oz., realgar ¼oz., fine charcoal ¼oz. Brilliant green: Barium nitrate 12oz., potassium chlorate 3oz., pure sulphur 2oz., fine shellac 1oz., mercurous chloride 1oz., fine charcoal ½oz. Rich green: Barium nitrate 16oz., potassium chlorate 5oz., pure sulphur 3oz., barium chlorate, 2oz., mercurous chloride 2oz., fine shellac 1oz., fine charcoal ½oz. "B. B. C. A." will doubtless understand that the success or failure of these formulæ depends on the fineness and dryness of the ingredients, and the perfect incorporation and the purity of the chemicals employed. These fires are, of course, fired from cases, and should be held in an almost horizontal position. Yadrewolfe.

[75399.]—**Defective Dynamo.**—To Mr. Bottone.—Perhaps you are driving the wrong way about. I cannot tell what is wrong from your meagre description. Can you send it to me, carriage paid? I will examine it, and tell you what is amiss with it.
Wallington, Surrey. S. Bottone.

[75401.]—**Bunsen Burner.**—One of Fletcher's boiling burners will, I should think, answer your purpose, and be cheaper than your own manufacture. Sm.

[75402.]—**Harvest Moon.**—For the purpose of explaining the peculiarities of the above, we may premise that the monthly path of the moon in its orbit is identical with the apparent yearly course of the sun called the Ecliptic. But as the moon describes one circuit in its orbit in less than a month, and the sun takes a year, any peculiarity caused by their rate of motion will be 12 times greater in the moon than in the sun. The moon's motion in its orbit is not in the plane of the earth's equator, but inclined 23½° to it; so that for half of a lunation the moon is above, or north of the equator, and south, or below, for the other half, and twice during the month it crosses the equator. When it is on the equator, the daily rotation of the earth on its axis causes the moon to be half of its day above and half below the horizon. That is, there is equal lunar day and night, just as there is equal solar day and night when the sun is on the equator, which it is twice in the year: at the vernal and autumnal equinoxes. Now at the vernal equinox, when the sun is travelling north, it rises 2½min. earlier, and sets 2½min. later each day, the rising and setting being at the equinox, due east and west; but as summer approaches, the rising and setting take place further and further north, till on the 21st of June little more than one-fourth of the sun's apparent daily path is below the horizon. Now in the case of the moon on its ascending node, as the point of its orbit is called where it crosses the equator going north, what was 2½min. in the sun becomes over 30min. in the moon, on account of its much greater apparent velocity; so that any given point on its orbit will rise 30min. sooner on each successive night; but as the moon does not reach that point till 50min. later, it really rises 20min. later, instead of the average 50½min. This happens every lunation, but we only notice it when the moon is conspicuous, as it is when full, and as to be full it must be opposite to the sun, it must be when the sun is also on the equator, which happens about the 23rd of Sept. Therefore the moon that is full nearest to Sept. 23 is the one that rises most nearly at the same time on consecutive nights. I have used approximations and round numbers as being sufficient in such an explanation, but perhaps I had better state that the moon's orbit is inclined 5° 8′ on an average to the Ecliptic, so that its inclination to the equator may be as much as 28° or as little as 18½°. Also, I have spoken of the moon as rising at regular intervals from day to day, whereas it is continually varying, the interval being least at its ascending node, where it may be as little as 17min., and greatest when in the sign of Libra at its descending node, where it may be about 1h. 17min. Of course, "A F. C." will see that the 50½min. alluded to above is the average amount by which the lunar day is longer than the solar day; so that on the average the moon rises that much later each succeeding day. H. Wake.

[75403.]—**Lever Watch.**—I should say there is a jewel or end-stone cracked or broken; but it is impossible to say without seeing the watch.
Brighton. T. C. Smith.

[75403.]—**Lever Watch.**—The balance probably rubs on the cock, caused by its being out of flat, or the jewel endstone being broken, or the balance pivot having become short from wear. Horo.

[75403.]—**Lever Watch.**—This fault is easily detected if "Tom" takes a little time to find it out. 1. Take movement out of case and hold it in left hand, face up (watch going full swing before doing so). 2. Notice then if balance is rubbing on balance-cock (if balance is out of truth and too much end-shake, it is bound to rub); true balance if it is not in truth. Should balance be correct, examine cock jewel and endstone; it is possible that balance may be rubbing on cap, if there is a cap. Inverness.

[75403.]—**Lever Watch.**—"Tom" will have to get a new staff fitted in the balance of his lever watch. The reason of the watch rubbing and stopping in one position is evidently because one of the balance pivots is so worn down as to cause foul contacts between the roller and lever, or else the guard-pin. Sometimes the cause of stopping arises from insufficient force in the prime mover—i.e., the mainspring. A lever watch requires a stronger mainspring than a Geneva for two reasons—first, on account of the heavier balance; and, again, because the action of the 'scape-wheel on the balance is so indirect, being altogether through the medium of the pallet-piece.

SCHLOSS SCHWERIN.

[75404.]—**Microscopic Optics.**—The power of the eye lens = $\frac{10+f}{f}$, as before, and if power of objective is assumed to be a certain amount, then one multiplied by the other = power of microscope. But finding the power of each lens separately, and then multiplying together, will not give the correct result; because, for a simple microscope, the distance between the object and the lens should be greater than the latter's focal length, and in the single lens case this is not so. Perhaps an example will make my meaning clear. Suppose, f for objective = $\frac{1}{8}$in; f' for eye lens = 1in. Distance between object and lens = $f + \frac{1}{100}$in. = D; and d = distance between image formed by objective, and the lens itself.

Then $\frac{1}{d} = \frac{1}{D} - \frac{1}{f}$; or $d = -25{\cdot}5$in.

Now D : d : : size of object : size of image ∴ $\frac{d}{D}$ = M for object lens = 50 : 1. M' for eye lens = $\frac{1+f'}{f'} = \frac{10+1}{1} = 11$. ∴ Magnifying power of microscope = 50 × 11 = 550 : 1. If distance between the lenses is required, the same = about 26·4in. for this particular case.

A. GADD.

[75406.]—**Electrical Units.**—Let c = strength of circuit in absolute electro-magnetic units, r = radius of ring, then the strength of the field (f) at the centre is—

$$f = \frac{2\pi c}{r}$$

Taking the data as given,

$$f = \frac{2 \times 22 \times {\cdot}05}{2 \times 7} = \frac{1{\cdot}1}{7} = {\cdot}1571$$

The potential caused by a closed circuit at a point near it is equal to the solid angle (ω) subtended by the circuit at the point; multiplied by the strength of the current in absolute electro-magnetic units; that is,

$$V = \omega \times c.$$

Hence, in the case given,

$$V = {\cdot}0625 \times {\cdot}05 = {\cdot}003125.$$

This potential will be + or −, according to the side of the current taken. The question is from Silvanus Thompson's book. WM. JOHN GREY, F.C.S.,

Newcastle-on-Tyne. Analytical Chemist.

[75407.]—**Semi-incandescent Lamps and Sun Lamps.**—Both these are extremely wasteful. The Reynier lamps, in which the upper carbon bar is toothed, and descending by its own weight engages in a pinion which turns the carbon disc against which the upper carbon rests (somewhat laterally), will work with a current from a few Bunsens or chromic-acid cells, but it will also give very little light. One of Beaumont's 50-volt 1-ampère arc lamps will work well with 25 chromic-acid cells and give an excellent light—far better than either of the lamps you mention, and about five times as powerful as an incandescent lamp, taking the same battery to work it.

S. BOTTONE.

[75408.]—**Organ Light.**—The lamp illustrated on p. 92 is well suited for this—no heat, mess, smell, grease, or fire. If preferred, the battery can be placed on the floor.

Sherborne. E. R. DALE, A.I.E.E.

[75409.]—**Pump for Locomotive.**—Seeing that steam of 60lb. occupies 355 times the room of the water from which it was generated, and that the double strokes of the two cylinders of 2in. bore equal an area of 16 circular inches for each stroke of the pump, the area of plunger that would, without leakage or other loss, supply enough water to completely fill the cylinders with steam at 60lb. for the full stroke would be $\frac{16}{355}$ = ·045 circular inches. This, in a full-sized engine, would be sufficient, as steam is seldom admitted more than half the stroke. But allow one-third more for leakage, making ·06in. To give this area the plunger would need to be very nearly $\frac{1}{4}$in. diam., so the present pump is by no means too small. See that the clack-valve does not leak and allow the pump to get hot. If you have any difficulty in keeping the gland tight, try a drawn steel plunger: this can be kept tight with less friction. Stick to the long stroke, as the only advantage of a short one is the lessened area of frictional surface; but it is the reversing at the end of the stroke that absorbs power and wears the gearing. This has to be done against a greater resistance with a short thick plunger. Other proportions will do; except that the width of the seating of valves is too great—$\frac{1}{64}$ would do—as the pressure on them ought to be sufficient to chop a hair or similar obstruction in two; which, with the present width, it would not do, I fancy.

F. WAKE.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

74915. Copyright Music, p. 485.
74918. Stone or Buff Colouring on Brickwork, 485.
74919. Tempering Tools, 485.
74922. Turbine, 485.
74926. Gregorian Tones, 485.
74933. Medical, 486.
74942. Heel Ball, 486.
74945. Gear on Worm, 486.
74946. Fastening Covers of Creasote Tanks, 486.
74948. Trumpeter Clock, 486.
74953. Tie-Making Contrivance, 486.
74957. Opals, 486.

75140. Iron for Casting, p. 581.
75142. Working Model Figures, 581.
75146. Small Sucker, 581.
75151. Brass and Nickel Casting, 582.
75153. Steel Castings, 582.
75157. Textbooks in Mechanics, 582.
75161. Photographic, 582.

QUERIES.

[75410.]—**Xylophon.**—I should be glad if some correspondent would kindly give particulars for constructing a xylophon as played by the Tyrolese singers at the German Exhibition. Any suggestions as to materials required, dimensions, how tuned, &c., would oblige. Is this instrument easy to play, and are there any instruction books written for it?—FOGHORN.

[75411.]—**Weather Indicator.**—What is the chemical solution used for steeping the muslin skirt of the figure of a girl of these indicators? It is supposed to turn rose-coloured for rain, lilac for change, and blue for fine weather. The one I have is either rose-coloured or lilac, and so represents the weather we are having exactly; but I have never seen it turn blue, except when exposed to the sun.—FOGHORN.

[75412.]—**Burnt-wood Work.**—Will some reader of "Ours" kindly give me some instructions respecting burnt-wood work. At the German Exhibition there are some very pretty articles, such as picture frames, &c.; but I could get no information as to process or tools used. —FOGHORN.

[75413.]—**Sloyd Work.**—Would any correspondent give some information respecting Slöyd work (I am not sure whether I have spelled it correctly)? In the prospectus of a school of art I saw it was taught; but had not an opportunity of making inquiries on the spot.—FOGHORN.

[75414.]—**Pyrotechny.**—Is there any license required for making fireworks for pleasure (not profit), and is there any law against it? Also would someone kindly give a formulæ for a good red star?—ROCKET.

[75415.]—**Smokeless Coal.**—There was a chemical advertised some time ago for treating coal so as to deprive it of smoke when burning. Can any reader tell me if he has had any experience of it?—FUMES.

[75416.]—**Dynamo.**—Will some friend kindly tell me the cheapest and best way, and also about the cost, of making a dynamo to light workshop about 15ft. by 25ft.? —IRONMONGER.

[75417.]—**Phonograph.**—To W. GILLETT.—Will you kindly tell me if it would make a difference to the working of the motor if I make the yoke of $\frac{1}{4}$ square iron, and rivet pieces on to form the tunnel for the armature? Will single cotton-covered wire do for motor if soaked in paraffin wax, or would it take up too much space?—W. A. JENNER.

[75418.]—**Dust Fuel.**—Could any of your numerous readers give me the latest results of experiments in burning coal-dust fuel under Lancashire boilers, or any particulars with regard to pattern of firebars and apparatus used?—A. T.

[75419.]—**Asthma.**—Would some correspondent tell a young engineman what would be a good thing to carry with him in case an attack of asthma came on in the night when at work, as I am rather subject to it; also what to take as a preventive?—GRATEFUL.

[75420.]—**Motor for Boat.**—I have a small boat, 20ft. long, which I wish to rig as a launch. What is the best motor to put in, and the cheapest? The question of first cost is most important, and a motor using liquid fuel would be preferred.—WORCESTER.

[75421.]—**Dynamo.**—To MR. BOTTONE.—I have made a dynamo with a 4in. armature by 4½in. long. The commutator has twenty sections. The magnet cores are 4¼in. by 1½in. by 4in. high. How many layers of wire should I put on the armature and magnets, and what gauge? How many volts and ampères should I expect? I should like to use 16c.p. lamps worked in series.—F. BUXTON.

[75422.]—**Solar Motion in Space**—To "F.R.A.S." Kindly inform me what angle does the plane of the earth's orbit make with the plane of the solar motion in space?—ANXIOUS TO KNOW.

[75423.]—**Electric.**—A friend of mine asked me to look to his battery, as his door-bell would not ring. I found on taking out the zincs that they were incrusted with a rather hard, white substance. This I scraped off, and the bell now rings all right. Can anyone tell me the cause of this forming on the zinc, and how it can be prevented. The cells were No. 2 agglommerate Leclanchés, and had been in use about six months for one bell only.—LEUMAS.

[75424.]—**Plating.**—I have a quantity of old electroplated articles. Is there any process by which I can obtain the silver and clean the metal? Any description of apparatus, &c., will oblige.—ROSE.

[75425.]—**Coal-Dust Bricks.**—Some time ago I saw in a shop-window in a Yorkshire town, bricks, or more properly speaking, what appeared to be setts, made from coal-dust. I understand it is a composition of coal-dust, pitch, and other ingredients. Will any reader kindly tell me what are the component parts, and if it is a patent, and if so, who is the patentee and manufacturer? GEO. RILEY.

[75426.]—**Dynamo.**—I am perplexed, among the many forms of dynamo, what sort to make. I want a about 200c.p. one, and I am going to drive by a steam-engine, and I want the greatest current from the least consumption of steam. What electrical pressure, distance 50ft., is the most economical? What armature—ring, drum, or cog? What field magnets—Manchester, Edison-Hopkinson, or those like an inverted Edison? I see cog-ring armatures constantly recommended in the "E.M.," but in going through an electrical exhibition some time ago I could see only one cog-ring, the rest being ring and drum.—A. J. P.

[75427.]—**Pyrometer.**—I have charge of a gas-heated furnace. The material treated is inferior in quality if the heat is below a certain temperature, and our only method is the "rule of thumb" method of judging by colour. Could some of our readers help me with any hints as to a pyrometer of a simple kind. I have thought of an iron rod, one end exposed to interior of furnace, and the other against the mercury-bulb of an ordinary thermometer. The furnace is brick built, and heats wrought iron to a light-red heat.—PYRO.

[75428.]—**How to Make a Violin.**—In Mr. Pickering's second paper on the above, he gives an illustration of a "quarter" back (Fig. 14), showing joint and direction of wood figure. It is remarkable that all the backs of violins coming under my notice have the figure running the reverse way. Would Mr. Pickering kindly say if there is a reason for this variation beyond the matter of taste?—JOHN RAE.

[75429.]—**Electric Lighting.**—Will some kind reader tell me how I can light a small shop with two 8c.p. lamps, Edison and Swan, for about five or six hours; what number of cells and what fluids I shall require, and the cost of the fluids? I have the lamps. Full information how to light my shop will be of great help to— J. DRAPER.

[75430.]—**Overshot Water-wheel.**—Will a practical correspondent give the dimensions of overshot water-wheel that will lift 10ft. high, by endless strap and buckets, enough water to supply a ⅜in. or ½in. bore pipe? The supply-pipe is 1in. bore, with 2ft. pressure of water. —KNOWLEDGE IS POWER.

[75431.]—**Calculating Speeds.**—I am in the habit of fitting up all kinds of machinery, and have always to order the driving pulley of such a size as will run the machines a certain number of revolutions per minute. I always know the size and speed of the pulley upon the machine, and the speed of the shaft is easily arrived at. The dimensions of the driving pulley is the nut I have to crack. I have a method of working this out, and I generally arrive within a few revolutions of the correct number, but I am not satisfied with my method. I will therefore be obliged if any reader will give me the formula for finding this correctly, with a few examples worked out.—REENIGNE.

[75432.]—**Fusee of Spring Clock.**—I do not remember to have seen a drawing of a machine for rifling the fusee of a spring clock in "Ours." If such has been illustrated, will some reader kindly refer me to the volume, as I cannot find any reference in the indexes to the volumes which I have, dating back to 1874?—H. G.

[75433.]—**To Mr. Bottone or Others.**—I have an electro-magnetic machine which will not give a current. Will you kindly give me a few hints as to probable cause, and say how the wire on armature should be connected? The beginning of one coil is joined to the end of other coil. What is the proper position of other ends of wire.— E. L. M.

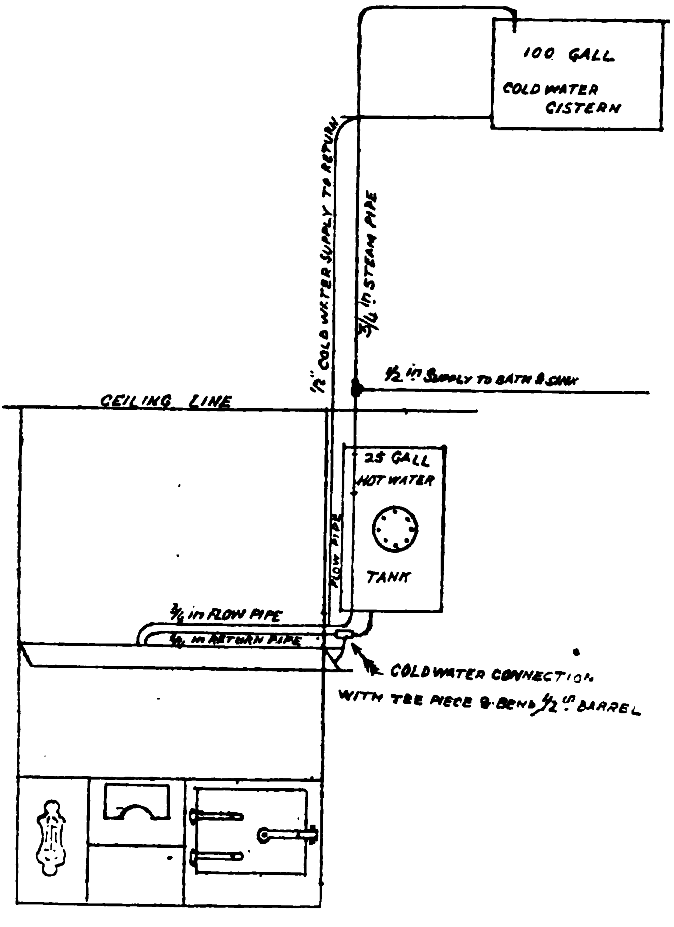
[75434.]—**Accumulator.**—Would Mr. Bottone kindly instruct me how to make an accumulator out of lead plates, and how to charge it to give a 5c.p. light when charged? Also another to light a 10c.p. incandescent lamp for about nine to ten hours, and how long will it keep charged if not touched?—A. LOCK.

[75435.]—**Phonograph.**—To MR. GILLETT.—Having noticed correction with regard to the length of the supporting column in a paragraph a few issues ago, I cut off ½in. as stated. Now the cutting-edge of the automatic turning tool rests upon the brass mandrel, while the screws of the adjusting stops at the bottom of the spectacle frame do not nearly touch the surface of the square brass on the front guide-rod even when screwed right down. In all other respects the instrument is absolutely correct. Kindly state what is wrong; also why, in determining position of pin in the slotted piece of brass screwed to the sliding tube, should you set the stylus only 1-16in. from surface of mandrel? Kindly say what to do in these cases, and oblige.—ONE IN A FIX.

[75436.]—**Nasik Squares.**—

15	8	19	24	35	10
34	21	23	7	12	14
2	22	27	29	13	18
31	11	9	4	20	36
3	25	32	30	16	5
26	33	1	17	6	28

Can any of your mathematical readers tell me how to make a nasik square of 36 cells, or prove that it is impossible to do so, as I suspect it is? In the above square all the 12 diagonals, the 6 rows and 4 of the columns add up to 111; but the second column makes 120, and the fifth 102. This is the nearest to a nasik square I can get.— ARITHMETIC.



[75437.]—**Hot Water.**—Can any kind reader of "E.M." inform me of cause and put me right with following, and rough sketch? I have taken out a 20-gallon hot-water tank and put in a 25-gallon one in place of same, and cannot get any water at bath or sink, but can get tank full, and no higher. Have blown out pipes, and find there is no stoppage anywhere. Cold water has been connected nearly a fortnight, and no water yet. The cold-water supply is connected to return pipe of boiler.—A Twelve Years' Subscriber.

[75438.]—**Small Lathe.**—To Mr. Bottone.—Please tell me if the electro-motor described in your book on electro-motors, pp. 25 to 33, would drive a small watchmaker's lathe, and how many chromic-acid cells I should want?—T. A.

[75439.]—**Screw-Cutting.**—Could any of our readers inform me if there is any standard depth for a V-thread, or what should be the proper size at the bottom of the thread of a ⅜ tap with a pitch of 24 threads per inch?—Fossil.

[75440.]—**Registering Earth's Magnetism.**—How are the daily irregularities of the earth's magnetism registered at different stations for comparison?—Magnetic.

[75441.]—**Sparking Dynamo.**—To Mr. Bottone.—Many thanks for your kind answer to my query, No. 75309. I am afraid, however, that the causes you give are not the true ones, as the machine is almost new, and made by a well-known professional dynamo manufacturer, so that this fact disposes of suggestions Nos. 1, 5, and 6. With regard to 2, 3, 4, and 7, I may say that the brushes are very carefully adjusted at the exact position, that they press at diametrically opposite points, that the commutator is faultlessly clean, and that I am certain there are no leakages, bad contacts, or earths in the outer circuit. Is it not a fact that all Manchester (or other type) machines, with consecutive poles and Pacinotti armatures, spark to a greater or less extent? Do you think that the very low resistance of 10-30 volt lamps in parallel (about 3 ohms), against 50 ohms in the F.M.'s and 1½ ohm in the A., accounts for the fault? Are you of opinion that lamps, say, of 55 volts would tend to improve matters, and do you think that carbon brushes will reduce the sparking, as they certainly do in some electro-motors?—Tyro.

[75442.]—**Enlarging Lantern.**—I want to make an enlarging lantern to be used in conjunction with my half-plate camera. Will some kind reader of "Ours" tell me how to proceed? I want one for use with a paraffin lamp. My camera R.R. lenses is 1 3-16in. diam. and 9in. focus. How large can I enlarge from a half-plate negative?—N. E. R.

[75443.]—**Air Pressure.**—Will an engineer used to the handling of air pressures give an answer to the following query? I am about to make an engine with double cylinders, each 2in. by 5in., the engine to run at 100 revolutions per minute. I want to know if I can use air pressure instead of steam to drive it? I propose to fix the engine permanently, and to supply it with air pressure taken from charged cylinders, similar to those used for forcing lager beer. Can this be done? If so, what size of air cylinder, and containing what pressure, must I use to drive engine for ten hours? the pressure cylinder to be renewed every ten hours.—Experimenter.

[75444.]—**Sulphuric Acid for Accumulators.**—This is supposed to be manufactured from pyrites, &c. Which is the best for battery work, and what is the test to know, if correct?—Nemo.

[75445.]—**Abyssinian Pump.**—Can any of your subscribers inform me whether an Abyssinian pump would answer if driven through strata, about 2ft. soil, and same of sand, partly quick, then into shaly gravel.—Abyssinian, Northallerton.

[75446.]—**Distilling.**—I am desirous of obtaining a distilling apparatus for distilling spirit from pure sugar, in quantities of 50 to 100 gallons of spirit per week, and am told that "Coffey's" still would answer the purpose. Will someone tell me—(1) Is this legal in Channel Islands; (2) size of still necessary; (3) quantity of water to ferment a given quantity of saccharine; (4) duty payable, if any, in the Islands? I know, of course, that it is not allowable in this country, and any hints will be obliging—Coffey.

[75447.]—**L. and N.W. New Compound Loco.**—I see they have just turned out of the shops at Crewe a new loco. of colossal size on eight wheels, placed as follows:—One pair of small wheels for leading end (radial axle); two pairs of 7ft. wheels under boilers. and another pair of small wheels under footplate. The boiler, I understand, is 18ft. long, and the engine weighs about 60 tons without tender. She is a handsome engine, and is the largest tender loco. I should think running in England. Can any of "ours" give me any further particulars of this fine engine, and what traffic she is intended for?—Chillington.

[75448.]—**Electrolysis.**—I shall feel obliged if any of "ours" will say if the gold and silver in a cyanide solution can be recovered by electrolysis, and if so, is it an expensive agent, or may it be adopted on the large scale? I have a notice of the Mœbius process beside me as carried out at Pinos Altos, Chihuahua, Mexico, in which it is said the gold and silver are electrolytically separated. The plant has a capacity of 3,500oz. to 4,000oz. of doré silver per 24 hours, with an expenditure of only 2½H.P. The solution, however, is a nitrate one.—S. D.

[75449.]—**Incandescent Lamp.**—Will Mr. Bottone or other readers please tell me whether I can mend my incandescent lamp, the platinum loop at the end being broken off level with the glass bulb?—R. S. V.

[75450.]—**Fire Balloon.**—Will any one kindly describe an easy way of making a small one?—J. B.

[75451.]—**Eyepiece.**—Would "F.R.A.S." be kind enough to tell me why I am unable to get a clear view of any celestial object when looking through eyepiece formed of lens ½in. focus, ditto 1in. focus, and plano-concave fitted to slide together or apart? If I remove the concave I obtain a misty image of moon or star, or if I reverse ends of small lenses can see pretty well, but not with concave in its supposed place. Wanted to know function and position of concave lens?—Alpha Beta.

[75452.]—**To Mr. Bottone or "Sigma."**—Having made up a set of 20 Baron cells as described in "Ours" in March, 1890, I want to know the best way to utilise full current to light every day some incandescent lamps. How many 16c.p. or 10c.p. lamps can I light? Please state what lamps, of what voltage and candle-power have I to buy, and oblige — Maurice de Clercq, Courtrai, Belgium.

[75453.]—**Cost of Electric Lighting and Gas.**—A 16c.p. lamp on a 100-volt circuit, burning on an average, say, 5 hours per day all the year round, equal, say, 1,800 hours per annum. The cost of supply being 6d. per B. of T. unit, what will be the cost of lighting for the lamp per annum? Also, what would be the cost of 16c.p. gas-burner for a similar 1,800 hours, gas at 2s. 9d. per 1,000? Any hints will oblige.—E. B.

[75454.]—**Making Platinum and Zinc Adhere to Glass.**—Where can information be obtained with respect to placing (*a*) platinum, (*b*) zinc, (*c*) tin, on glass, so that it will adhere in a very thin film of metal—B. G. W.

[75455.]—**Asthma.**—I have been living in a damp house, which I must blame for giving me the asthma. It is a very distressing complaint, and worse during night. I am 35 years old, and strong and healthy otherwise. Is there any cure for asthma? Any help greatly esteemed.—A. G.

[75456.]—**To Mr. Bottone.**—Will he kindly put me right? I want to use one incandescent lamp about five minutes now and then. What battery would be the best, and how often will it want charging? Can I use a battery so that I can pull the plates in and out of the solution?—One in a Fix.

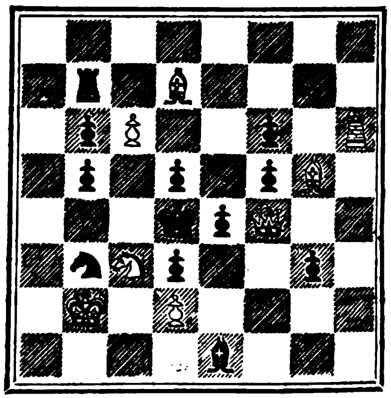
[75458.]—**Altering Halse's Medical Battery.**—I have a Halse's medical twelve-cell battery and coil which I wish to use for electrotyping and bells, yet still use as a medical battery. What are the best constant batteries to put in the place of the present ones? I want something powerful, lasting, and cheap. Where can materials and fittings be bought? Please be explicit so as a non-electrician can understand. I want to do the alteration, if possible. Space for cells in box: 18in. long, 6½in. wide, and 7in. high.—Conversion.

CHESS.

All communications for this department must be addressed to "J. Pierce, Knollside, Yawl, Lyme Regis, Dorset."

PROBLEM MCCLXXIV.—By "Black Pawn."

Black.



White. [8 + 12

White to play and mate in three moves.

Solution to 1272.

White.	*Black.*
1. Kt-K B 4.	1. P-Q 4 (dis ch) (best).
2. K-Kt 3.	2. Any.
3. R or Kt mates.	

NOTICES TO CORRESPONDENTS.

Correct solutions to 1272 by W. T. Hurley, W. L. Martin, E. Bygott, W. Jay, A. H. (Bishop's Stortford), G. Collins, T. Guest; to 1271 by W. Jay, E. Bygott, W. L. Martin, W. T. Hurley.

W. Hurley and W. Jay.—There is no dual to count in 1272, as it occurs in a short mate.

G. Collins.—We are very sorry to hear that you had so much trouble over 1270. The author's name would have seemed sufficient guarantee for its correctness.

W. L. Martin.—We think not, as when there is no solution, it ceases to be a problem.

P. H. Williams and W. T. P.—Problems received with thanks.

We shall be glad to have some good two and three-move problems from our composers.

Liverpool Weekly Mercury.
CHESS COLUMN.
The second Problem and Solution Tourney will be commenced in November. It will be divided into two sections for two and three-move direct mates respectively. All classes of competitors are invited. The prizes will be of a substantial character in cash or chess works at the option of the winners. For rules see the October issues of the *Weekly Mercury*.
The *Liverpool Weekly Mercury* will be sent, post paid, for 1s. 8d. per quarter.—[Advt.]

It is stated that the Japanese Government purposes spending the sum of £140,000 in connection with the World's Fair at Chicago, of which it is expected £30,000 will be for Government exhibits alone. Japan undoubtedly intends to make a display which will do credit to Japanese enterprise.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, OCTOBER 9, 1891.

THE EXPIRATION OF THE MICROPHONE PATENT.—III.

By F. C. Allsop.

Author of "Telephones: their Construction and Fitting," "Practical Electric-Bell Fitting," "Electric-Bell Construction," &c.

THE form of microphone transmitter, the construction of which is now about to be described, has a thin iron diaphragm, with a platinum point in the centre, against which presses a hard carbon button, mounted on a thin steel spring, with an arrangement for adjusting the pressure. The vibrations of the diaphragm cause the platinum contact to vary its pressure on the carbon button, which, by its inertia, resists the swing of the diaphragm. The resistance of the contact varies as the pressure, so that the vibrations of the diaphragm are transformed into undulatory electric currents. In constructing the microphone, a case of the same form and dimensions as that described for the first can be used, though a somewhat different pattern is shown in the figures, which may, perhaps, be preferred by many readers as being easier to construct.

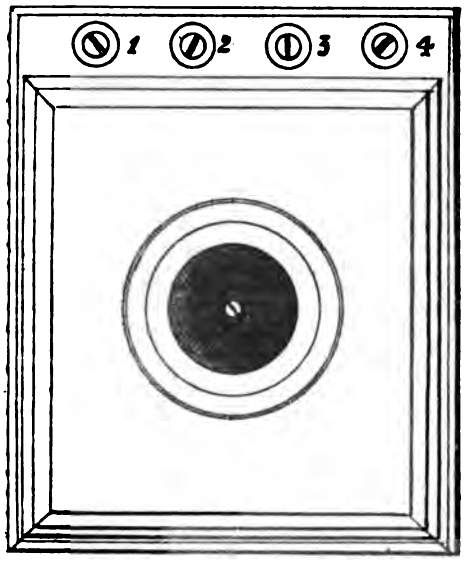


Fig. 9.

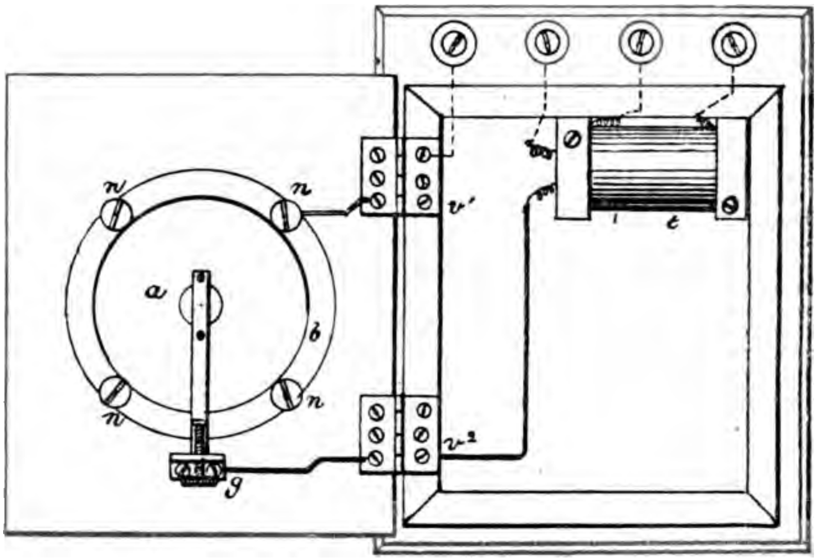


Fig. 10.

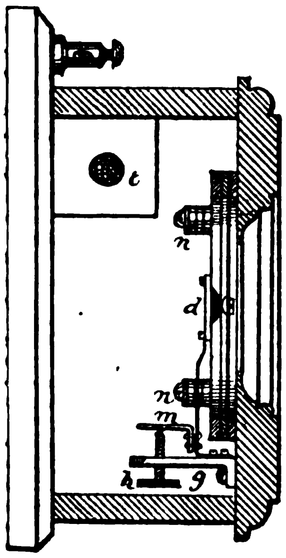


Fig. 11.

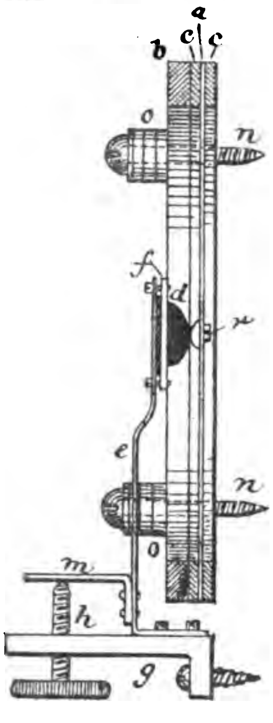


Fig. 12.

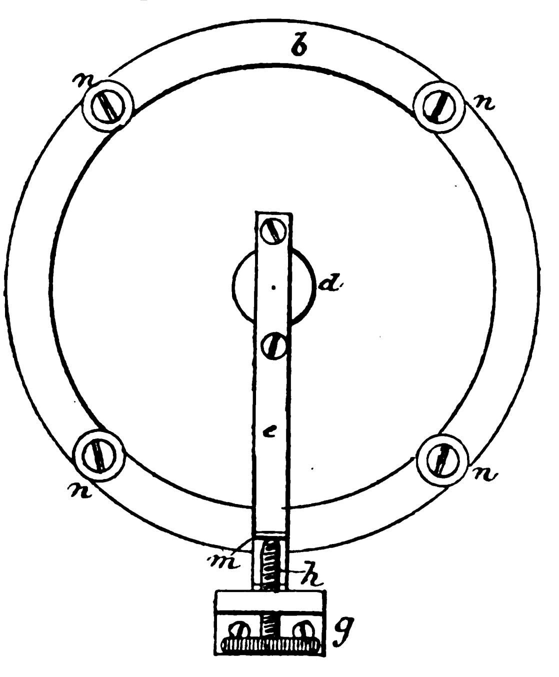


Fig. 13.

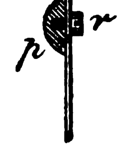


Fig. 14.

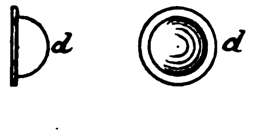


Fig. 15.

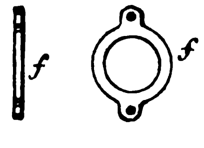


Fig. 16.

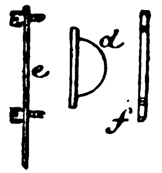


Fig. 17.

Fig. 9 shows the external appearance of the microphone complete, Fig. 10 with the lid open, and Fig. 11 is a section on Fig. 9, some of the parts being shown in elevation; these three figures being half size. Figs. 12 and 13 are full size, and show the diaphragm, carbon button, and method of mounting same; Fig. 18 being a plan, and Fig. 12 a part section and part elevation. Figs. 14, 15, 16, and 17 show in detail the methods of fixing the carbon button and platinum contact. Similar letters in the different figures denote similar parts. In the figures, *a* is the thin iron diaphragm, *b* the circular clamp, and *c*, *c* two indiarubber rings. The carbon button is marked *d*, while *e* is the supporting spring, and *f* the brass clamp which fastens the button to the spring. This spring is secured at the bottom by two screws to the adjusting post *g*, and in this post screws the milled head screw *h*, which, by pressing against the arm *m*, regulates the pressure of the carbon button against the diaphragm. The diaphragm is secured to the back of the lid by the screws *n*, *n*, and the platinum contact is fixed to the iron diaphragm by the screw *r*. The terminals at the top of the case are marked 1, 2, 3, 4, Nos. 1 and 2 being the primary, and 3 and 4 the secondary, as in the previously described form.

It will be found best, in constructing the instrument, to commence with the wood case, which should be finished right off, and have the terminals fitted to the top. This allows of each part, as it is finished, being fitted at once into its correct place. If the form of case shown in the accompanying figures is adopted, grooves should be cut at the back for the wires to run to the different terminals; but in the form shown in the last article it will be found more convenient to fix the wires inside.

To construct the diaphragm, a piece of thin ferrotype iron must be procured (this can be obtained at most photographers), and out of this is cut a circle about 3in. in diameter, and having a $\frac{1}{16}$in. hole drilled in the centre. Next the circular clamp *b* must be made, which can either be cast from a pattern or cut from a piece of sheet brass. This ring is ¼in. and ⅛in. thick, and has four holes drilled in it to receive the screws (*n*, *n*, *n*, *n*).

Before we can fix the diaphragm four holes must be bored in it to correspond with those in the clamp *b*, and two rubber rings, *c*, *c*, must be procured or cut out of some insertion sheet. These rings must likewise have holes bored similar to those in circular clamp and diaphragm. This being done, the diaphragm can now be fixed permanently in its place on the inside of the lid. It must first be held against the lid and moved till the hole in the middle is in the centre of the mouthpiece, when it can be screwed down by means of the screws *n*, *n*, one of the rubber rings *c*, *c* being placed above and below the diaphragm. As will be seen from Fig. 12, three rubber washers, *o*, are placed between the heads of the screw and the circular clamp *b*, and the screws should only be screwed down so as to just grip the clamp. When properly fixed the diaphragm should give slightly when pressure is applied from the front, owing to the rubber washers compressing.

The next operation is to fix the platinum contact *p*, the method of fixing which is shown in Fig. 12, this figure being about double the actual size. The little button *p* is of brass, the round part of which is faced with platinum by soldering on a piece of sheet platinum, and rounding it off with a fine file. Great care must be exercised in facing this button, the sheet platinum being rather thick, and a nice smooth surface must be obtained. If the platinum is thin, holes are liable to be filed in it, leaving the solder exposed instead of the platinum. In the back part of the button a hole is drilled and tapped to receive the screw *r*, but care must be taken to see that the hole is not drilled so deep as to come right through. When finished the button must be fixed to the diaphragm as shown in Figs. 12 and 14, the screw *r* being screwed up firmly. The proper size for the brass button *p* and also the screw *r* can be obtained from Fig. 12.

We next proceed with the carbon button and support. The support *g* can either be cast from a pattern or made up by soldering two pieces of ⅛in. sheet brass together. In the foot are two holes, through which pass the screws that fasten it to the inside of the lid. In the body of the support a hole is drilled and tapped to receive the adjusting screw *h*, which must fit so as to run stiffly; otherwise the adjustment will be liable to vary. The spring *e* is a thin steel one, bent to the shape shown and fixed at the bottom by two screws to the support *g*. Just above the bottom bend of the spring is riveted to it the brass arm *m*, against the end of which presses the adjusting screw *h*. When this screw is turned it moves up or lowers the arm *m*, which in turn increases or diminishes the pressure of the carbon button against the platinum contact according to the direction the screw is turned. By making the head of the screw *h* of rather large diameter, a very delicate adjustment is obtained. We will now turn our attention to the carbon button itself, the preparation of which requires some care, as this is one of the most important parts of the apparatus. Fig. 15 shows the carbon button *d*, Fig. 16 the brass clamp *f*, and Fig. 17 the way they are put together, all these figures being full size. The carbon button is first turned up out of a piece of hard carbon to the shape shown in Fig. 15, and afterwards the rounded surface where it presses against the platinum contact must be highly polished. This is best done by rubbing it first on some very fine glass-paper, then on plain paper or smooth cardboard and finishing on a piece of sheet glass. When finished, it should have a hard, smooth, polished surface. The way in which the carbon button is fixed to the spring will readily be understood on reference to Figs. 12, 16, and 17. The brass clamp *f* encircles the carbon button *d* and has a lug at the top and bottom, in each of which a hole is drilled and tapped to receive the two screws that fasten it to the spring *e*. The carbon button, spring, and support being finished, they can now be fixed in their place, as shown in Figs. 12 and 13. Care must be taken in doing so to see that the platinum contact presses fairly against the centre of the carbon button.

The support being in place, we next make the coil, which must be of the same dimensions, resistances, &c., as that described in the last article. It must, if the form of case shown in the figures is used, be fixed at the top, as here it will be seen is the greatest amount of clearance when the lid is shut. The coil can be fastened either by screwing from the back or fastened from the front, as shown in the figure, this latter method being perhaps preferable if the instrument is intended for experimental purposes, as the coil can be removed without taking down the whole instrument, as is necessitated by the former method. Having fixed the coil, we have now to connect up the different parts of the terminals, as shown in Fig. 10. One wire is run from one of the screws, *n*, care being taken to see that a good connection is obtained with the iron diaphragm. This wire is taken to the top hinge v^1, and afterwards to the terminal 1. A second wire is run from the support *g* to the bottom hinge v^2, and from there to the primary of induction coil, and thence to terminal 2, thus completing the primary circuit. The two ends of the secondary are connected, as shown, to the terminals 3 and 4.

The instrument is now complete, and can be connected up and tried. For this purpose a No. 2 Leclanché cell is connected to terminals 1 and 2, and terminals 3 and 4 are connected to the switch-bell—that is, presuming that the microphone is being tried in conjunction with an instrument complete in every respect save the microphone. If it is wished to adjust or try the instrument by itself, terminals 2 and 3 should be connected to a distant receiver only (say an Ader), a similar receiver being also looped in at the microphone end. The person at the distant end can then hear the speech from the microphone and report the results by talking into his receiver, an arrangement which will be found very convenient, as it is necessary to know the results of each fresh adjustment.

The microphone should be fixed in an upright position, and the adjustment is effected by turning the screw *h*, as before described. If the adjustment is too loose, disagreeable noises will occur during speech, such as a buzzing sound; and, on the other hand, if too taut the speaking will be faint. A transmitter should always be adjusted under the actual conditions on which it is required to work. Rather, however, leave the adjustment too taut than too loose.

PRACTICAL PHOTOGRAPHY FOR AMATEURS.*

By S. R. Bottone.

§ 43. In the process just described we have made our first acquaintance with development. Many views are held with regard to the exact nature of the changes which take place when a silver salt is exposed to light, to a point not sufficient to produce any visible outward change, but yet of such a character as to enable the developing solution to bring about a total decomposition when it acts upon the altered portions. The older view was that the two elements constituting the haloid salt (silver and chlorine, silver and bromine, silver and iodine, &c.) are partially dissociated by the action of light, and that this dissociation is accentuated and becomes an actual decomposition under the influence of any substance greedy of oxygen, and which could, therefore, supply hydrogen to the chlorine, bromine, or iodine forming the other constituents of the haloid. Later researches, however, tend to prove that a trifling decomposition is set up by the action of light; and in point of fact we can, in all instances, annul the effects of the exposure to light by flooding the sensitive surface with a solution of the alkaline chlorides, bromides, or iodides, which would tend to prove that the eliminated chlorine, bromine, or iodine is again reabsorbed. The effect of light may, therefore, be considered as a setting up of a kind of tottering equilibrium, which becomes total decomposition under the influence of the developer. All our developers are *reducing* agents—that is to say, they are bodies which, if placed in contact with substances containing oxygen, seize upon it; and if this effect takes place in the presence of water, hydrogen is generally liberated, and this assists in the reduction of the haloid salts by providing the chlorine, bromine, or iodine with hydrogen, to combine with and form hydrochloric, hydrobromic, or hydriodic acids, the silver at the same time being reduced to the metallic state. The extent to which this "development" takes place is dependent entirely on the amount of change produced by the light. This is a very fortunate circumstance. Were it not for this, our pictures, instead of having all the gradation of tone due to varying intensities of light and shade as we see them in nature, would be mere daubs and patches of black and white.

§ 44. There is another peculiarity about this reduction which we know as development, which lies in the fact that the reduced silver, while in the moist condition, is capable of receiving further deposits of silver if treated with fresh doses of developing solution containing in solution a soluble salt of silver. What always strikes the beginner as being very remarkable is the fact that the silver in the "intensifying" solution (the developer to which the silver has been added is thus designated) is that the silver deposited should adhere only to those parts acted on by light, *and nowhere else*. This peculiarity enables us to intensify a picture to any desired extent, even to producing complete opacity in the high lights.

§ 45. The next process which demands our consideration is one which, for a quarter of a century, took the lead of all others, and which for brilliancy of results, and for marked contrasts between the high lights and deep shadows, is still unrivalled by any. This is known as the *collodion process*.

§ 46. When pure cotton wool, pure Swedish filtering paper, or any other forms of pure cellulose are acted on by nitric acid of a certain strength, or by a mixture of nitric and sulphuric acids, the cellulose, without losing its outward appearance, becomes altered in composition and properties. It is found to have absorbed a certain amount of nitrogen dioxide, and has become soluble in a mixture of alcohol and ether; and also to have acquired explosive properties. In fact it has become converted into a form of guncotton. When such a guncotton (known to photographers as pyroxyline) is dissolved in a mixture of equal parts of pure alcohol and pure ether in the proportion of about 1 per cent., or four grains to the measured ounce, a perfectly transparent and slightly viscid solution is the result: and this solution, if poured on to a sheet and allowed to dry, which it does very rapidly, owing to the great volatility of the ether, a beautiful glossy transparent and even film of pyroxyline is left on the surface. Iodide of potassium, bromide of potassium, iodide of ammonium, and the iodide and bromide of cadmium are soluble to a small extent in the ethereal solution of pyroxyline (known as collodion), and owing to this property we can "iodise" the collodion in a somewhat similar manner to that in which paper is iodised in the calotype process (see § 33), and this iodised collodion, when spread upon a glass plate and allowed to set, if immersed in a solution of nitrate of silver, becomes coated at its surface and permeated throughout its mass with iodide of silver, and in this condition is highly sensitive to the action of light. We will now proceed to describe fully the manipulations required in the collodion process.

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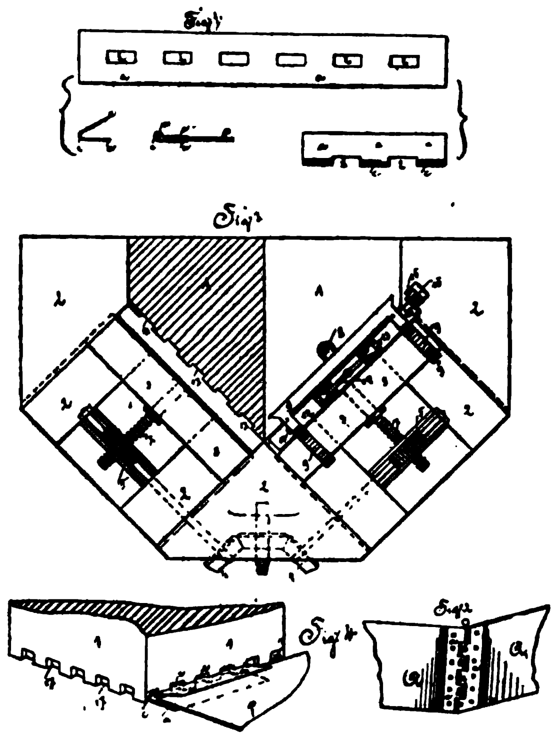
§ 47. *Preparation of the Collodion.*—Although collodion of a very excellent quality, both uniodised and iodised, can be purchased of most photographic dealers, yet for the sake of those who, wishing to learn thoroughly the details of the process, would prefer making their own, the following recipe is subjoined. Take dry, powered nitrate of potash, 8oz. by weight; sulphuric acid, sp. gr. 1·84, 14oz. by measure; water, 1oz. by measure; best cotton wool (dried), 165gr. The nitrate of potash must be first thoroughly dried and powdered, and then weighed. Two glass rods for stirring, and a good well-glazed red earthenware pipkin, in which to place the mixture, must be provided. These materials having been got together and placed conveniently at hand, the pipkin must first be warmed. This is best done by filling it with boiling-hot water, and letting it stand until the outside feels warm. It should then be emptied out, quickly dried, and then placed on the hob, or under a flue that will serve to carry off the nitrous fumes generated during the operation. Immediately put in the nitrate of potash, then the water, stir for three or four seconds with one of the glass rods. Lastly, add the sulphuric acid, and get an assistant, who has the cotton wool ready in his hand, to count *three minutes*, during which time the mixture must be kept stirred. When the *three minutes* have expired, the assistant must throw in the cotton wool, pulled out into small tufts, one piece at a time, while the operator pushes them under, and keeps them moved about with the glass rods. The time occupied in putting in the cotton-wool should not exceed *two minutes*. When it has all been immersed it should be kept moving about and teased with the rods for another *five minutes*; then the whole contents of the pipkin dashed into a large tub of water, and the cotton-wool immediately pulled out and washed about in the water—best with the hands; but if they are too delicate, at first with the glass rods, so as to bring the cotton-wool into contact with a large quantity of fresh water. This point is very essential, since if the cotton-wool with the imbibed acid be allowed to rest for even a second in contact with the same water, it *heats*, and the product is spoiled.

When this preliminary washing has been effected, the cotton-wool (which has now become converted into pyroxyline) is to be squeezed as a sponge, and carried under a tap of running water, and there pulled out and squeezed over and over again, until at last the effluent water is perfectly free from acid, and leaves no perceptible taste on the tongue. Finally, the pyroxyline, having been again squeezed out, is placed in a clean vessel containing about a half-pint of distilled water, to which four drops of liquor ammoniæ fort has been added. Here it should stand for about half an hour, when a final rinsing under the tap will complete the operation. The pyroxyline should be then pulled out into loose tufts and placed on a piece of blotting-paper to dry. It must not be placed near the fire; otherwise it may inflame. When quite dry the weight will be found to have increased to about 210 or 220 grains.

§48. The pyroxyline being dry, we weigh up a given quantity in the proportion of three grains to every ounce of collodion to be prepared. To this we add a mixture of pure ether sp.gr. ·725, 4 drachms, and pure alcohol, sp.gr. 805, 2 drachms. In this, on shaking, the pyroxyline should dissolve perfectly, leaving little or no appreciable sediment, and furnishing a solution perfectly colourless and rather more limpid than good olive oil. To iodise this plain collodion we take:—Alcohol, sp.gr. ·805, 1oz.; iodide of ammonium, 8 grains; iodide of cadmium, 8 grains; bromide of ammonium, 2 grains; bromide of cadmium, 2 grains. These are to be placed together in a clean stoppered bottle and shaken together until the salts are thoroughly dissolved in the alcohol. This iodising solution is to be added to the plain collodion, prepared as above in the proportion of 1 drachm of iodising solution to 7 drachms of the plain collodion. Collodion thus prepared should be kept in small (say 2oz.) bottles, well stoppered or corked, and nearly full, in a cool, dark place; otherwise iodine is liberated, the collodion becomes deep yellow in colour, and comparatively insensitive. Provided the chemicals are good and pure, there is not much advantage in keeping the plain collodion unmixed from the iodising solution; but if the collodion is much exposed to light it will be found preferable to mix only a small quantity at a time—say about 2oz.—as it is somewhat more sensitive when freshly mixed.



CORNER FASTENINGS FOR BOXES.

THE improvements in corner fastenings for cardboard boxes, shown in the annexed engravings, are the subject of a patent obtained in this country by Mr. A. J. Boult on behalf of Herr Saltzkorn and Herr Nicolai, of Dresden. The object of the invention is a separable corner fastening for cardboard boxes, or the like, and the mechanism to be used for the application thereof. Suitable metal plates or strips, *a* (Fig. 1) are provided with slots, *b*, and then folded at an acute angle, so that the material between the slots forms projections or teeth *c*. The walls or sides of the cardboard box to be fastened together are then inserted into these notched and folded plates *a*, and the edge of the piece of cardboard is cut out where it meets the notched portions *b*, whereupon the strip is finally folded together, suitable pins being used for fastening it to the cardboard. The projections or teeth *c* thus form practically circular hollow spaces. The notches on both strips being arranged alternately, the projections or teeth *c* fit into or between each other, after the manner of a hinge, while the hollow spaces or sockets formed by the turned-down portions coincide and enable a wire, *d*, to be passed through them for the purpose of maintaining the connection between the two sides or walls AA^1, as in Fig. 2. When it is desired to disconnect these parts AA^1, all that is necessary is to remove the wire from the coinciding sockets. This arrangement enables a cardboard box to be unfolded and spread out flat, thus affording great convenience for packing and exporting purposes. The machine used for applying corners on this principle is mainly characterised by a guide or gauge-block arranged in its lower part and suitably toothed, adjacent to which a stamp or die is adapted to move first straight down and then sideways and obliquely. Fig. 1 represents the metal strip or plate in the different stages of its preparation; Fig. 2 shows the complete separable corner fastening; Fig. 3 is a plan of the machine; Fig. 4 is a perspective view of the gauge-block, with the metal strip and a portion of the box applied thereto.

The gauge-block 1 is secured to a supporting bed-plate or table 2, in which close to the sides of the block 1 two adjustable bars 3 are operated by means of toothed wheels 4 and 5, worms 6, and spindles 7. Other spindles, 8, are imbedded in the gauge-block 1 on both sides. Each of these carries a yoke, 9, in the slots or guides, 10, 11, of which a stamp or punch, 12, is guided by means of journals or pins, 13. To the stamps 12 are pivoted the rods or links 14, arranged to be operated by lever mechanism not shown in the drawing, and which may be operated by hand or foot as desired. Each stamp is provided on one side near its lower edge with a pin or stud, 15, by which it is guided in a yoke, 16, and which thus acts as its real pivot.

The operation is as follows:—The metal strips or plates *a* bent beforehand at the desired angle are placed against the block 1 on either side, so that the teeth *c* of the strip *a* enter and fit the spaces 17 of the gauge-block 1. The two bars 3 of the bed-plate 2 are then moved towards the block 1 into contact with the smooth edges of the metal strips *a*. Each strip is in this manner firmly held in position and prevented from accidental shifting. The side edges of the sheet of cardboard, *p* (Fig. 4), placed upon the bed-plate 2 are then moved up to the block 1, after which the stamp 12, which is bevelled at its lower part and provided with a number of points, is lowered. In so doing the stamp 12 first moves vertically under the action of the straight slot 10 of the yoke 9, and during this stage slightly presses one of the edges of the strip *a* nearer to the other. In the second stage the curved or inclined slots 11 cause the stamp to take a slanting direction, when the points are driven into the metal and cardboard. During the whole of this operation the teeth *c* of the bands *a* lie safe in the recesses of the gauge-block 1, so that they are not touched by the stamp, and retain their tubular shape for the reception of the connecting wire.

FITTING.—VII.

I WILL now finish my remarks on screwing tackle by describing the making of taps, to which I will add some brief remarks on the tempering of chisels and drills.

It is true that in most workshops there is a tool-smith, whose special work is the making and tempering of the tools used by the turners, machinists, and fitters. All the same, it is the case that a fitter may frequently be so circumstanced as to find himself very awkwardly placed if unable to make and temper a special form of tool; so that as a matter of fact it is highly desirable that all fitters should, on occasion, be independent of the tool-smith. In general country shops there is scarcely a man who cannot do jobs of this kind for himself. Lads trained in very large establishments, however, have no chance to learn such work, nor even to grind their own tools. These are simply handed round ready for use, and taken away again when out of order.

Crucible steel is the best for taps, though Siemens steel is largely used. The blanks are cut off from the rod and forged to outline. They are then annealed by slow heating to a cherry-red, and slow cooling in the ashes of the forge. This process softens them, and relieves the steel of any internal stresses that might cause curving during hardening. They are next centred, and rough-turned in the lathe, and carefully examined in order to ascertain the presence or otherwise of seams in the metal. If found all right, the turning is completed, and the square head is machined or filed. Finally, the threads are cut, but slightly bare to required size, as the process of hardening expands them.

The grooving follows. This is done in wholesale manufacture in special machines; but it can also be done in any lathe with a circular mill of suitable section set running between centres, the tap passing underneath it in a suitable fixing on the slide-rest; or the tap can be set between centres, and the mill be driven from overhead. Or it can be done more clumsily with a cutting-tool in the shaping machine. The small taps may be done by filing. After the grooving, the backing-off, illustrated in my previous article, is done with a file.

When taps are manufactured in quantity they are heated in special furnaces. When they are hardened and tempered in the jobbing workshop they are heated in the fire within a hollow piece of gas or steam-tube. The tube must be large enough to permit of the entrance of the tongs which hold the tap. It is placed in a sloping position in the fire, and the tap is slowly rotated when it is getting hot, in order to prevent risk of its bending, which it would do if left in one position. Its temperature must be raised slowly to heat it uniformly, and a dull red heat must not be exceeded. Then it is plunged vertically into lukewarm water and held there till quite cooled down to the temperature of the water. These points are of great importance—the uniformity of temperature throughout, the vertical direction when plunging, the keeping in the water till cold. Neglect of these will cause fracture and curvature.

Next polish one groove at least, with a buff or with a piece of stone or of broken emery-wheel, in order to have a bright surface on which to observe the tints.

To temper, hold the tap in the red-hot iron ring until a light straw colour or golden yellow appears, and then plunge into water. It is better when heating for tempering to make the tube white hot and remove it from the fire previous to the insertion of the tap. The changing tints will then be more readily observed than if the tube were left in the glare of the fire. If the tube is thick it will retain heat sufficiently long for the purpose required.

The square necks are better if tempered at a blue heat, as they are then less liable to fracture.

I have not said anything about the use of special mixtures for tempering. They are not used to any great extent by the jobbing engineer's tool-smith. Water, with or without salt, and water that is seldom changed, but used over and over again, is chiefly employed. Sometimes, however, for taps the water is made thick with soap; also, to protect the edges of the threads, the grooves are filled with soap. But neither are essentials.

Dies are somewhat less troublesome to make than taps. The two halves are cut from the bar and fitted by shaping or filing into their stocks, their thickness being in excess of the finished thickness. A liner is then fitted and inserted in the stock between the die blanks, its thickness being equal to the amount of normal opening allowed between the dies. The three pieces—namely, the two half-blanks and the thickness piece—are then screwed up tightly by means of the adjusting screw of the die-stock, and their top and bottom faces are planed or filed level and parallel. A central hole is then drilled through the three, equal in diameter to the roots of the screw-threads of the master tap that is to be used for screwing the dies. The packing piece is then removed, the blanks opened out, and the threads cut with the master tap. As the threads deepen the dies are gradually screwed up, until the threads are of their full depth. Lastly, the grooves are filed out.

The dies are hardened by immersion in water or oil while at a dull red. They are then polished, and tempered by heating on a hot plate, upon which they are turned over a few times to insure uniformity of temperature, and quenched at a dark straw.

There is not very much involved in making and tempering the various chisels and common drills, but a little practical experience, soon gathered, is necessary. As far as description will make the matter clear, I will endeavour to do so.

The art of forging these plain tools simply consists in hammering them down to shape from rod of suitable section, which is kept in stock for the purpose. It is simply a case of tapering down under the hammer; there is no upsetting or welding, or really difficult work about it. The real art lies in the observance of two cardinal matters—viz., the heat suitable for forging, and the heat, as indicated by colour, suitable for tempering. To these matters I will confine my remarks.

There are two extremes of temperature equally injurious to tool steel. One is a white heat, at which the steel becomes burnt, the other is the black or "blue" heat, at which, if hammered, it becomes very much weakened. The range of temperature for forging, therefore, lies between a red, or full, or blood-red, and that at which the last faint tints of red disappear. I need not waste time in talking about the uses of physics to restore steel that has been burnt by overheating. They are not used to any important extent in the shops. If a tool becomes burnt—a not very unfrequent occurrence—the burnt end is just knocked off and thrown away, and the tool is reheated and reforged.

In reference to the heat for tempering, some difference exists, depending partly upon the character of any given bar of steel, and partly upon the nature of the work that has to be done by the tool. Colours range from a straw to a purple for most of the tools which I have named. The first is that for cutting the hardest materials, the last for tools of softer temper.

The precise method of tempering chisels, drills, and similar tools is this:—

The tool is first placed in a clear fire, the blast put on sparingly to raise the temperature gradually and evenly, until the tool becomes of equal temperature throughout. This is important, because if the outside is heated too suddenly the interior will remain comparatively cool, and the effect of plunging it into water in that condition will be to crack it, by reason of the unequal shrinkages of the exterior and interior unequally heated layers. When heated to a blood red, or a dull red, the tool-point for a length of 2in. or 3in. is plunged vertically into the water bosh and moved slightly up and down in it until quite cold. The point is then, of course, intensely hard. One face of the hardened portion is then quickly polished with a bit of a broken grindstone or emery-wheel, and the finger or a bit of waste brushed over it. By that time the heat left in the unhardened portion of the tool has begun to sensibly communicate itself to the hardened portion. The tints of oxidation begin with the light straw, and so pass through successive tints into deep purple. It is not easy to describe tints by name, as different smiths will call the same colours by different names; and tint, moreover, depends on the nature of the light in which it is observed. Light straw, deep straw, yellow, plum-colour, purple, purplish straw, and so on are more or less confusing. The best way is to watch a tool-smith at work, and then imitate his methods. Still, broadly, in the average light of the shops in daytime, we may say that chisels for steel and cast iron should be quenched for tempering at a straw, lighter for hard iron, darker for soft; for wrought iron and brass, the straw should have merged into a faint purple, not a deep purple, or the tools will be of spring temper. When the tool is to be finally quenched for tempering, it is immersed vertically, and moved up and down in the water until quite cold.

As a rule, the common flat drill is that used most by fitters. The twist drills are not used to so great an extent as they are at the machines. A greater variety of drills are employed in lathes and machines than at the bench. The flat drill and the ratchet brace are almost exclusively used in work done at the bench.

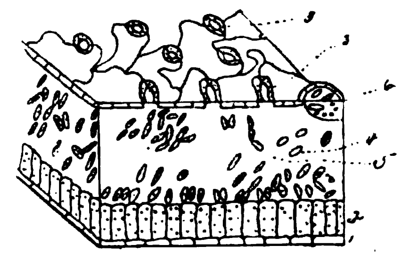
Flat drills are easily forged by hammering them down from a suitable bar, and cutting the bevels of the lips with a hot set, leaving the finish to be imparted at the grindstone. They are first hardened like chisels, then tempered at a dark straw in the same way as chisels.

J. H.

PRACTICAL MICROSCOPY FOR STUDENTS.—II.

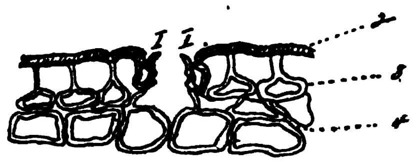
By Frederick Davis, B.Sc.

If we turn to the frond of the fern, we shall find it to be built much in the same manner and upon the same principle as any other leaf. The plan to be adopted for its examination is first to imbed in "paraffin." The paraffin to be employed is really a mixture of three substances in equal proportions, and may be prepared by melting together one or two parts *each* of hard paraffin (paraffin durus, B.P.), paraffin oil, and hog's lard, and stirring until cold. This forms a mass of a suitable consistency for all practical purposes. To imbed a portion of the frond, scoop a hole in a piece of the prepared "paraffin," place the object in this cavity, and having previously melted a little of the prepared mass, pour it carefully into the cavity upon the object, and permit to remain until quite cold. It may be well to mention the surface of the object should be as dry as possible.



Transverse Section of Frond of Fern (inverted).

1, Epidermal cells; 2, Closely packed cells of Epidermis; 3, Stomata; 4, Parenchymatous Cells; 5, Intercellular Spaces; 6, A Fibro-vascular Bundle.



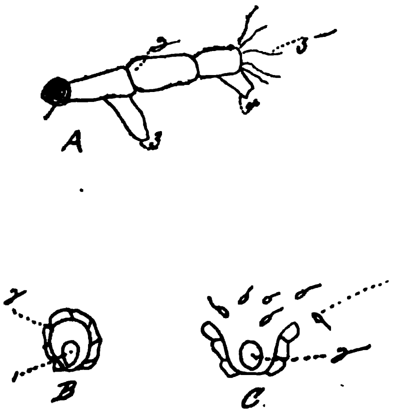
1, Transverse Section showing Valves of Stoma; 2, Epidermis; 3, Parenchyma; 4, Intercellular spaces.

When quite cold, cut a very thin section, and having placed it in water for a time to expel air from its intercellular spaces, mount carefully in water, and examine with the 1in. objective. It will be noticed immediately beneath the epidermis upon the upper surface of the leaf the cells are placed perpendicularly, somewhat elongated, and contain chlorophyll; beneath these we arrived at a layer of cells, stellate in shape, and these, by means of the intercellular spaces, have communication with the external air by way of the stomata or so-called breathing pores.

The accompanying diagram will explain the general structure. If the student desires to particularly observe the cell structure of the frond, he should carefully stain with iodine; this solution may be made by saturating distilled water with iodide of potassium, and then adding as much iodine as will dissolve, afterwards filter and dilute with water to the required strength—namely, a light brown colour.

Note the change which the cell undergoes by this treatment. The protoplasm becomes stained, but the walls of the cell are unchanged; or, again, if dilute hydrate of potash be employed, the sac is unaffected, but the protoplasm entirely removed by dissolution. It may be convenient to the student to mention the protoplasm in this case is termed the primordial utricle.

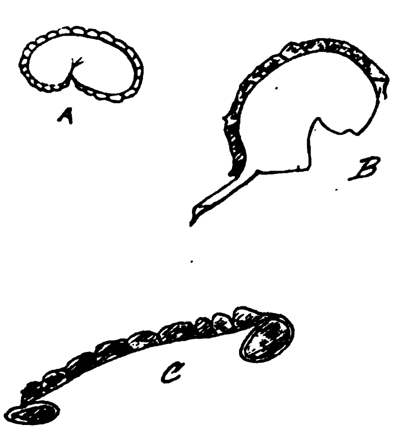
The reproductive organs of the fern are perhaps one of the most interesting series of phenomena that the student can study with the aid of the microscope. The whole process is termed "alternation of generation." If we take the frond of a fern at the proper season—namely, the end of summer or the beginning of autumn—we shall find a number of brown patches upon its under surface. These are termed "sori," and are really "spore cases" containing a large number of sporangia. They may be either annulated or exannulated—that is, inclosed by an elastic ring of cells or not so inclosed. The sorus bursts and sheds these spores; the spores with proper treatment send out a number of prolongations termed prothalli; each prothallus then develops upon its under surface a body termed the archegonium (the female portion) and the antheridium (or male portion). The archegonium is stationary; but the antheridium continues to grow until it comes within measurable distance of the archegonium. It then sheds a number of bodies termed spermatozooids, which enter the archegonium, and fecundation takes place, the pro-embryo resulting, and from this is developed the true fern. If the sorus be taken and examined under the 1in. objective, we shall find it to be composed of an immense number of sporangia. These sporangia should be removed from the sorus and placed under the 1in. power. They will be seen to consist of doubly convex bodies provided with a minute stalk; the annulus will be distinctly visible, and the method of dehiscence—i.e., shedding the spores—apparent. By taking the spores, mounting in water, and examining with the one-eighth objective, they will be observed to be triangular in shape, possessed of two coats, the outer and the inner, with the protoplasm and a nucleus. For the purpose of developing the prothalli, the spores must be sown on an ordinary slide, being careful to provide them with moisture and warmth for a considerable period. We shall find eventually a leaf-like prolongation will be developed—this is the prothallus containing chlorophyll granules; the antheridia and archegonia will then be quickly developed; the antheridia being very abundant amongst the little rootlets growing upon the prothallus; swimming about in the water in which the spore is mounted may be found a few spermatozooids shed by the antheridia; these are spirally-coiled little bodies, somewhat resembling a tadpole: their activity may be interrupted by staining with iodine solution, and their structure the more closely examined.



A.—1, Spore; 2, Prothallus; 3, Antheridium; 3, Archegonium; 5, Rootlets.

B.—Closed Archegonium.
1, Basal Cell; 2, Archegonium.

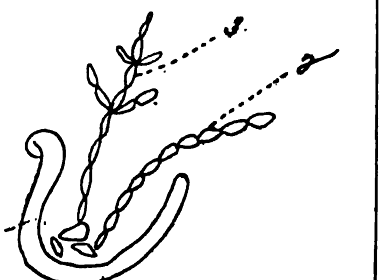
C.—Opened Archegonium.
1, Spermatozooids; 2, Basal Cell in Archegonium.



A.—Sorus Covered with Indusium.

B.—Sporangium after Bursting.

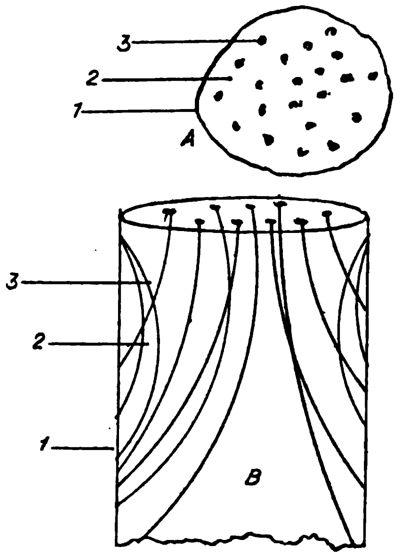
C.—Annulus straightened by its own elasticity, showing a spore at each end.



1, Fecundated Archegonium; 2, Rhizome Stem; 3, Frond in embryo.

Each archegonium will be seen to be composed of a layer of semi-opaque cells, at the summit of which, in the cavity, a large nucleated basal cell will be observed; this is really the germ-cell. This, then, terminates our microscopical examination of the fern or acrogenous plant.

Turning our attention to another form of vegetable growth—i.e., the section of a palm, we see the typical structure of the monocotyledonous stem. Very little need be said concerning it if the illustration given be carefully compared with its microscopical characters. We have, as in the acrogen, a groundwork of parenchymatous tissue, in which are imbedded a number of fibro-vascular bundles—there is no true bark; but at the margins the cells will be seen to be compressed, the hard external layer of the stem being formed by the ends of the fibro-vascular bundles.



A.—Transverse Section of Stem of Monocotyledon. 1, Cortical Portion; 2, Ground Tissue, or Parenchyma; 3, Ends of Fibro-vascular Bundles.

B.—Longitudinal Section of same. (The numbers refer to the same parts as in Section A.)

These fibro-vascular bundles are termed "closed" bundles, because they have no cambium layer. The endogenous or monocotyledonous stem increases in length only—hence its peculiar structure.

PRACTICAL HINTS IN BOILER DESIGN.—III.

By W. C. Carter.

Flat Surfaces.

THE next point claiming our attention is the strength of flat surfaces to support a pressure acting in a direction perpendicular to the surface. This question, if investigated analytically by the aid of mathematics, is of a nature too complicated to be of service in practical work. We shall therefore confine ourselves, as in the case of the furnace, to experimental data.

With a given thickness of plate and a given pressure upon it there is a certain area which is the greatest that the plate in question can support without assistance. When the flat surface exceeds in area this maximum, as is usually the case, it must be subdivided by stays placed at regular intervals, and the pressure is then passed through the plate to the stays which support it. As each stay obtains a reaction from its attachment, or an exactly similar and opposite pull from another similar and opposite flat plate, we obtain a number of fixed points of support. This will be rendered clear by a reference to Fig. 3.

Suppose A B C D to represent a surface requiring to be stayed, and suppose also that we know by experience that the plate in question when exposed to the pressure to be carried by it will only allow an area of 100sq.in. to be left unsupported. As it is usually customary to disregard the support afforded by the attachments of a flat plate to the surrounding parts of the structure, we must provide such an arrangement of stays as will carry all the pressure upon the surface, the area of which is 30in. by 20in. = 600 square inches. We therefore require to divide the whole surface into $\frac{600}{100} = 6$ divisions of 100sq.in. each, and must provide a stay to carry each division. It is, of course, reasonable to suppose that a stay, placed as shown, will act equally in every direction, its effect failing at the same distance from the centre of the stays, and, therefore, the portion of the plate assisted by each stay will be more correctly represented by the overlapping dotted circles in the figure, the area of each of which is 100sq.in. This method, no doubt, shows the real action of the stay in the truest way; but when we reflect that the whole area is carried by a certain number of stays evenly distributed, we see that the final result will be the same, if we suppose each stay to support a rectangular area, with the stay passing through its centre of gravity, and this method is the one adopted in practice. So far, we have considered the plate strength only; but we must bear in mind that the surface derives its support from the stays. There are, therefore, always two problems to be solved in every question of the staying of flat surfaces, and by keeping them distinctly separated in the mind, many difficulties and inconsistencies will be avoided. They are—first, the plate strength; second, the stay strength; and these strengths must be made equal, to procure an efficient arrangement. For example, in the case shown in Fig. 3, each stay must be of sufficient sectional area, to support a pull equal to the

FIC 3.

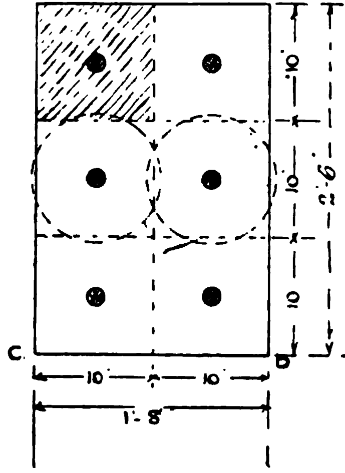
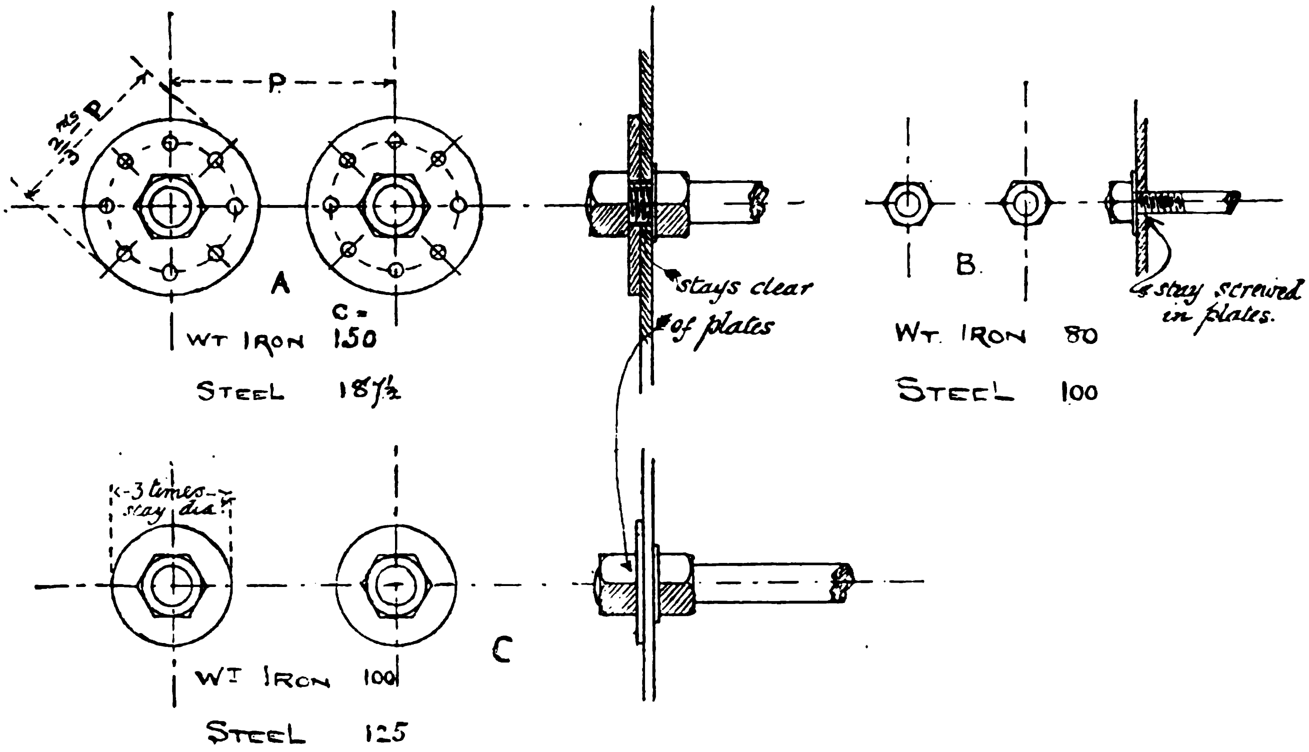


FIG 4.



total pressure on its own division (100sq.in. × WP).

The strength of flat plates has been found to vary according to the method of attachment of the stays, and therefore we have to introduce into the formula expressing this strength a factor (C) varying with the method of attachment. The formula used by the Board of Trade is—

$$\frac{\text{Constant} \times (\text{Thickness} + 1)^2}{\text{Surface supported by each stay} - 6} = \text{Working Pressure} \ldots \text{(xi.)}$$

To find thickness:

$$\sqrt{\frac{S - 6 \times WP}{C}} - 1 = T \ldots\ldots\ldots\ldots \text{(xii.)}$$

To find surface that can be carried without support:

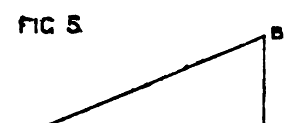
$$\frac{C \times (T + 1)^2}{WP} + 6 = S \ldots\ldots\ldots\ldots \text{(xiii.)}$$

As explained, what is here termed a *constant* is only constant while the method of attachment remains unchanged. In Fig. 4 are shown various methods, and under each is given the constant both for iron and steel for each case. Other cases are provided for, and constants stated by the Board of Trade rules. Referring to Fig. 4, method A shows circular washers not less than two-thirds the pitch in diameter, and of equal thickness with the main plate, riveted to it, and the stay passing through clear holes, with a nut inside and outside. B shows stay screwed through the plates, and fitted with an outside nut. C shows an arrangement similar to A, except that washers are not riveted to the main plate, and are smaller, being only three times the stay diameter, and two-thirds the thickness of the main plate.

By taking the length of the side of the square containing the surface found (see the shaded portion of Fig. 3), we get the distance that the stays will be apart from centre to centre, i.e., the pitch of the stays ($= \sqrt{S}$). As we have seen, the whole of the pressure upon the flat surface is carried by the stays, and we must, therefore, make these of such a size as to provide a sufficient sectional area of metal to carry it without exceeding the working stress that we decide upon. This may be for wrought iron unsmithed stays 7,000lb. per square inch; steel unsmithed stays, 9,000lb; for wrought iron welded stays, 5,000lb.; steel stays worked in the fire are forbidden by the Board of Trade. Stays are nearly always arranged in the direction of the pressure that is perpendicular to the plate; when this is not the case by a simple construction based upon the triangle of forces, the equivalent angled force can be found corresponding to the perpendicular pressure (refer to Fig. 5). Suppose that a stay is required at an angle as at A B; we require to find the strength it must possess to carry an ascertained perpendicular pressure. Draw A C horizontal (i.e. perpendicular to the plate which is supposed vertical) to represent by its length to some scale the pressure in question. From A draw A B parallel to the direction of the angled stay, from C erect C B perpendicular to A C to determine the length of A B, and thus comparing the length of A B with that of A C, we find the stress upon the angled stay. The same method may be used in the case of angled gusset plates; but these should always have an excess of sectional area above that theoretically determined.

When the ends of the stays are fastened by nuts the effective area is at the bottom of the thread, which may be either *plus* or *minus*—that is, either raised *above* the surface of the stay if lightness is the most important consideration, or cut in *below* the body of the stay if cheapness of manufacture is of greater consequence.

FIG 5.



The diameter of any screw below the thread

$$= \text{Diameter over thread} - \frac{1{\cdot}28}{\text{Number of threads}}$$

The area of the resulting circle can be found in the usual way.

In the course of designing our boiler, we may find that the simple methods of staying here described may not meet every case; but the changes necessitated will be only in detail and not in principle, and we have now discussed sufficiently for our purpose the principles of construction involved, and we shall find that all questions of plate strengths that we are likely to meet with in any ordinary boiler work can be solved by one or other of our three principles, either taken separately or in combination, and it is very necessary to have a clear understanding of these simple points:—

First, the strength of a cylinder with internal pressure, as in the shell.

Second, the strength of a cylinder with external pressure, as in the furnace.

Third, the strength of flat plates.

Hemispherical surfaces may be treated as self-supporting; curved surfaces must be treated as if flat, as the strength obtained from their curvature is too uncertain to be relied upon, and because no curves except those of the sphere and the cylinder are free from the tendency to change their shape under pressure. They therefore require staying to prevent the alteration of form, and it is safest to take the extreme case of the flat plate.

Before leaving this part of the subject it will be well to consider the question of the reaction of stays. Suppose you have a cubical cardboard box lying upon a table; one of its vertical sides is bulged inwards, and you wish to pull it out by means of a string attached to the centre, so as to make it flat like the other sides of the box. When you pull the string with one hand, you would, without thinking, naturally put out the other hand to keep the box from shifting while you applied the tension to the string. In other words, experience has taught you that you cannot expect force without reaction; or, to paraphrase the truth, no stay can be effective in any position unless a reaction equal to its strength is provided for it. This truth is of the utmost importance, and many instances exist in which staying arrangements are to a large extent impotent because an efficient reaction has not been provided for in the stays.

HOW TO MAKE A VIOLIN.—IV.*

By W. Pickering.

THE *Neck and Scroll* can, if you prefer it, be purchased with the finger-board, nut, and pegs all *in situ*, so that you will only have to let it into the neck at the proper angle; or the neck and scroll can be bought separately at from 9d. to 2s. 6d. If, however, you determine to make one yourself, it will be necessary to procure a piece of maple 10in. long by 2in. square, having figure to match the back and ribs as nearly as possible. Any good scroll will do as a copy; but if one be not available, Figs. 25 and 26 will give an idea of the form. The work should be planned out on the wood (keeping the figured side for the side of the scroll), on which you may draw your profile, Fig. 27. Remove as much of the wood as possible with the bow-saw, and carve out the rest with the small chisel. A bit of glasspaper about 2in. square, and folded cornerwise, will be found handy for finishing the volutes. The fluting of the back, or shell, and round the top of the scroll may be done with tools, which may be improvised out of a couple of old half-round files, ½in. and ¾in. in width. In making these you must first take out the temper by bringing the file to a dull red heat in the fire or gas, and allowing it to cool very slowly. Then grind the round side so as to get the file cuts out for about 1in. from the point, and make it smooth and bright. Next grind a long bevel, as in Fig. 28, down the flat side, which also make smooth and bright, and bring up a keen edge on the Washita stone. You may then temper the tool up again by heating to a white heat and suddenly plunging into cold water. Again rub bright, and hold it in a gas jet about a couple of inches from the point. Carefully watch the bright part, and you will observe it turn a pale yellow, or straw colour, whereupon you are to plunge it once more into cold water to arrest the softening process, as if you delay an instant the bright surface will become violet and the tool will be too soft. Therefore, plunge it into the water the instant it has assumed the straw tint at the cutting edge. A home-made tool of this kind will be all you require for carving out the fluted part of the scroll. Some of the Italian makers did not trouble to cut these flutes, but left the back plain.

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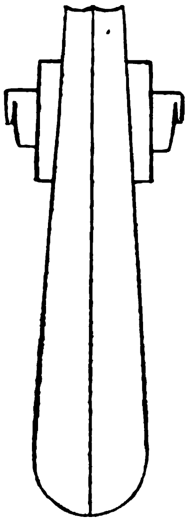


Fig. 25.

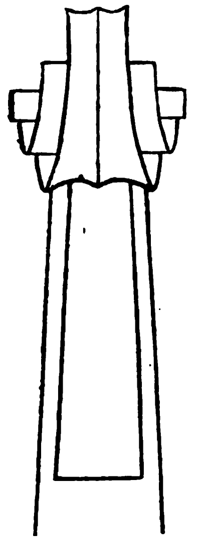


Fig. 26.

Throughout the whole of the process it is advisable to continually watch the carving as it proceeds, holding it frequently at arm's length and scanning it closely each time you remove a bit of wood, and you will not fail to notice how the very slightest touch affects the whole design, the trouble being how little, rather than how much, to cut away at each stroke. With care and attention you will be able to produce a very creditable scroll.

The pegs having been fitted carefully, and the string-hole bored through each in the proper place, the neck may be shaped so that the end view is as Fig. 29, and it may then be let into the upper block. For ascertaining the proper angle it should bear to the body of the instrument, there is a "rule of thumb" that the ear of the scroll should be in a line with the edge of the back, and this is a fairly general point to abide by; but you may as well first shape your finger-board, which should be 10½in. long, 1in. wide at the nut, and 1⅝in. wide at the other end. Fasten it temporarily on the neck with two drops of glue, and you can then determine the pitch of the neck by placing a bridge in position on the belly, and taking sight along the finger-board, allowing room for the play of the strings. Then take a note of the distance between the finger-board and the belly, and keep your neck to that angle when gluing it into the block. Recollect that the neck proper, from the shell of the scroll to the button, should be about 4½in. (see Fig. 27). Having made the neck fit nicely into the space you have cut for it in the neck block, you may now, before fixing it there, glue the finger-board to the neck and clamp it. Whilst it is setting you can prepare the nut—a strip of ebony or ivory 1/16in. higher than the finger-board, and which can also be glued in position. When set, cut four slight notches in it for the strings, and finish off the neck and finger-board with file and glasspaper. It may then be glued to the body of the instrument, and should be left for 24 hours at least, so as to get thoroughly firm. In the mean time you can prepare the nut for the string of the tailpiece to pass over, which has to be let into the margin of the belly just above the tail-pin.

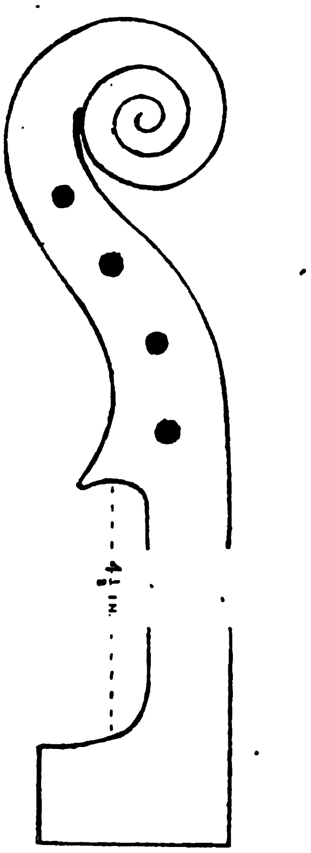


Fig. 27.

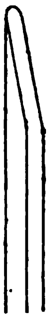


Fig. 28.

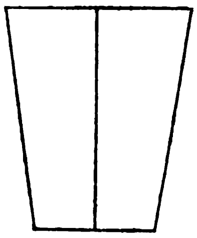


Fig. 29.

Next prepare a bit of soft, straight-grained deal for the soundpost; it should be from 3/16in. to ¼in. thick. A soundpost setter, if you do not buy one, can be made of a piece of soft wire ⅛in. thick, and about a foot in length. Sharpen one end to a thin edge, like a bradawl point, and bend the other end; then curve the whole lengthwise.

When you conclude that the neck has become firmly set to the body of the instrument, you may thrust the sharp end of the post-setter into the soundpost (Fig. 30), and introduce it cautiously through the right *f*-hole. Then look through the hole made for the tail-pin into the interior, and you will be able to get an idea as to the right length of the post, and the degree of bevel necessary to be made at either end, so that it shall accurately fit to the slope of the back and belly. The usual place for the soundpost is about ¼in. behind (that is, towards the tailpiece) the right foot of the bridge. When you have got it nicely into position, put on the strings, and draw them up just sufficient to keep the bridge standing between the notches of the *f*-holes. Then fit the feet of the bridge accurately to the curve of the belly. The upper edge of the bridge, which is crossed by the strings, should be rounded so as nearly to agree with the arching of the finger-board, leaving it, however, slightly higher for the G string, which requires more room for vibration than the other strings.

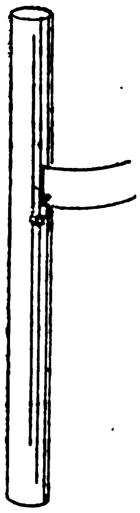


Fig. 30.

Most bridges are, as purchased, much too thick, and have to be reduced. This is best accomplished by laying the bridge flat upon a sheet of glass-paper, and rubbing until the upper edge is a little over 1/16in. thick, and the lower, or feet side, about ⅛in. There are, however, bridges to be bought which are of a proper thickness, and which simply want the feet fitting to the curve of the belly, and the upper edge shaping to the finger-board. In cutting the notches for the strings the slightest indentations are sufficient.

MAGNETISM IN TOOLS.

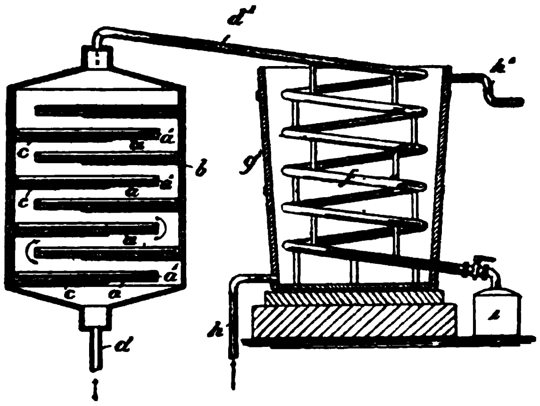
THE cause of magnetism in drills and other tools has excited no little wonderment, for it has been noticed that a drill which showed no magnetism whatever before it was put to use would, in a very few minutes after the drilling commenced, be found to contain so much magnetism that a large quantity of the iron or steel dust would cling tenaciously to certain portions of its surface. Nearly all drills which become magnetised show this quality to the greatest extent at portions of their surface which differ in each individual drill. The cause of this accumulation of magnetism has not been satisfactorily explained, to our knowledge; but it has been suggested that it may be caused by the heat developed in doing the work. This explanation is not tenable, for, if such were the case, all portions of the drill which were equally heated would show an equal intensity of magnetism, which is not the case, for it is most frequently noticed that it is the point and corners that show the greatest power of attraction, while with a twist-drill it sometimes occurs that one edge along the full length which has penetrated the metal is more or less strongly magnetised; but the opposite side will show barely a trace of magnetism, and another drill of the same kind will be found to be strongly magnetised at the point only. That heat has but little, if anything, to do with the production of magnetism in the steel is shown when an attempt is made, by the use of heat alone, to develop the magnetic property. Such attempts uniformly result in failure to produce any indications of magnetism.

The position occupied by tools with regard to the magnetic meridian has also been suggested as a cause for their becoming magnetised. It is well known that when iron or steel has lain or stood for some time in one position it will show traces of having become magnetised. But that the magnetism in tools is produced by a different cause is evident; for different tools which have lain in various directions are found to become magnetised, while others, which have lain in what is considered the direction most favourable to the absorption of magnetism have failed to develop any traces of the magnetic quality when used. The direction in which tools lie or stand when at rest does not appear to have any perceptible effect on the development of magnetism in the tools when they are at work.

To what, then, can the production of magnetism be attributed. There are some excellent reasons for believing that friction has considerable to do with producing the magnetism; for if a drill that has become highly magnetised while at work be closely examined, it will be found that the magnetised parts have been slightly worn by friction, but if the friction is sufficiently great to cause perceptible heating, it is also capable of destroying any magnetic effect that may have been produced or was previously present. Lathe and planer tools frequently become magnetised while doing work; and the same is often found to be the case with cold chisels, and is most frequently noticed on such tools as are soft enough to stand considerable work without breaking, and yet hard enough to hold an edge. This latter fact shows plainly what has long been known in science, that a piece of steel but slightly hardened makes the strongest magnet, but the magnetism does not remain as long as in the steel which is harder. In making steel magnets it is a very difficult matter to get the lines of force to act on the particles of hardened steel with sufficient force to produce a large amount of magnetism; but when once the steel is magnetised, the magnetism remains for a very long time. Softer steel may be easily magnetised to a very high degree of saturation, and it will remain for a length of time in proportion to the hardness of the steel.—*Stationary Engineer.*

A SUBSTITUTE FOR GLASS.

THIS is the invention of Friedrich Eckstein, of Vienna, Austria. In the production of the new substitute for glass, he says:—I dissolve from four to eight parts of collodion wool in about one hundred parts, by weight, of ether or alcohol or acetic ether, and with this I intimately combine from 2 to 4 per cent. of castor-oil or other non-resinous oil, and 4 to 10 per cent. of rosin or Canada balsam or other balsam (soft rosin). The compound, when poured upon a glass plate and subjected to the drying action of a current of air of about 50° Centigrade, solidifies in a comparatively short time into a transparent glass-like sheet or plate, the thickness of which may be regulated as required. The sheet or plate so obtained has substantially the same properties as glass, as it will resist the action of salts and alkalies and of dilute acids, and, like glass, is transparent and has no smell. On the other hand, it has the advantage of being pliable or flexible and infrangible to a great degree, while its inflammability is much less than that of the collodion substitutes.



In the drawing, *b* indicates a vessel adapted to be hermetically closed, and having the air-inlet pipe *d* at bottom, the outlet pipe *d'* at top connected with or forming part of a condenser worm, *f*, contained in a refrigerator, *g*, of which *h'* is the inlet pipe for the refrigerant liquid and *h* the exhaust pipe. As shown, the condenser worm has a valved discharge, with which the receiver *i* for the condensed solvent is connected.

In the vessel *b* are arranged shelves that extend alternately from one wall of the vessel toward the opposite wall for the reception of the glass moulds *a* that have an edge flange *a'*, that determines the thickness of the plates or sheets to be cast. These moulds *a*, when placed upon the shelves *c*, extend from wall to wall of the vessel *b* in one direction, and project beyond their shelves in an opposite direction from one wall of the vessel *b* to near the opposite wall thereof, so as to form a zigzag passage for the heated air entering at *d*, thence passing under the lower mould around the right-hand end thereof under the next succeeding mould and around the left-hand end of the latter, under the mould next above the same, and so on alternately from right to left and left to right, the solvent being evaporated and condensed as it passes through the condenser.

The compound, after exposure to an air current of a temperature of about 50° Centigrade, as above stated, for some time, first becomes opalescent, then hardens and becomes horny and perfectly transparent, after which the moulds are taken out of the drier and the sheets or plates removed, when they are ready for use.

The compound, as will be readily comprehended, is of such a nature that any desired colour or shade of colour may be imparted to it by the admixture of the necessary pigment. The pigments should be soluble in the solvent used in the preparation of the compound, if incorporated therewith; but the colour may be imparted to the substance by surface application, aniline dyes or colours being employed, so that the sheets or plates may be used in lieu of stained glass. The material may also be ornamented by printing any desired design thereon.

If magnesium chloride or grape sugar is combined with the material, the inflammability thereof is very materially reduced, while an addition of zinc white or heavy spar imparts to it the appearance of ivory, so as to adapt it for use in the manufacture of collars, cuffs, shirt fronts, and the like.

By suitably increasing the relative proportions of castor oil and rosin, a material having substantially the toughness and pliability or flexibility of leather is obtained, and such material may be fashioned into driving and other belting. The composition of matter is, however, adapted for use in many other ways—as, for instance, for table and other ware, in lieu of glass, as a substitute for celluloid, for emulsion plates, for surgical and measuring instruments, and for many other purposes.—*Scientific American Supplement.*

THE SWELL IN THE ORGAN.[*]

THE subject of my present paper is one that, in my opinion, has not, in Europe at all events, received the amount of consideration and earnest attention it deserves, and which it long ere this ought to have received from both organ-builders and organists. It may seem presumptuous on the part of one, who is neither an organ-builder nor an organist, to attempt to "lay down the law" in matters connected with organ construction and appointment; but such a consideration shall not prevent my opening my mouth in protest against the half-hearted manner in which the portion of the organ I am now about to consider at some length has been treated by all English and almost all Continental organ-builders. Why Europe should be behind America in any matter connected with organ construction is a matter not easily fathomed. Although my chief aim in the present paper is essentially an artistic and practical one, it may not be out of place for me to open it with a few historical notes on the Swell organ. I shall, however, make these notes as brief as possible. The history of the Swell opens, I am proud to say, in this country. England saw the inception of the Swell, although it has not yet witnessed its highest development. Our organ-builders move very slowly, and will continue to move slowly until organists and organ-lovers prick them on. If radical changes and improvements are to be made in our system of organ-building, they must be initiated outside the organ factories. Why is it that our musicians and organists are so apathetic in matters of organ construction and development in this organ-loving country—why is it that year after year they are content to accept what our groove-loving organ-builders think proper to give them? I am free to admit that I cannot find a satisfactory answer to these questions. But it seems quite clear that until organists take a lively interest in all matters connected with the instrument on which they perform, and direct their minds towards its improvement and development, abandoning at the same time the stereotyped form of specification which has for the last fifty years shown neither individual thought nor indications of advance, it is hopeless to look for any great and general improvement in the art and science of organ-building, now very generally degraded into a mere trade. I am not aware of the exact date at which the small department of the Organ, known as the "Echo," was first introduced by English organ-builders, but it seems certain that it was first devised in this country. In the description given by Mace, in his "Musick's Monument," published in 1676, of his own "Chamber Organ," we find the following remarks:—"It is in its Bulk and Height of a very Convenient, Handsome, and Compleat Table seize (which may become and adorn a nobleman's dining-room), all of the best sort of wainscot. The length of the leaf, 7ft. and 5in.; the breadth. 4ft. and 3in.; the height, 3ft. 1in., and better. The leaf has in it eight desks, cut through very neatly, with springs under the edge of the leaf, so contrived that they may open and shut at pleasure, which, when shut down, join closely with the table-leaf; but, upon occasion, may be opened, and so set up (with a spring) in the manner of a desk, as your books may be set against them. Now, the intent of those desks is for far more excellent use than for mere desks, for, without those openings your organ would be but of very slender use, as to consort, by reason of the closeness of the leaf; but, by the help of them each desk opened is as the putting in of another quickening or enlivening stop, so that when all the eight desks stand open the table is like a little church organ, so sprightfully, lusty, and strong, that it is too loud for any ordinary private use. But you may moderate that by opening only so many of those desks as you may see fit for your present use. There are in this table six stops—the first is an Open Diapason; the second, a Principal; the third, a Fifteenth; the fourth, a Twelfth; the fifth, a Two-and-Twentieth; and the sixth, a Regal. There is likewise (for a pleasure and light content) a Hooboy Stop, which comes in at any time with the foot; which stop, together with the Regal, makes the Voice Humane." Now, although this quaint and interesting description appears in Dr. Rimbault's "History of the Organ," and accordingly has been under the notice of the organ-loving world for 35 years, I do not remember ever having seen it commented upon. Let us see, on the present occasion, if it is not worthy of a little study. I have only given extracts from Master Mace's full description of "this Table Organ," which the writer claims as his own contrivance. He says:—"Two of such organs only are but as yet in being in the world; they being of my own contrivance; and which I caused to be made in my own house, and for my own use, as to the maintaining of public consorts, &c." Now when we look carefully into his description, we cannot avoid seeing that the instrument showed the true starting-point of the swell organ; and, with such an instrument before their eyes, it is a surprising thing that the organ builders of the time did not catch the idea of the swell. We are told by Mace that the "leaf," or top of his table organ, had eight desks, which were so fitted as to be almost invisible when closed down, but which could be raised up and fixed open with springs, leaving openings in the leaf through which the sounds from the pipe-work, inclosed in the body of the instrument, found egress. He tells us that these desks were "of far more excellent use than for mere desks, for, without these openings, your organ would be but of slender use, as to consort, by reason of the *closeness* of the leaf. In closing all the "desks," it stands to reason that the entire instrument became so subdued as to be an echo organ. "But by the help of them," as Mace quaintly remarks, "each desk o-pened, is as the putting-in of another quickening or enliv'ning stop; so that when all the eight desks stand open, the table is like a little church organ, so sprightfully lusty and strong, that it is too loud for any ordinary private use; but you may moderate that," says this pioneer in organ building, "by opening only so many of these desks as you see fit for your present use." Master Mace, as he wrote those words, or, with feelings of pride, surveyed his very curious and noteworthy "table organ" was standing on the threshold of a great discovery or invention. Had he abandoned the practice of opening and shutting those eight "desks" by hand, and simply connected them by a system of levers to a single foot-pedal, he would have invented the true swell, and, at one step, have imparted powers of expression to the organ. Such an oversight—to call it by no harder name—seems to us almost unpardonable. There was the swell forcing itself on everyone's observation every time they opened one, two, three, or more of the desks, to let out sufficient sound for the requirements of the "Consort." It is self-evident that the organ builders of the year of grace 1676 were just as dull of comprehension, and as adverse to improvements, as the generality of our builders of to-day are. However this may be, it took nearly a century to carry the idea I have just shadowed forth in connection with Mace's "desks" into anything like practical form. It seems quite probable that at the date Mace constructed his notable chamber organs, the closed department of the church organ, called the "Echo," had been introduced, but it is quite evident no such department existed in the organ built by Robert Dallam, of London, in the year 1634, for the cathedral of York. This important instrument had only two departments, namely, a Great Organ and a "Chair," or Choir Organ. The Echo was probably not known at so early a date. I need not dwell on the subject of the Echo, as, beyond its being the precursor of the swell organ, it can have no special interest for us on the present occasion. I shall accordingly pass on to the year 1712. Amongst the advertisements in the *Spectator*, issued on February 8, 1712, the following interesting announcement occurs:—"Whereas Mr. Abraham Jordan, senior and junior, have, with their own hands, joynery excepted, made and erected a very large Organ in St. Magnus Church, at the foot of London Bridge, consisting of four sets of keys, one of which is adapted to the art of emitting sounds by swelling the notes, *which never was in any organ before*; this instrument will be publicly opened on Sunday next, the performance by Mr. John Robinson. The above-named Abraham Jordan gives notice to all masters and performers that he will attend every day next week at the said church to accommodate all those gentlemen who shall have a curiosity to hear it." This announcement fixes two facts beyond question—namely, that the invention of the swell is due to Englishmen, and that its first introduction took place in the year 1712. The invention, as introduced by the Jordans consisted of a front to the old Echo box fitted with a sliding shutter, which was raised and lowered at the will of the player by means of a foot lever. On depressing the lever the shutter was raised, the box opened, and the sounds from the inclosed pipe-work permitted to escape more or less freely. On reducing the pressure of the foot the shutter closed by its own weight. As Dr. Hopkins correctly remarks:—"The '*nag's-head swell*,' as the above early kind of swell was called, was not well designed, nor happily adapted to its purpose in a mechanical point of view. The weight or resistance to be overcome by the pressure of the foot was so great that the shutter could be set in motion only with difficulty, and when it was in motion there was equal difficulty in regulating the rate or extent of its ascent; for it would then not unfrequently run up almost of itself. Its descent was similarly beyond control, and it would often fall with an audible noise. The nag's-head swell continued in use for upwards of half a century, till it was superseded by what has since been denominated the 'Venetian swell.'" Prof. Dudley Buck, who quotes Jordan's advertisement in his interesting lecture on "The Influence of the Organ in History," remarks:—"Very little is known of this Mr. Jordan, except that his invention pleased greatly, and was found of such practical use that not only were all new organs in England (virtually from this date) furnished with swells, but himself and son found much occupation in adapting and adding their invention to the older London organs. The lack of a swell is the weakest point of the great majority of German organs. Even Dr. Burney, fifty years after swells had become common in England, expresses, in his famous work entitled 'Continental Tours,' his great surprise to find them utterly unknown upon the Continent. His remarks would hold true at the present day [1882] with but little modification, so far as Germany is concerned; but few instruments outside the larger ones of recent date possessing this great improvement. The reason of this is to be found partly in the extremely conservative character of their organ-builders—almost a national trait, and still more in the *fact* that but little use would be found for a Swell organ outside solo playing. With us," concludes the able Prof., "nearly the reverse is true, the Swell being most indispensable in accompanying choirs as here constituted." Passing on to the year 1738, we find not only that the Swell has become (even in its primitive form) firmly established, but that it is described in glowing terms. In the articles of agreement entered into by John Harris, organ-builder, of London, for the construction of an organ for the parish church of Doncaster, the following passage occurs relative to the Swell Organ:—"The Eccho Organ to contain the following stops, which shall Eccho and Swell to express passion in degrees of Loudness and Softness, as if inspired by human breath,—viz., one open Diapason with twenty-seven speaking pipes, one stop'd Diapason with twenty-seven pipes, one Principall with twenty-seven pipes, one Cornet of three rows with eighty-one pipes, one Trumpet and one Hautboy with twenty-seven pipes each. . . . The keys of the Ecchos and Swelling from C sol fa ut Cliff to D la sol in all being twenty-seven keys." At this time the "Nag's-head Swell" continued in use, and had only a very limited compass—namely, from middle c^1 to d^2, or thereabout. In the year 1769, Burkat Shudi, a maker of harpsichords, took out a patent for "a piece of mechanism or machinery by which the harpsichord is very much improved." In his specification he thus describes his invention:—"A cover extending the breadth of the harpsichord, and from the front board of the harpsichord to the ruler, of an indefinite number of valves, which, with their frame, extend the breadth of the harpsichord, and the length thereof from the ruler to the small end, which valves are opened and shut by a number of small levers equal to the number of valves inserted or fixed in an axis spindle or bar turned by a pedal." You are to understand by this description that the top or cover of the harpsichord, instead of being a solid board, such as we see in Handel's harpsichord in South Kensington Museum, was formed of narrow pieces of wood suspended by centre-pins in a frame of the size and shape of the instrument, and made to open and shut all together by means of a series of small levers controlled by a foot lever or pedal. When closed, the sound of the strings were very subdued; and, of course, when the pedal was depressed by the foot of the performer, and the narrow pieces of wood or the shutters turned, more or less, so as to leave openings between their edges, the sounds swelled forth. You will observe that Shudi's invention was really shadowed forth in Mace's chamber-organ, with its table top and eight lifting desks or shutters. Only, as we have seen, these desks had to be raised or opened by hand, and were not under the direct control of the performer. These facts show how slowly ideas develop, for it was about thirty-six years after Mace's invention for controlling the sound of his organs that Jordan invented the nag's-head swell; and it took another long period of fifty-seven years before any appliance was introduced which pointed the way to the improvement of the organ swell-box. Shudi's invention was the precursor of the mechanical portion of the Swell Organ as we now have it. The honour of having applied Shudi's system of moving shutters to the organ swell-box is accredited to Samuel Green, of London; and the swell as constructed by him was termed the "Venetian Swell," probably on account of its resemblance to a venetian blind or shutter. All who believe in the great importance of the Swell Organ, should hold Green's name in high respect; for, apart from his ingenious adaptation, he developed the entire department considerably beyond the limits adhered to by his predecessors. Indeed, he may justly be called the father of the Swell Organ in its modern treatment. In the organ he built for the chapel of Greenwich Hospital, he carried the Swell department down to F F, only three notes short of its present full compass downwards. This instrument was built in 1789. In the following year he built his notable organ for St. George's Chapel, Windsor, inclosing even the Great Organ in a large swell-box. He might have had a prescience of the important rôle the swell-box, as treated by him, was to play in the organ of the future. I cannot, in honouring the name of this great English organ builder, help wishing that we had some Samuel Greens amongst us now, for it would be well for the art we love. It was not a small step for any one man to take, from the half-stop, nag's-head swell to the Venetian swell of almost the full modern compass, and to the bold experiment of inclosing the Great Organ stops in a swell-box. We now enter the 19th century, and may pass over its first half with the general remark that it saw no further development of the Swell than had been achieved by Green in his ordinary instruments. In the year 1855 the large concert-room organ was erected in St. George's Hall, at Liverpool. This most important organ, although remarkable for the great compass of all its four manual departments and the grandeur of its tonal resources is only furnished with one *expressive* department—the Swell Organ. This contains 25 speaking stops, and is, unquestionably, a very fine and most effective department. As it is in all probability due to this organ that I have the great pleasure of addressing you this evening, I may be pardoned if I dwell upon it a little. Between the years 1856 and 1884 it has been my privilege to listen to this magnificent instrument weekly—very often three times a week—played by probably the greatest master of the Organ now living. During those twenty-six years I had every opportunity of realising all that both the Organ and its master were capable of doing. You will admit that I had the best possible means of discovering both the strong and weak points of the instrument. On its strong points—so well known to all lovers of the Organ—I need not enlarge; but on its chief weakness I have to pass a few remarks. This weakness may be summed up in a very words—deficiency of powers of expression. The expressive powers of its truly fine Swell Organ are, of course, perfectly satisfactory, so much so that it is impossible, for me at least, to avoid regretting that similar powers have not been bestowed upon other departments of the Organ. It was within a very few years after I first became acquainted with the St. George's Hall organ that the weakness alluded to forcibly struck me. I soon discovered that its weakness lay in its *strength*—in its strength or inteusity of tone, which could not be regulated at will without manipulating the stops—a mode of regulation quite different from that understood in the term expressive power. Manipulation of the speaking stops gives tonal colouring, whilst the use of the swell gives degrees of power, flexibility, and expression to such tonal effects. As I shall have a good deal to say on the subject of the swell and its application to the several departments of the modern organ later on, I shall content myself now by pointing out the manner in which a performer on such an instrument as that in St. George's Hall is handicapped. He has an immense organ under his hands and feet—four manual departments, comprising 83 speaking stops, with a compass from G G G (commonly, and I think unwisely, called G G) to a^3 = five octaves and two keys; and a pedal department of seventeen stops: yet, of all these stops, only twenty-five are capable of control or expression, in the sense I use the terms. Now, the whole of the fine series of stops in the solo organ, comprising nine powerful reeds, and such solo stops as the Tromba, Clarinet, and Orchestral Oboe in the choir organ, and all the reeds in the great organ are absolutely beyond the control of the player; and accordingly have to be used at one unvarying strength of tone from one year's end to another. Surely no one with anything like a refined ear, or a sense of musical propriety, can question the absurdity of leaving entirely without powers of expression such stops as the Clarinet, Orchestral Oboe, and heavy-pressure reeds, such as the Solo Tromba, Ophecleide, Cornopean, and Trompette Harmonique, which speak, with almost overwhelming power, on wind of 15in. and 20in. After being an attentive listener to the organ in question for a lengthened period, and having carefully noted its tonal effects, and its manipulation under the skilful hands of Mr. Best, I came to the conclusion that, notwithstanding its great and grand tonal resources, it was sadly deficient in flexibility and powers of expression. The more I thought of the matter, and the more closely I analysed the methods followed by the talented organist in using the different departments of the instrument, the firmer became the conviction that the organ *per se* was inherently an expressionless instrument, and that it was, in its usual construction and appointment, radically wrong. This conviction, which was arrived at about the year 1864, induced me to take up the study of organ construction.

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[*] Paper read before the College of Organists by George Ashdown Audsley, F.R.I.B.A.

(*To be continued.*)

ONE WAY TO GILD ON GLASS.

THE glass must be thoroughly cleaned and polished. A size must be prepared as follows: Isinglass, 1oz.; dissolve in just sufficient water to cover it. When dissolved, add a pint of rectified spirit of wine, then increase the quantity to a quart with water; keep tightly corked. Or, take best rum, half a pint; isinglass, ¼oz. Dissolve the isinglass in the rum at a low temperature, then add half a pint of distilled water, and filter through a piece of old linen. Place the glass flat on a perfectly level table, then with a clean brush flood the glass with the size to the depth of ⅛in.; raise the gold leaf with a tip, and lay it flat on the size. It will almost instantly adhere to the glass. In five minutes afterwards place the glass endways at a slight angle against a wall, that the surplus size may drain off. Allow the glass to remain in that position for twenty-four hours. By that time it will be perfectly dry. Draw the pattern or letter on a piece of paper, and with a thick needle pierce holes on the lines at the distance of $\frac{1}{16}$in. apart. Place the pounced paper on the gold surface, then dust some powdered whiting well on the paper, that it may penetrate the holes. Remove the paper carefully, and there will remain a correct copy of the design on the gold. Now fill up the outline of the design with oil goldsize in which has been ground some orange chrome; thin it with a little boiled oil and turpentine. When thoroughly dry, wash off the surplus gold with water and a piece of cotton wool.—*Pottery Gazette.*

THE VANISHING LADY.

THE following description of the "vanishing lady" is given by *La Nature*:—All that is necessary for the performance of this trick is a chair, a newspaper, and a shawl made of very light silk. The prestidigitator takes the newspaper, unfolds it, and spreads it on the floor under the chair, so as to separate the latter entirely from the floor. A screen is placed a short distance back of the chair. After this has been done a lady enters dressed in any style of costume, but generally in a Roman or Greek dress, and takes her seat in the chair. She is then covered by the shawl which we mentioned above, as shown in the figure, until she is entirely enveloped, even to her knees and feet. The sleight-of-hand performer then withdraws and calls out solemnly "one, two," and at the word "three" the shawl and the lady disappear as if by magic, leaving only the newspaper and the chair, Fig. 2. The effect is very startling, and until the trick is explained it is almost impossible to believe one's eyes.

Since this trick was first introduced it has been more or less perfected or modified in its form; but the following description states the methods generally employed in performing the trick.

If the newspaper is carefully examined, it will be found to be made of indiarubber, and to contain a large rent at about the centre. The paper is placed directly over a trap door, and the chair is placed upon it, and in such a position that the trap will open directly under the feet of the lady as she sits in the chair. While the lady is being enveloped in the shawl, an invisible frame is raised, which sustains the shawl, and gives it the form of the figure. When the shawl is finally in place, the lady tilts the seat of the chair, and passes between the legs, through the paper, into the trap opening which has been prepared for that purpose, and slides under the floor. At the same instant the chair tilts back to its original position, and at the word "three" the shawl is suddenly drawn behind the screen by means of an invisible thread. It appears as if it were the woman and the shawl which both suddenly disappear, as the movement of the shawl cannot be followed by the eyes of the spectator. The frame disappears at the same time, leaving nothing behind but the chair and the paper. The rubber newspaper returns to its natural form, and leaves no trace of the opening beneath.

THE BLUE OF THE HEAVENS.[*]

(*Concluded from p.* 132.)

IT may be readily allowed that ozone in large strata looks blue; but, after all, ozone exists in very small quantities in the atmosphere, certainly far too small to afford the solution of the deep blue of the heavens.

Lallemand[†] and Hartley[‡] are of opinion that the air is blue in the sense that it absorbs the ultra-violet rays, and emits them again changed to blue —*id est*, because air is a blue fluorescent body. As, however, all the components of the air are known, and none of them have proved themselves to be fluorescent bodies, this view must be considered as little else than an arbitrary assertion without actual basis.

Consequently, then, the explanation of the blue of the heavens is not to be sought in the fact that the air itself is blue. We are thus reduced to one supposition—air reflects the light, and lets red through; or, to speak more accurately, air, or its constituent particles, reflect the readily refrangible rays of short-waved length, and let the less refrangible long-waved rays through.

The reflected light of the sky appears blue to us, the sun yellowish, and when low in the horizon, even red, when its rays have to make a long passage through the atmosphere before they reach to us. But do not by any means take this theory as the explanation: it is but the expression of the fact that has to be explained, and, in reality, implies nothing more than that the sky is blue. Consequently the question renews itself in the following form: Why does air reflect blue rays, and let the red through?

The first answer to this question was given by Newton,[*] who says: "All vapours, when they begin to condense and coalesce into small parcels, become first of that bigness whereby such an azure must be reflected." These now reflect light from their external and internal superficies exactly as do the larger drops in clouds, or in rain, as, indeed, you are all aware from the explanation of the rainbow. This external and internal reflected light, however, comes into interference, and, in consequence of the latter, must necessarily be blue, provided that the suspended aqueous particles distributed through the air be very minute. According to this, the blue of the heavens would be an interference colour, and, in fact, the so-called blue of the first order! To enable you better to understand this, I would recall to your minds Newton's colour-glass. You know that it is composed of a plain sheet of glass, upon which rests a very slightly-curved lens, so that from the centre of the glass, where the lens rests, to the edge is a very thin stratum of air, slightly increasing in volume towards the outer edge. If now you allow a white light to fall upon this colour-glass, and examine the light reflected from it, you will see coloured rings. The colours of these rings are produced by the interference of the light reflected from the upper and lower superficies of the inclosed air space, and, as a matter of fact, the colour at the thinnest part of the air stratum (that is, the centre), is blue. In like manner, Newton believed that the blue of the heavens was generated by the interference of the rays reflected from the external and internal parts of minute water globules.

Now, it is by no means positively known whether Newton considered those infinitesimal water particles to be minute drops, nor, indeed, whether he imagined them to himself as minute as the above theory demands. But it is undoubted that he conceived the blue of the heavens to be an interference colour, and, moreover, a blue of the first order. Newton's conception was accepted by most natural philosophers. Later it received its strongest support from Clausius, who, after having first sought[†] to prove that the moisture suspended in the air must be present in the form of minute hollow bubbles, filled with air, worked out a calculation showing that if the walls of these bubbles were only some 0·0001 millimètre thick (about one quarter of the wave-length of violet light), that the light reflected from these bubbles must of necessity be blue, and that this blue was the blue of the first order, accepted also by Newton. He finds that the greater the tenuity of the walls of these bubbles, the deeper must this blue become.[‡]

Clausius's theory upon water bubbles and the blue of the sky achieved a wide reputation and acceptance, and, even in the present day, has many supporters; although it has become, as far as regards the bubble form of the moisture present in the air, utterly untenable. From direct observation, as also in many indirect ways, in later and most recent times, there is indubitable proof that the floating moisture in the atmosphere is only present in the form of drops. If, then, the blue colour of the heavens is to be explained as an interference colour of light reflected by aqueous particles, those particles must of necessity be accepted as in the form of drops. We shall see presently that these drops, however, must be conceived as so minute that the whole theory falls to the ground.

Brücke,[§] in a celebrated experiment upon the colours of turbid media, has demonstrated that it is very essential that the magnitude of the gross elements be taken into account. A turbid medium we call any substance through which are distributed particles of another substance differing from it in density and refracting power, and in which these particles must be sufficiently minute as to be invisible, and only act by diminishing the transparency of the whole mass. In this sense, air is necessarily a turbid medium, inasmuch as heterogeneous particles are always in it; at any rate, always infinitesimal water drops. Now, in transmitted light turbid media appears yellow to red, while light reflected laterally is of a bluish white. Brücke's investigations establish the fact that the colours of turbid media are only seen in their full beauty and purity when the gross particles are so small as to be invisible under the highest power of the microscope; while with larger particles the difference of colour betwixt transmitted and incident light becomes less; also that the light dispersion lessens according to the diminution of the size of the particles. From this, Brücke draws the following deduction:—The facts I have been describing point, in my opinion, clearly and distinctly to but one conclusion from the optical properties of the atmosphere, with regard to particles whence the blue of the sky and the red tints of morning and evening are derived—namely, that these particles are exceedingly minute, and, as a rule, are more or less uniformly distributed throughout the atmosphere, although the upper strata of the same may contain them in much smaller quantities than the lower. Herewith a new aspect was imported into the whole observation of the colours of turbid media, that naturally was also authoritative in the solution of the blue of the heavens. Clausius, at once recognising the full import of Brücke's investigations, wrote:—"A new aspect of the whole matter is presented by the result of Brücke's experiments . . . . From it it were necessary to assume that very minute bodies are not subject to the ordinary laws of refraction and reflection . . . . In this case, however, the theory of the colours of thin laminæ is also no longer applicable, and must be worked out afresh."

Brücke's observation that the more minute the particles, the less is the light dispersion, and the finer the colours of turbid media, was confirmed by the following investigations; hence the above hypotheses of Clausius, the principal representative of the theory that the blue of the heavens is an interference colour, constitute in themselves the most complete refutation of his and Newton's views. It is evident, then, that the blue of the heavens is not to be conceived as a blue of the first order, nor as the interference colour of thin laminæ. Hence it becomes a question of a new development, as Clausius had said, and this new development must be irrespective of reflection and refraction, inasmuch as Brücke's experiments had proved such minute particles to be unaffected by ordinary laws.

Lord Rayleigh[*] (then the Hon. W. J. Strutt) followed out this new line in 1871. Close upon two decades have passed since then, and yet this only sound solution of the blue of the heavens has aroused little or no attention even in meteorological circles. I have, therefore, felt it desirable to give you, if possible, a clear statement of this apparently sole correct theory of our subject.

Imagine to yourselves the actual conditions of our atmosphere. Everywhere, where the shadow of the earth does not directly fall, our ether is flooded with an uninterrupted stream (so to speak) of light rays and solar rays. First picture to yourselves this stream of rays, which is, in fact, a wave movement spreading out unhindered in a perfectly uniform homogeneous atmosphere. If now, however, gross bodies are generated in this atmosphere, the wave movements of the sun's rays will encounter obstacles in these small particles, which, you will remember, we must consider as infinitesimal. What is the result? We know that we must not say that reflection or refraction, in the ordinary sense, takes place. Let us, then, say that a disturbance of the original wave-movement results. How are we to represent to ourselves such a disturbance? We can only imagine it as the infinitesimal particle having become the centre of a new wave-movement, so that from it, as the centre, there are new elementary waves being radiated on all sides in the form of an ever-increasing sphere. To the solution of this problem two magnitudes have to be especially taken into account: the volume of the infinitesimal particle, which we have come to know as the generating centre of the new elementary waves; and the wave-length of the light coming from the sun upon which the gross bodies act obstructively. Unfortunately I cannot here give you an exact insight into the following mathematical solution of the problem, nor would it be possible for anyone in its present state of development to offer the Clausius theory for popular acceptance. The result, however, is easy of comprehension. It is: the light emitted laterally from these small gross particles, or, let us say, the light reflected from them, is, with reference to its intensity, inversely proportional to the fourth power of the wave-length of the incident light. In other words, the short waves of light, consequently

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[*] A lecture delivered by Dr. J. M. Pernter to the Association for Promotion of Scientific Knowledge in Vienna. (Vereines zur Verbreitung Naturwissenschatliches Kenntnisse in Wien).

[†] Compt. Rnd. 75 Bd. 1872, p. 709.

[‡] Nature, 1889, Vol. xxxix. p. 474.

[*] Optics, 2nd bk. pt. 11, prop. 5 and 7.

[†] Poggendorff, Annalen, 76 Bd. p. 161.

[‡] Poggendorff, Annalen, 76 Bd. p. 188.

[§] Poggendorff, Annalen, 88 Bd. 1853, p. 382.

[*] Philosophical Magazine, 4th series, Vol. XLI. 1871, p. 167.

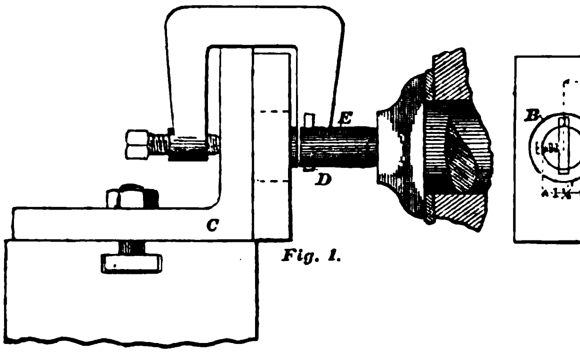


Fig. 1.

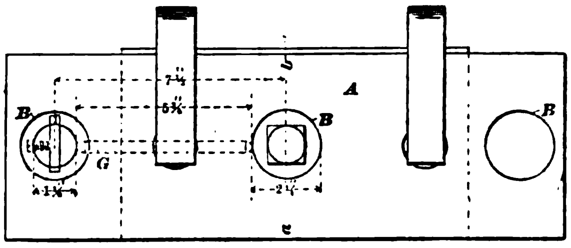
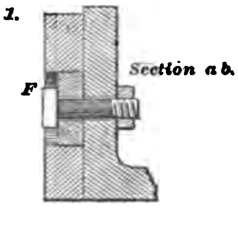


Fig. 1.



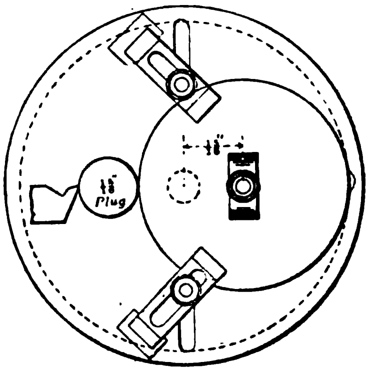


Fig. 2.

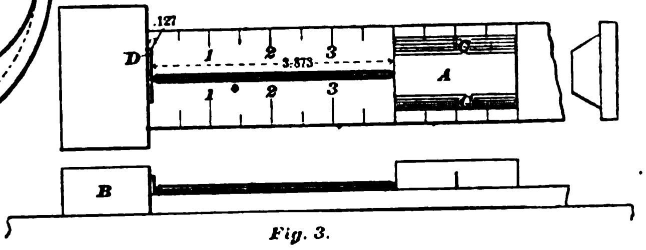


Fig. 3.

the blue colours, are much more strongly reflected than the long-waved red ones. On calculation we find that the blue in the light reflected from the sky is 4-5 times stronger than the yellow, and 6-7 times stronger than the red; violet even 6-8 times stronger than the yellow, and 9-10 times stronger than the red. These relations of intensity must necessarily, then, cause the reflected light to appear blue. Lord Rayleigh proved these results of measurement of reflected skylight, and found both calculation and observation to be in close agreement.

Observation has not determined the definite size of the gross particles; in any case, Lord Rayleigh's calculations hold good if the particles be smaller than the smallest wave-length under consideration, that is, less than 0·00035mm. Whether somewhat larger particles would have the same action, is not to be affirmed or denied with any certainty. One thing is however certain: that particles many times larger than a wave-length of light do reflect light by the ordinary laws of reflection, and as this reflected light is white, as is that projected upon it, the presence of these larger particles must cause the blue vault of the sky to appear increasingly white, and as they become larger and larger, to gradually assume a pale whitish grey. The which again is perfectly in accord with experience, which teaches us that the greater the density of the atmosphere, the paler and whiter does the sky appear, until a veil of cloud imparts to it an absolute dead white or greyish hue.

The blue of the sky is connected with the phenomenon that the blue light of the heavens is always polarised, and ever in the same direction, which is quite independent of the nature of the turbid particles, as long as these last do but produce a pure blue colour. This fact remains to be elucidated in a completed theory of the subject. Lord Rayleigh explains it in principle, although he has not worked out his reasoning. Soret[*] has also assigned grounds for it in accordance with Rayleigh.

I will not go further into this point, as it is more difficult of universal comprehension, although, as appertaining to my subject, I could not leave it unnoticed.

The red hues of the rising and setting sun, as also the green tints observable at twilight, find their solution in Lord Rayleigh's theory. I may have occasion to address you on those points later.

GOOD WORK AND GOOD WAYS OF DOING IT.[†]

In order to decide the best way to proceed in doing a given piece of work, a large amount of study is often required. When we say that such a man is a good machinist, one who is capable of doing good work by the most modern methods, we should not try to convey the impression that that man can decide the very best way to proceed in any given case at a moment's notice. Years of experience, together with careful study of all occurrences during these years of experience, will help the right kind of a man to correctly weigh all the points in a case, and so pass a fairly correct opinion; but this is never an instantaneous process, nor is it always dead sure.

Inventing little kinks to fit the work by the workmen themselves is an every-day occurrence. Each little kink is a distinct invention, just as much so as the telegraph or telephone is, but, of course, of less value; for the value of an invention depends upon the extent of its application. It is just as unreasonable to reflect on the ability of any foreman for not showing a boy or man all the kinks that will apply to the work in hand, as it would be to reflect upon the abilities of all the smart men of the ages gone by for not inventing the telegraph.

I find it a good plan, when starting to do a good piece of work, to first find out, if possible, just what the work is for, or, if this is impossible, to find what degree of accuracy is needed in different parts of the work. No person can work with intelligence without knowing this. Next in order comes the means at hand to work with; we have to plan to fit our tools.

I have a few practical examples to show. In Fig. 1 I undertake to show how a piece was bored for a jig to the accuracy required. A shows the face of piece to be bored, and B B B the three holes that were required to be spaced equally, and all on a line parallel with the edge of piece, within a limit of about ·002in., or, if less, all the better. We knew just what this piece was for, so the first thing was done.

We could locate three buttons on the face of the work, and then true them in the lathe by swinging the piece over; but that would not do, for there was not a lathe to be had that would swing the piece when boring the end holes, and, besides this, we do not like this way of working when there are better ways within reach. There is a chance for error in locating each button, and there is a chance for another in truing each one in the lathe; and besides these chances for error, there is a good chance to waste a large amount of time and patience by such a method.

We could bolt the work to the lathe carriage, but this would be too inconvenient. We could do the job on a good upright drill, but we did not have such a tool. We could do the job on a good boring machine, but this we did not have. The next thing we think of is the milling machine, which we have. We drill and counterbore the holes on the old drill press to within $\frac{1}{16}$in. of size.

We then clamp the work to a knee on milling machine platen, as shown in Fig. 1, and bore the central hole first, with the single-pointed cutter D, first just truing the hole, then measuring through the sides with calipers to find which way the knee of milling machine needs moving to bring the hole in the centre of piece; then, after we have found the centre, we bore the hole to size. Before starting the boring we had trued a spot at E on the boring arbor, and turned it to the size (1¼in.) in its place by holding a lathe tool in the milling machine vice and turning it as in the lathe. After boring the central hole we fitted to it the bushing, or collar F (shown in section A B), to just a snug push fit. We then arranged the work as shown in Fig. 1, bolted the collar F to the knee through the hole in work, with the work resting on the edge of platen as shown, then set the distance from hub F to end of boring arbor E with the "end measure" G, by drawing the milling machine platen back.

When everything was right we made the platen fast, and bored the first end hole. Then, leaving things set as they were, we turned the piece "end for end" and bored the other hole, and so easily got what we wanted.

In Fig. 2 I show that I have used for spacing two holes in a disc accurately. As in the case shown, I want two holes $\frac{11}{16}$in. apart. I bore the central hole first on the face plate as shown, having first made sure that the face plate is true and flat, and having the back side of disc squared true. After boring the central hole, without changing the position of work I true the outside of disc. I then set the work off centre till the $\frac{11}{16}$in. plug will just fit the throw as shown, and we could quite easily by this way get the space within ·0005in. of what is required.

In most modern machine shops a great many "end measures" are used. For short "end measures" many places have either micrometers or verniers, but for long ones in most places I think a steel scale is the only thing available. I show in Fig. 3 a little block (A) which is a convenience in "taking off" measurements from a scale.

I would have the scale rest on a flat surface, and have the square block B at an end, as shown, so as to fit end measure between block A and block B, as shown. I make block A just two inches long, with square ends, then stand it on end on a surface plate, and with a scratch block draw the two lines on each side (C C) by changing the piece "end for end," and with the pointer of scratch block set, I plan to make the space between the lines about the width of a line on the scale. When we have an "end measure" to make, as shown (3·873in.) to some dimension not on the scale, I use a thin piece as shown at D, which I can make to the required dimension by the use of a small micrometer caliper. Sometimes I use paper of the desired thickness.

A SEWING-MACHINE that was exhibited in Boston a few days ago stitched easily and rapidly through layers of leather ⅜in. in thickness. In a second trial stitches were made evenly and rapidly through a piece of birdseye maple ⅜in. thick, and in a third test the machine sewed through a layer of brass ⅛in. thick, placed between pieces of leather.

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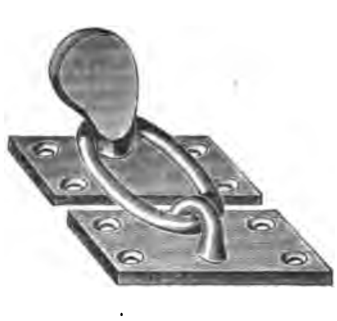
[*] Archives des Sciences (Geneva), Vol. XX. 1888, p. 442.

[†] Extracted from an article by "A MECHANIC" in the *American Machinist.*

PICCAVER'S PATENT SASH FASTENER.

THIS invention provides in a simple form a really reliable and strong fastener, drawing the sashes together, and preventing all shaking. It is specified for the buildings being erected for the Guinness Trust Commissioners, and is the invention of Mr. J. A. Piccaver, architect, of 2, Newland-chambers, Northampton. The link-plate is fixed on the lower sash, and the thumb-bit on the upper sash, so that when closed the link touches the neck of the thumb-bit, in same position as shown in the sketch. The fastening is perfectly burglar-proof, and there is no fear of the sashes sticking. It is reasonable in price, and ought to find favour.



Germ-Free Drinking Water.—We now know, says Dr. F. Blanchard, of Washington, enough about the causation of disease to be certain that a large proportion, particularly of intestinal diseases, are due to organic impurities in drinking water. To provide healthy drinking water for dense populations is one of the most difficult problems of sanitary engineering. While the engineers are solving the problem, and while Philadelphia, Chicago, and Cincinnati are trying to make filthy water fit to drink, it is well enough to remind the individual that, as far as the home circle is concerned, each family may be safe at this point by a very simple expedient—viz., boiling all the water used for drinking purposes. Strain or filter ordinary hydrant water, to remove coarser impurities; boil it for half an hour in the family tea-kettle; put it in a clean receptacle; cool it by packing ice *around* it, not by putting ice *in* it, and you may be tolerably certain that there are no disease-producing germs left in the water. When you go away from home, the problem becomes more complicated. You must either take your chances, or go to greater trouble to be safe. Coffee is safe. Whisky is worse than bacilli. The side-walk pump and the "old oaken bucket" are reeking abominations. The public drinking fountain—who knows what diseased lip has touched the cup just before you? Away from home, as well as at home, if you want to be safe, boiled or distilled water is still your best drink.

Underground Electrical Cables.—In a note on an underground line laid in a cement conduit by Mr. E. Brylinski — *Proceedings* Inst.C.E. — the author relates his experience of a line from Tarare to Reanne, a distance of 25¾ miles. It was constructed in 1885, and consists of three cables laid in a cement conduit. In 1890 it was examined, and 394 faults removed. They were found to fall into two classes:—(1) Those due to lightning discharges. These were shown either by a small round hole in the insulation, or else by a rent extending nearly round the wire; in either case the copper was blackened by oxidation near the hole, and when the discharge had been violent, bits of broken copper were found. When the insulation was otherwise good these faults were easily found and removed. (2) The faults of the second type were quite different: long lengths of a mile or more were found to be rotten, the outer covering of the yarn and prepared tape having completely disappeared. The trough contained an ill-smelling blackish fluid, and the gutta-percha on the wires was covered with yellowish-grey stains, apparently due to particles of cement torn off by the water which flows in the conduit and deposited on the insulation. This is proved by the top cable, which was not in the water, being little affected. The author is of opinion that the mischief is started mechanically, and that a chemical action then sets in, rendering the gutta-percha spongy and the insulation very low. These faults were most difficult to repair, working on one causing another to develop near it. After careful examination the author was unable to find any relation between the faults and the surroundings of the line, though the composition of the cement varied from point to point, and this, apparently, had something to do with the action. A noteworthy fact is that the cables were unequally attacked.

SCIENTIFIC NEWS.

THE nearest approach of Wolf's Comet to the earth will be on the 26th inst., when its position at Berlin midnight will be R.A. 4h. 41m. 33s., N. Dec. 31·4′, the brightness then beginning to decrease. Mr. Bellamy gives its position for Oct. 11, Greenwich midnight, as 4h. 36m. 31s., N.P.D. 81° 21′.

From Edinburgh Circular, No. 20, we learn that Prof. Krueger telegraphs from Kiel that a bright comet was discovered at the Lick Observatory, Mount Hamilton, by Mr. E. E. Barnard, on October 2nd, at 16h. 53·9m. local time, in R.A. 7h. 31m. 24s., and S. Dec. 27° 54′. It was moving to the south-east. Through the same channel we learn that the long-expected Tempel-Swift Comet (1869 III.) was also found by Mr. Barnard, who describes it as exceedingly faint, and was subsequently also seen at Berlin, the respective places being:—Mount Hamilton, Sept. 28, 8h. 39·4m., R.A. 20h. 53m. 25·4s., S. Dec. 1° 22′ 36″; Berlin, Oct. 4, 12h., R.A. 20h. 52m. 44s., S. Dec. 0° 24′ 0″. The comet is now nearly stationary in right ascension, but is moving northwards 11′ per day. It was independently detected by Mr. W. F. Denning, at Bristol, on Sept. 30, who found it still very faint.

From another source we have received the following:—Tempel-Swift's periodical comet was rediscovered by Prof. Barnard at the Lick Observatory on Sept. 28 in R.A. 313° 21′ 21″, Dec. S. 1° 22′ 36″, motion to north-west, excessively faint. The comet was independently discovered by Mr. W. F. Denning, of Bristol, on Sept. 30 at 9.30 p.m., and he gives the approximate place as R.A. 314°, Dec. S. 1°, and describes the comet as very faint, pretty large, with a daily motion of about 12′ to N.W. The discovery position is about 4° S.W. of the computed place. The comet was also observed at Bristol on Oct. 1, 2, and 3, and Mr. Denning says it is pretty obvious in a 10in. reflector, power 60.

It appears from the calculations of Herr Lange, of Berlin, that the minor planet discovered by Dr. J. Palisa on August 14, is, as suspected, identical with 149, Medusa, so that the total number known is at present only 317.

The Gresham Lectures on Astronomy, to be delivered on the evenings of Oct. 20, 21, 22, and 23, will be by the Rev. Edmund Ledger, M.A., F.R.A.S., who will on this occasion take for his subject, "The Sun in Relation to the Past and Future of the Tides." The lectures are free, and are delivered in Gresham College, Basinghall-street, E.C., commencing at six o'clock each evening. They are illustrated by means of the limelight.

The death is announced of Capt. Vandevelde, the Belgian artillery officer whose travels on the Congo made his name well known. He died on board the steamer *Lulu Bohlen*, on his way back from the Congo.

Prof. Max Müller was present at the distribution of prizes at the Mason Science College, Birmingham, and took the opportunity of saying that he thought it was likely that the Universities of Oxford and Cambridge would so far relax their rules as to permit students educated at Mason College to receive degrees, if only of a second-class character, without residence in the University. Some public-spirited citizens had greatly assisted them by the establishment of an endowment fund; but he thought they ought to call on the Government of the country to see that much greater assistance was given to an institution like theirs, which had done so much. Their curriculum was very much extended beyond what was originally laid down; but he should not be content until he saw the college in possession of means which would enable them to establish professorships and lectureships to cover the entire ground of such learning as was requisite to a degree in any University. If the wealthier classes of the country were alive to the signs of the times they would certainly establish, not only in that college, but every other institution which gave public instruction, professorships of logic and political economy.

A paper on a curious but interesting subject has been presented to the Paris Academy of Sciences by M. A. Chauveau. He finds that the excitation of the retina of one eye by coloured light influences the optic nerves of the other eye as well, in such a manner, too, that while the eye acted upon indirectly sees the colour, the retina actually excited sees the complementary colour. Observe a white surface with one eye for a short time through a bit of coloured glass, then when the glass is removed the white surface appears to be tinted with the complementary colour of the glass. That is a comparatively well-known fact; but what M. Chauveau points out is that if the eye first used is closed, and the white surface is examined with the other, it appears to be of the same colour as the glass. That would appear to show that the optic nerves of the closed eye are acted upon by those of the examining eye.

Mr. Louis Fagan, of the Print Room, British Museum, will deliver a course of three lectures—viz., on line engraving, etching, and mezzotint—at the St. George's Hall, Langham-place, on Oct. 20, 27, and Nov. 3.

Dr. Von Limbeck has been lecturing before the German Association of Physicians on paralysis from lightning. He divides all cases of paralysis from lightning into direct and indirect. He separates the symptoms of true paralysis from lightning into those which are due to the direct action, and those due to wounds of the nerves. The paralysis of the nerves ceases much sooner than that of the muscles, he thinks, because the effect of the "stroke" is greater on the muscle's functional energy than on the nerve.

The *Kew Bulletin* for September, besides Mr. Shipley's report on orange scale in Cyprus, contains sections on the rediscovery of guttapercha trees at Singapore, on a new process for recovering some portion of the guttapercha which is left in the bark of the trees after collection by the ordinary native method, on the fodder plant Tagasaste, and on Kangra buckwheat.

It appears that goitre is increasing in France, no fewer than 420,000 persons being affected in thirty of the departments. It is technically a swelling of the thyroid gland, and is known here commonly as Derbyshire neck. It is often found accompanied by cretinism, which, it seems, is becoming more common in the valleys of the Alps and the Pyrenees. The origin of the term does not seem to be known; but it means imperfect development, not to say deformity of the whole body, and is found chiefly amongst those who live in the valleys of mountainous districts. The French Government will probably be asked to order an inquiry into the whole subject.

A twin-screw steamer of light draught, the first of two sister vessels intended for the Brazilian trade, was launched the other day from the yard of Messrs. Day, Summers, and Co., Southampton. These steamers are 155ft. in length, with a beam of 30ft., and are designed to carry 250 tons dead weight of cargo on a draught of 5ft. They will be propelled by triple-expansion engines, working at 160lb. pressure.

The *Railroad Gazette* gives a full account of the wonderfully fast run on the Philadelphia and Reading Railroad. According to that paper, the 90·5 miles an hour appears to have been made for a few minutes on a level bit of line immediately following 50,000ft. of down grade of 37ft. per mile.

The Camera Club, Charing Cross-road, are holding their seventh exhibition of the "one man series," and visitors can obtain admission on presenting a card, to be obtained of the hon. sec., or any of the members.

In connection with the exhibition of the Photographic Society, attention should be drawn to the "Aërial Graphoscope" of Mr. Eric Stuart Bruce, which is used for showing magic-lantern pictures without a screen. It consists of a lath, painted a suitable shade of grey, and caused to revolve at high speed. It is shown in action on the evenings when the optical lantern is used.

The Battersea committee of the University Extension Society have arranged for a course of ten popular lectures (with experiments) on Magnetism and Electricity, by Mr. J. W. Waghorn, D.Sc. of the Royal Naval College, Greenwich. The lectures will commence on Thursday evening, October 15th, at 8, and will be delivered in the Public Library, Lavender-hill. Certificates will be awarded by the joint universities board at the completion of the course. Students attending these lectures will be entitled to free tickets to the University lectures on

Physics, and the Greek Drama at Gresham College. Tickets for the course (5s.) may be obtained at the lecture-room on the evening of the lectures. The committee have also arranged for a course of lectures on Botany. Information may be obtained of the hon. secs., 101, Ashbury-road, or 4, Brynmaer-road, Battersea.

In conformity with the Board of Trade regulations, the North London Railway has commenced to fit its rolling stock with the automatic vacuum brake, in place of the chain brake hitherto used on the line. The first train so fitted began running last Monday on their Great Northern suburban service.

The outcome of the recent competitive marine anti-fouling trials made by our Admiralty authorities, is that last week the French composition (Tugots') was applied to H.M.S. first-class ironclads, the *Camperdown* and *Howe*. It may be remembered by some that this paint was recommended to our Naval authorities by Admiral Domville, British Naval Attaché in Paris, who had observed its successful achievements in the French navy. July twelve months ago our Admiralty ordered a trial of this composition to be made on H.M.S. *Orontes*, side by side with other accepted paints. The result was satisfactory; but the experiment was repeated in February last, the vessel returning to Portsmouth in July, after a cruise of over 23,000 miles. Upon dry-docking the ship, it was at once seen that the portion of her bottom coated with the French paint was again quite clean, whilst the rest was all more or less foul. The French composition is also being tried by Donald Currie, Wilson and Glen Companies, &c.

A Remarkable Californian Tree.—One of the greatest curiosities of the Chicago World's Fair promises to be that sent by Tulare, California. A red-wood tree is growing there which is 390ft. high. It is intended to cut from this tree a log 90ft. long and 20ft. in diameter. By cutting the log in half, and hollowing out each portion, it will be turned into two railway carriages, one fitted up as a dining car, with buffet, bathroom, barber's shop, and kitchen, the other to be a sleeping car, with an "observation" room. The rough bark of the tree will be left on for the roof, while the sides and ends will be of the natural wood, unpolished. The cars will be occupied during the exhibition by the families of the makers, and the rest of the tree will be cut up and worked into souvenirs.

Fast Mail Service.—The Inman and International Company's s.s. *City of New York* arrived at Queenstown from New York at 2 p.m. on the 8th ult., having made the passage in 5 days 22 hours 50 minutes, which is the fastest eastward passage on record. Her daily runs were 44, 436, 461, 460, 462, and 452 miles. The same company's s.s. *City of Paris* made the run eastward in exactly the same time in December, 1889, when she broke all existing records. The *City of New York* had on board the Japanese mails, which were brought from Yokohama to Victoria (Vancouver) by the Canadian Pacific Railway Company's fast s.s. *Empress of Japan* in 9 days 19 hours 39 minutes, and the same company carried them across the Continent to New York in the very short time of 88 hours. Both these performances broke all previous records. The *City of New York* arrived off the bar at Liverpool at 3.30 a.m. on the 9th ult., and anchored in the Mersey opposite the landing-stage at about 4.15. Her mails were dispatched to London by the 6.22 train from Lime-street, reached Euston at 10.12, and were delivered in London the same afternoon. Thus the Japanese mails were received in London well within three weeks after leaving Yokohama. The best previous record is, we believe, 30 days. According to American advices the speed on the Canadian Pacific was about 36·3 miles an hour, and on the R. W. and O. and New York Central it averaged 53½ miles for the 361 miles. The 95 miles from Utica to Albany was run in 90 minutes. This is very fast time, but it seems not to be the fastest. American railway companies are determined to show visitors to the Chicago Exhibition what American locomotives can do. The special correspondent of the *Standard* states that on Monday last an experimental railway trip took place which resulted in making the world's fastest long-distance record. This is preliminary to the establishment of a regular service by the New York Central Railway. A train made the journey from New York to Albany, 143 miles, in 140 minutes; to Syracuse, 148 miles, in 146 minutes; to Buffalo, 150 miles, in 148 minutes; a total of 436 miles, in 439 minutes, including six minutes for changing locomotives at Albany and Syracuse, and nearly eight minutes owing to a hot axle-box. There were no other stoppages, and an average speed was made, deducting stoppages, of nearly 61½ miles per hour.—*The Engineer*.

LETTERS TO THE EDITOR.

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[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor *of the* English Mechanic, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

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THE LAKES OF MARS.

[32788.]—La lettre 32767 de M. Schleusner vient à l'appui de ce que je dis dans ma lettre 32766. Avant de traiter *ironiquement* les lacs de Mars de *fameux* et leur nom de *pompeux*, cet auteur ferait bien d'approfondir encore plus ses études aréographiques; il saurait alors que certains de ces lacs ont été dessinés comme tels depuis 1830 par Mädler (*Lacus Solis* et *Lacus Tithonius*), que d'autres, comme le *lac Ismenius*, ont été dessinés sans le moindre apparence de canaux; les aréographes sont décidément bien à plaindre. Il n'y a pas d'example d'une pareille atteinte à la liberté; on leur défendait de dédoubler les canaux et voilà qu'on veut les empêcher d'observer des lacs!

"F.R.A.S." ne doit pas être embarrassé, comme il le paraît, par la critique de son dessin de Jupiter; avec son 4 pouces *il ne peut voir double la bande 4, au nord de 3 III.*; il faut une atmosphère parfaite pour que je la dédouble avec mon huit pouces; alors le dédoublement apparaît avec une grande délicatesse et je ne crains pas l'avis de M. Schleusner qui prétendra peut-être que c'est une illusion. Mais pour dédoubler facilement cette bande avec un six pouces, celui-ce doit être excellent et la vue de M. Williams doit aussi être extraordinairement perçante comme l'attestent toutes ses admirables observations. Pareil observateur seul peut espérer marcher sur les traces de M. Schiaparelli!

Dr. F. Terby.

THE DOUBLE LAKES AND CANALS OF MARS.

[32789.]—M. Schleusner appears to me to be altogether too hasty in his conclusions on these subjects. From his last letter on p. 134, we learn that the double lakes are "nothing but *a mere widening of the canals themselves*, and being part and parcel thereof, duplicate according to the same optical law." Well, let us test our knowledge on this point by comparison with observation. We will propose as an example, the Lacus Tithonius, the Dawes Sea of Proctor's "Map of Mars." This lake is much longer than it is broad, and hence might be considered to a certain extent, as "a mere widening" of a canal. In June of last year this lake was seen double by Prof. Schiaparelli. But in what direction? Not along or parallel to its length (when it might perhaps be argued that it formed a short double streak), but in the opposite direction. In other words, it appeared as two elongated spots *placed end to end*. How does this agree with the conclusion of M. Schleusner? It is simply inexplicable on the hypothesis advocated by him. With all respect to your correspondent's opinion, I am also totally unable to recognise that such objects as the Lacus Solis (the Terby Sea of Green's map) are "nothing but mere widenings of the canals themselves."

In letter 32736, p. 111, we also find an explanation of the reason why one canal appears double at the same time that a neighbouring one remains single. But rather unfortunately for this explanation, it does not appear to accord with the observed facts. There are many instances on record of very dark and definite canals appearing single, at the same time that very faint and delicate ones have been seen double.

A. Stanley Williams.

Burgess Hill, Oct. 3.

WOLF'S COMET.

[32790.]—I agree with Mr. J. Bartlett (letter 32768, page 134), that Mr. T. Moore should inform observers generally the maker of such an extraordinary instrument as to show the above in a finder of less than 1in. aperture. From my experience of such telescopic comets, I can affirm that a refractor of about 4in. is required to reveal them as small objects resembling some of the well-known nebulæ. As Sir William Herschel described a nebula he found on Dec. 18th, 1783, near δ Ceti, "it is small and cometic."

I saw the comet with my 4in. achromatic by Grubb on the night of Sept. 28 in the same field of view with θ^1 and θ^2 Tauri, and again on Oct. 3rd, when it was situated a little below the Hyades. It was a pretty little object, and particularly so as a very small nucleus unmistakably flashed out at moments of best definition.

J. Locke Lancaster.

West Brighton, October 5.

[32791.]—In reply to Mr. J. Bartlett's letter (32768), I beg to inform that gentleman I did see the comet through the finder of less than 1in. aperture, and as for him wanting me to publish the name of the maker of so small an instrument, it is quite absurd; but to convince him that it could be seen with less than 2in. aperture, I reduced mine to 3in. aperture, it then having a circular disc placed at the back of the flat of 1¼in. in diameter, and allowing for the great quantity of light absorbed in the double reflector, it was then scarcely equal to a 2in. refractor, I then could see the comet quite distinct. I shall be very pleased to hear of any one else who has seen it with 1in. aperture, and to prove that I am correct in my statement.

Hatfield, Doncaster. **T. Moore.**

BARLOW LENS—CORRECTION OF TELESCOPES.

[32792.]—A little discussion that has taken place between a gentleman and myself in reference to the Barlow lens has led me to think that its action and the increase of power it gives are both somewhat indistinctly understood. A search through the back numbers of the "E. M." and such books as I have at command has not thrown much light on the matter.

Mr. Browning, in his "Plea," merely says it adds from ⅛° to ¼° to the power of any eyepiece. "F.R.A.S." said the rule for the increase of power was to divide the distance of the Barlow within the focus by the focus of the Barlow, which is not correct, unless it is understood to mean within the resultant focus.

One other writer found that he could vary the correction of his mirror according to whether the plane or concave side of Barlow was inward or outward, giving a valuable power of correction. I cannot find it makes the least difference with an achromatic Barlow which side is towards the mirror.

The true rule for increase of power is this. If the Barlow is placed 1in. within the focus, it will be found the focus is lengthened another 1in.—i.e., an 80in. focus with Barlow at 79in. will result in 81in. focus. If placed at 78in. it will be 82in.; if at 76in. it will be 84in.; and this is *entirely independent of the actual focus of the Barlow.*

The increase in size of the focal image is dependent on the focus of the Barlow; and calling the distance within the new resulting focus (or twice the distance of Barlow within original focus) D, and the focus of Barlow F, and the size of the original image 1, then the size of enlarged new focal image will be $1 + \frac{D \times 1}{F}$. If a Barlow of 8in. focus is placed 2in. within the focus of any o.g. or mirror, it enlarges the focal image one-half. But in measuring it is necessary to be very accurate, for a difference of 1¼ per cent. will be caused by ⅛in. error; and it is also necessary to ascertain the exact focus of the Barlow.

Many amateurs are at a loss to know whether their mirrors are properly or under- or over-corrected, and the Foucault and zonal tests are to the unpractised only a puzzle which they cannot solve. I will detail an easy way of settling the matter. The cylinder of light which reaches a Newtonian mirror has an interior cylinder dark, caused by mounts of flat. These are returned as a cone of light with an interior cone of darkness. If the mirror is properly corrected, both come to a point at the same focus. If it be under-corrected, the dark cone extends beyond the light one; and if over-corrected, it falls short. Place the telescope on the Pole Star, and focus as exactly as possible with a tolerably high power. Mark the place on slider. Now, with a small diaphragm on eyepiece, push in the slider until the dark centre of cone enlarges enough to just fill the field. Mark this again on slider, and pull out outside the focus until again the dark centre fills the field. Mark this place and measure the distance within and without the focus. If the mirror is quite correct, the best focus will be just half-way; if incorrect, it will be nearer the one or the other. Suppose we find that it requires to be drawn out twice as far as pushed in for same enlargement, then it is under-corrected; if the reverse, it is over-corrected. This can be easily seen diagrammatically by ruling two lines 1in. long at proportionate distances from a point laid down as the focus and joining their opposite extremities, when the apex of the dark cone will be shown by the point of crossing. I may add that if under-corrected the least push within the focus will show the black centre distinct, while outside it will require to be withdrawn some distance before it makes its appearance, and then will be less black and well defined. Over-corrected will show black centre quickly outside focus, and slowly and less definitely within.

Edwin Holmes.

NIGHT-GLASSES.

[32793.]—"F.R.A.S." cannot be a young man, and it is strange that he should have never heard of a marine telescope, or "night-glass," as it was called. Until they were superseded by field-glasses, such telescopes were in common use at sea, made without the erecting lenses. The saving of light was considered to compensate for the inconvenience of inversion. There must still be old telescopes with the words "Day and Night" on them, meaning that the erecting lenses could be taken out. In the beginning part of "Peter Simple" is a story about a night-glass. **C. M.**

THE AUGUST PERSEIDS.

[32794.]—I have no objections to future discussion with reference to the nature of the radiant of the August Perseids. But I am firmly convinced that there is a shifting of the point of radiation amongst the meteors that I have been fortunate to observe, and which have their centre of divergence nightly in this region of the heavens during the latter part of July and early part of August. The cause of the shifting I leave to abler exponents than myself to explain. I simply deal with facts of observation. I appreciate Mr. W. H. Milligan's confidence in his observations; but when he learns that my observations on the 15th August gave me every confidence *from naked eye observation* that I had a satisfactory radiant for this date, yet when I came to discuss the meteor paths I was very much disappointed to find that I had no definite centre of radiation, he will, I think, acknowledge that it is possible to be in error if there are no materials collected during the progress of the shower which one can discuss at leisure.

A dozen meteors well recorded are worth any amount of rough estimations. I hope my friend, Mr. Monck, does not overlook the great difference between 5° of R.A. on the equator, and the same number of degrees of R.A. at Dec. 50° to 60°, between which points the alleged shifting occurs in R.A. Also some allowance must be made for errors of observation, personal equations, and zenithal attraction.

70, North-street, Leeds. **David Booth.**

THE ICE AGES.

[32795.]—Not having read any article of Prof. Huxley's on the "Ice Ages," I do not feel much interested in what a penny pamphleteer calls his "mendacity," by which I presume he means error. Politicians do not appear to enjoy a monopoly of strong language at the present day.

An important element in the case, however, is the relative amount of solar heat in the past and present. On this point I suspect that I am not the only one of your readers who would wish to see a proof of what is known as Lane's law—viz., that a gaseous sphere contracting in consequence of the loss of heat will rise in temperature (the gaseous particles being, of course, subject to the law of gravitation). I have several times seen this law referred to as proved, but have never seen a proof of it. Neither do I know whether the increased radiation arising from this enhanced temperature would balance the diminution arising from the contraction of the radiating surface, or otherwise; and until this is determined, even assuming the gaseous nature of the sun, it remains doubtful whether the heat received by the earth is increased or diminished in consequence of the sun's contraction.

Dublin, Oct. 3. **W. H. S. Monck.**

WASTED FOOD.

[32796.]—I beg to return my sincere thanks to all those that have answered my query about fungi; but I find my first information was correct as to the difficulty of detecting poisonous from edible, and the high price of good books on the subject. I wanted to know if there was any book that was better than the rest in describing the difference between the edible and poisonous sorts, and at a low figure.

"The Lydney Dispenser" has kindly described the manufacture of sauerkraut; but as cabbage can be bought in the Forest at any time of the year, I think most persons would like it fresh. "Eos" advises me to join the Yorks Naturalist's Union, "where I should *see* specimens gathered." The New Forest is in Hampshire, on the borders of the Solent, therefore, a long way from Yorkshire. Any further information about fungi, or books on the subject will be thankfully received, as I have already had inquiries from outsiders to give information.

Lyndhurst. **J. Gerrard.**

MAGIC SQUARES.

[32797.]—I inclose (Fig. 1) a "magic" square of 64 squares, which vertically, horizontally, and diagonally add up to the same amount. I have been unable to evolve from it any rule; but the following coincidence may be noted as curious.

Fig. 1.

18	63	4	61	6	59	8	41
49	32	51	14	53	12	39	10
2	47	36	45	22	27	24	57
33	16	35	46	21	28	55	26
31	50	29	20	43	38	9	40
64	17	30	19	44	37	42	7
15	34	13	52	11	54	25	56
48	1	62	3	60	5	58	23

Fig. 2.

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64

Referring to Fig. 2, in which the squares are numbered consecutively. The adjacent pairs of numbers taken symmetrically:—

1·2 —63·64
9·10—55·56
33·34—31·32
41·42—23·24
19·20—45·46
27·28—37·38
Each add to 81.

7·8 —57·58
15·16—49·50
17·18—47·48
21·22—43·44
25·26—39·40
29·30—35·36
Each add to 49.

3·4 —61·62
5·6 —59·60
13·14—51·52
11·12—53·54
Each add to 65.

Now, the total of any column is 260. Add 81 to 49, and it is equal to half 260, or 130. Twice 65 is equal to 130.

Some of your mathematical readers may be able to solve a rule from the above.

For forming a similar magic square, with an *odd* number on a side—of any progression of natural numbers—I give a simple rule.

Fig. 3.

		16		10		4
5			&c.		11	
	6					12
13		7				
	14		1			
		8		2		
	15		9		3	

Fig. 4.

22	47	16	41	10	35	4
5	23	48	17	42	11	29
30	6	24	49	18	36	12
13	31	7	25	43	19	37
38	14	32	1	26	44	20
21	39	8	33	2	27	45
46	15	40	9	34	3	28

Take a square with seven on a side. See Fig. 3. Commence with the lowest number of the progression in the example = unity. Place 1 in the square below the centre square, and follow on 2, 3, diagonally downwards to the right. Imagine a similar square underneath, then 4 would come in the right-hand top corner—so place it in this square. Working still downwards to right, 5 would come in the second square down on left hand—in an adjacent similar square—so place it in this, and work on until we come to a stop at 7. Place the next number = 8, in the next square but one—directly below 7—and work on downwards diagonally, as before, remembering at a stop to drop directly downwards, missing one square. The result will be seen to be as in Fig. 4; and the same rule will hold for a square with any odd number in a side, from 3 upwards.

It will be seen in this arrangement that any two numbers, symmetrical about the centre, added together will give a result equal to twice the centre number, and equal to one more than the number of squares.

Wm. H. Gates, A.M.I.C.E.

Willesden Park.

[32798.]—In my last letter, 32703, I omitted to mention what will be welcome to all who have been interested in Dr. Willis's letter, 32673, inasmuch as generalisations are always appreciated when they do not detract from clearness. Dr. Willis gives three slightly different rules, in order to meet the cases of three kinds of oddly-even numbers; but one can be framed applicable to all. It is simply an alteration in the rule for filling up the first quarter of .the skeleton with the figures 2 and 1. We can, however, say that the difference between the number of twos and the number of ones must be three, or a multiple of three, and that is all the alteration necessary. The rest of the rule remains unchanged. Even the square of six is included in this generalisation, for when there are only three cells to fill, it is evident they must be all filled by 2 or by 1 to the exclusion of the other, since 3 − 3 = 0. This amended rule will, in the case of roots of 18 and higher numbers, give additional variations to the square, as a choice may be made between three and a multiple of three. With regard to the rule given by Mr. Cram, letter 32618, I have received from him an interesting suggestion as to the formation of his skeleton squares, *without* the necessity of any subsequent correction. If it be arranged that the first quartet on the left (Fig. 3) be such that complementary numbers are diagonally opposite to each other, and if the row of quartets be slided to the right at each step, so that the quartets all down the diagonal are similar, we get a skeleton which, although it has only one diagonal with the correct summation, may be used after transposition, as below.

Fig. 1.

	1	6	2	5	3	4
1	1	2	3	4	3	2
6	3	4	1	2	4	1
2	3	2	1	2	3	4
5	4	1	3	4	1	2
3	3	4	3	2	1	2
4	1	2	4	1	3	4

Fig. 2.

	1	2	3	4	5	6
1	1	3	3	2	4	2
2	3	1	3	4	2	2
3	3	3	1	2	2	4
4	1	4	3	4	1	2
5	4	3	1	2	4	1
6	3	1	4	1	2	4

Fig. (1) is the skeleton of quartets, and when the numbers are altered in position in accordance with the numbering, along the top and side, a skeleton is produced, Fig. (2), which is available for use, as it will be seen that both diagonals now sum correctly. It should, however, be pointed out that the four superimposing magic squares must have a corresponding difference in their respective positions (or "aspects"). Reverse right and left the 2nd and 4th, and then invert the 3rd and 4th.

I notice Mr. Truscott's letter (32755). His square of 6 is interesting, and no doubt there are many others very similar out of the billion (or more) squares of 6 that can be made. It would, however, have been still more interesting if we had been told how it was constructed. **T. S. Barrett.**

New Athenæum Club.

PNEUMATIC AND BICYCLE TIRES.

[32799.]—Pneumatic and bicycle tires will, I fear, receive their death-blow next season, when the "Stuart" cycles will be then introduced into the market. My attention was called within the last few days to one of these machines, the invention of Mr. Charles Stuart, a well-known mechanical engineer and inventor, late of the Bletchley Ironworks, Bletchley, Bucks, and from a practical test which I made over some very rough roads I must say that I never enjoyed such luxurious riding in my whole experience. The machine was an ordinary 30in. safety, with ¾in. solid tires, and as it was the experimental machine it did not possess such high points of perfection as will ultimately be found in those of a future construction; but, nevertheless, the points claimed by the inventor were so perfectly attained as left no doubts in the mind of the rider that little, if anything, was left to be desired.

It is extremely simple, and can be supplied to any existing machine at a cost much below that of the cheapest pneumatic tire, and its life may be proportioned between an ordinary solid tire and that of a pneumatic one, besides being very much lighter.

The rider is supported absolutely off the wheels of the machine, and therefore whatever jolts these may be subject to, the rider sits quite still, and wholly independent of such, and may be compared to always riding upon a perfect flat and level plane.

Another good feature in this invention is that wherever the rider may be placed upon the machine, his weight can be transferred to any other part of the machine suitable for climbing purposes. The action of this invention is such that the rider is supported entirely upon a column of air, and may be compared, as it were, to sitting in the car of a balloon, the sensation from which can better be experienced than explained.

We shall be hearing more about this invention when a more perfect machine is finished than the one which I have ridden and tested for some 20 miles over some of the rough-paved streets in different parts of the City.

J. Townsend,
Bicycle Maker and Repairer.
Essex-road, Islington, N.

[32800.]—In answer to Mr. Beal (letter 32787), speaking from a rider's point of view, I think spring spokes, &c., are not to be thought of, on account of the loss of power in driving, without counting side slip. In reference to tires, I believe nothing will beat the ordinary pneumatic, not broke up in sections or filled with rubber balls, &c. The great thing wanted is not so much a tire that will not puncture, as if there was one I don't think there would be much speed in it, but one that is as fast as Dunlop's, a quick, *certain*, and clean method of repair, and no side slip. This last might be overcome by having the surface corrugated as mentioned in one of the cycling papers lately, and the machine built with long wheel base. For speed and method of repair combined, a French tire—the Michelin, I think the name is—is the best at present. Both edges of the rim are turned inwards to form a flange each side, a flat steel ring is fastened to each flange by screws, the outer covering, which has bead edges, is fastened between the ring and the flange by the screws. To get at the inner tube, unscrew one or two screws, and the outer covering can be undone. I don't think this method is quite as good as the Clincher, as the screws might get rusted in, and believe the Clincher could be made faster by having the rim grip about one-third, or less, of the tire, instead of over half as at present, which does not allow nearly so much play as the other kinds—Boothroyd, &c. **H. N.**

INCUBATORS.

[32801.]—In accordance with the promise made on p. 138, I make a few preliminary remarks on incubators and the artificial hatching of eggs. It must be remembered that it is useless for anyone to attempt to make a business of it who cannot devote a good deal of attention to it, even if the best automatic arrangements are adopted. It is necessary when once the hatching or incubating process is started to maintain a temperature of 102 to 104 degrees, day and night; but whether it is absolutely necessary to turn the eggs is a moot point. Certain it is that the hen does leave the nest occasionally, and she does turn the eggs over in a rough-and-ready way, and it is also certain that some vapour must be provided to keep the eggs moist to a certain extent, as a dry heat will not do the work effectually or satisfactorily. Perhaps Hearson's is one of the best incubators in the market, and it is also fitted with a good regulator, which acts automatically. It was illustrated in the number for Feb. 23, 1883. It consists of a tank inclosed in a framework of wood, which supports the non-conducting material — felt, say — and through that tank passes the funnel or chimney from the lamp, used for keeping up the temperature. This funnel is somewhat in the shape of └─┘ —the horizontal line representing the part which passes through the water reservoir, and the vertical lines the chimneys or outlets, that on the left being the ordinary chimney, that on the right being the lamp chimney closed normally by a flap attached to a rod, which is operated by the regulator. In the engraving on p. 562, Vol. XXXVI., the apparatus is shown as described; but in practice the tube is returned to give more heat, and the two chimneys are brought up side by side. The heated air from the lamp passes through the tube and warms the water, which is in a tank just above the "nest" of eggs. When this water begins to get too warm the "regulator" comes into action. That is a little capsule placed just below the tank and filled with some liquid which vaporises or expands at a temperature of a little over 104°, and the capsule, being made of flexible metal, consequently swells, and by means of a rod in connection with the lever causes the latter to lift the flap from the top of the chimney of the lamp, and the hot air therefore escapes direct without passing through what may be termed the "flues." As the water cools the capsule resumes its normal condition, the lever again puts the flap on the lamp chimney, and the hot gases produced by combustion again pass through the "flues," and the water is thus kept at a temperature ranging from 100° to 104°. The "nest," or egg tray, is a perforated sheet of metal placed below the water tank, and the capsule is immediately above the eggs, so that the temperature of the "nest" acts upon it at once. Beneath the nest is a tray of water, which is used for damping the air entering by the ventilators. Zinc can be used for making the tanks, and the case is of wood, double, and packed with asbestos or other non-conducting substance, rather thickly. The tank and flues may be of tinplate, but zinc is preferable. Ventilating holes must be made to secure a current of air over the eggs, besides that entering through the bottom, which is "damped" by contact with the water. I think that gives a general idea of the principles on which incubators are built; but in all the "regulator" is perhaps the most important, for the temperature must not be allowed to fall for any long time, and it must not be allowed to rise much above 104°, or the eggs will be "cooked," instead of the chickens being "hatched." I follow on with something further next week; but I have given sufficient for your readers to exercise their ingenuity in drawing up devices on paper, which should always be done before commencing the actual work.

Incubans.

[32802.]—I am very glad to see the note of "Incubans" (reply 75108). I have for a long time been looking out for information on this subject, and all the papers I have been able to obtain yet are absolutely useless when it comes to the most important point—the heat regulator.

"Incubans" will, I trust, commence at once, so as to give mechanics who, like myself, wish to make the whole thing themselves, a chance to get it made in the long evenings that are now upon us in time for January. Also, I, for one, would be glad of any hint as to the best way to utilise gas for the purpose. **Threesquare.**

SMALL GAS-ENGINES AND ELECTRIC LIGHTING.

[32803.]—I am afraid that "W. P." will have to wait some time before he gets the engine he wants for £5; but it is quite practicable to produce a small engine suitable for lighting on a small scale, driving amateurs' machinery, &c., at a cost far below that now charged for such machines. I am at present working on such an engine myself. I hope to get it perfected and on the market this side of Christmas. I shall be pleased to give full particulars to anyone interested who will write to men.

T. C. Smith,
Electrical and Mechanical Engineer.
46, Queen's-road, Brighton.

STONEHENGE.

[32804.]—By some accident—probably arising from the tables which I used (Mackey's) tabulating the azimuth of celestial objects on the amplitude—I observe I have in my letter, in error, made the sun rise *nearer* to the North Pole now than it did fourteen centuries ago. Of course, I should have written *farther* from the North Pole. I hasten to correct this as soon as noticed, to prevent possible trouble.

Oct. 2. **E. Erskine Scott.**

[32805.]—My thanks are due to Mr. Scott for his letter, No. 32756. I hardly think he will have supposed I could have forgotten the variation in the obliquity of the Ecliptic and the effect this would have, in lapse of time, upon the position of sunrise at the times of solstice. I had, in fact, roughly calculated this, and satisfied myself that it could not be rigidly taken into account.

To begin with, the Friar's Heel is only about 200ft. from the altar-stone, its apex is ill defined, and it has apparently settled somewhat out of its original position. Then again, the Altar Stone itself is of considerable dimensions, and being, moreover, encumbered with the wreck of a fallen trilithon, it is difficult to know exactly where to place the eye to take a correct observation. At the same time, it is impossible to witness the midsummer sunrise and not be convinced that the remarkable orientation of the pointer stone was intentional. It will give me a great deal of pleasure to carry out, when able, the suggestion of "F.R.A.S.," and take the bearings of the Friar's Heel as accurately as may be; but as my mode of transit will probably have to be the bicycle, I shall not be able to take anything more bulky than a prismatic compass.

Newbury. **John M. Bacon.**

PECULIAR RAINBOWS.

[32806.]—October 2, 1891, 12.45p.m.; fine early morning, then showers from 8.30 to 10.45; clearing up, sunshine, though with heavy clouds and some fog. In the north-east, a bank of long, rolling, pocky clouds.

A most peculiar phenomenon never observed by me before—four rainbows closely packed under each other; the top one of large size extending nearly to 90°, the three lower and smaller bows extending from about 20° to 40° in length, the lower being the shorter. When first seen, there was only a slight difference in the intensity of the colour, but, after a time, the lower bow became very faint. I observed the appearance for from ten to twelve minutes. The red colours of the lower bows were closely under the violet of the upper bows.

I have seen three rainbows at one time, when the second was a reflection of the first, and when the third (very faint) was a reflection of the second; but I never heard of a series of primary rainbows, as these certainly were, having been observed.

About a month ago, I was informed by three friends that they had seen in this neighbourhood, about half-past four one afternoon early in August, in the N.E., high up, approximating to the zenith, an inverted rainbow, the red being the lowest. This was apparently caused by a reflection upwards from some rainbow invisible to the observers. My friends were sure of the time, and of the position of the rainbow.

Winterton, Durham. **R. S., M.D.**

THE ETHER THEORY.

[32807.] — "Sigma" will be interested and amused by the following extract (*memoriter*) from one of the inaugural addresses of the present Gresham Professor of Geometry. "Scientists," said he, "have been obliged to invent the theory that matter is composed of atoms in constant motion; and as atoms could not move if they were closely packed together, scientists have had to invent the further theory that they are separated from each other by an elastic jelly-like ether. But," continued the professor, "if everything is composed of atoms in motion, the ether must be made-up atoms separated by another ether, and that other æther must be made up of atoms separated by another ether, and so on *ad infinitum*." He showed, in fact, that the atom-and-ether theory destroys itself.

Strange to say, the aim of his addresses was to prove that nothing is to be accepted as true that cannot be stated with "scientific" exactness and intelligibility! **R.**

HINTS FOR EXPERIMENTALISTS.

[32808.]—It is well known that practically a considerable excess of air is necessary for the complete combustion of coal, &c., also that by the employment of forced draught the excess of air thus requisite can be reduced. A point that I think has not been much remarked on is that the quantity of heat carried to waste by gaseous products of combustion will be less as the pressure at which they are discharged is greater. Heat liberated by the compression of the unburnt air will be conveyed into the furnace, and the heat necessary for the proper expansion of the products of combustion will be absorbed after all practically useful heat has been abstracted from them, not as in the common method during combustion, and where every available degree rise of temperature is of importance. It is worth remarking, too, that after the heat of the compressed products of combustion had been utilised as far as possible, these products might be further cooled to the temperature of the atmosphere by a water or air condenser, so as thus to constitute a valuable source of cold at their exhaust valve. No doubt the engine of the future will involve something approaching to combustion at constant volume, and in the meantime I think that the principle I refer to may partly explain the economy resulting from the use of high-pressure blast, as in American blast furnace practice, and that it warrants the expectation that still further economy may be gained by proceeding further in the same direction. Some calculations I made three years ago bear out these suggestions; but at the moment of writing I have not time to verify the calculations, and probably the explanation given above will be sufficiently clear without them. A. D.

THE ANGLO-GERMAN CONCERTINA.

[32809.]—In inquiring and suggesting respecting the above instrument, I hope that I shall not evoke the old cry, "only a toy," for not only do I know that the manipulation of a 51-keyed Anglo is no child's play, but it is to me what the violin, organ, trombone, or piano is to others, the "king of instruments," due, perhaps, to my democratic proclivities, or plebeian origin.

That it commenced as a toy, that its basic formation is wrong, I admit. Originally constructed with two rows of keys, twenty in all, one for tunes in key of C, the other for those in G, other keys have been added to make it chromatic, and still more, which are duplicate keys—i.e., to obtain the same note both pushing and drawing, and these are placed about promiscuously, apparently without any thought of the best position for fingering; and the student is further nonplussed by finding handbooks differing in their scales, and makers in their keyboards. Whose arrangement is best? Could any reader give the scale of a 51-keyed by a good maker? Although I have heard instruments in the hands of professionals that were, apparently, perfect in tone and tune, I have never been able to procure one myself, although I have tried several, and price was no object.

Some of the faults which I think might be rectified are:—(1) The exhausting of the bellows through a series of notes, drawing or pushing. Could not this be remedied by making the bellows longer—i.e., more folds? (2) The inability of getting at the tongues or reeds upon the bellows side of the tongue-board. Could not this be remedied by making the board detachable, like the one carrying the levers and keys? (3) The awkward position of the "drone key" for left-hand thumb. Remedy: Making it higher, bringing it nearer to strap-board, and cutting this down a little. (4) The stoppage of notes through tongues or leathers getting fixed in slot. Remedy: More care in manufacture. (5) The want of purity of tone, perfection of tune, and equal temperament. Remedy: The same care bestowed upon it as upon the English concertina. Can anyone kindly help me to evade throwing more money away upon imperfect instruments?

Felix Holt.

Tall stories are coming from the States about a three-coach special train on the Philadelphia and Reading Railway, which, they say, made a speed of 90 miles an hour on the 27th August. The driving-wheels of this engine were only 5ft. 8in., so that at the speed mentioned these wheels would have to "wizzle" round at about 472 revolutions per minute, and the piston-speed would be about 1,730ft. per minute. Looks likely.—*Engineer*.

The St. Clair Tunnel.—The St. Clair Tunnel, an international work, which forms a land connection between the Canadian lines and the American lines running to Chicago, was formally opened by Sir Henry Tyler, the chairman of the Grand Trunk Railway. The tunnel, which has a length of 6,026ft., or 11,553ft. including its excavated approaches, is constructed under the bed of the St. Clair River, between Point Edward, in Ontario, and Port Huron, in the State of Michigan. It is 20ft. in diameter, and is lined throughout with cast-iron plates 2in. in thickness, the lining weighing altogether 28,000 tons. Hitherto the trains have been carried across the St. Clair River on huge ferry boats, which were liable to be delayed by ice in winter, in addition to the ever-present risk of crossing a rapid stream. The tunnel not only abolishes these dangers but reduces the length of the journey by six miles. Arrangements have been made for electric lighting all through the tunnel, and for thorough ventilation. The St. Clair Tunnel adds another important link to the chain of railway communication between Canada and the United States. The Niagara Bridges, the International Bridge at Buffalo, and the structure at Sault Sainte Marie have previously afforded direct connections across the international boundary line; but Chicago business has hitherto been obstructed by the deep and rapid St. Clair River. The boring of the tunnel proper was done by means of large and heavy wrought-iron shields with sharp, cutting edges, each shield being driven forward by hydraulic rams of enormous power. From the time when the shields were lowered into position at the two proposed entrances till they met in the middle, the work occupied just a year. Over 880 tons of bolts and nuts were used in constructing the lining, which weighs altogether 28,000 tons. The road bed under the river is practically level, but the gradient of the approaches is 1 in 50. The cost of the tunnel proper is given as £292,000. Four large ten wheels coupled locomotives, as illustrated in *The Engineer*, 24th of April last, have been provided for use at and in the tunnel, weighing 42½ tons each. The rails weigh 100lb. per yard, and are of the largest section in use on the American continent.

REPLIES TO QUERIES.

◆

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75000.]—**American Organ.**—I see no reason to alter a single word of what I said on p. 115 about the pallet-springs for A. organs. If they can be bought for 1s. a set of 61, so much the less does the builder expend altogether. A "Practical Organ Builder" ought to know; but why are not these low-priced springs advertised, together with those "voiced and tuned" reeds at 10s. 6d.? Why, a really good "voicer" would want at least 5s. a set (61) to properly voice them. I know very well that some "voicers" get a shilling a set for filing, "tuning," and bending; but that is not what I mean by "voicing." I do not understand the "Practical Organ Builder's" remarks about "if the pallets bed well over the mortise holes," &c. They must "bed well," or the instrument is not worth a rap. The pallets and springs on my A.O. have been in rather hard usage for about fifteen years, and I do not remember having occasion or necessity to open the windchest to remedy any defect. (I think I should have remembered, for it is no joke to pull a rather complicated instrument to pieces to remedy so simple a defect.) But then my springs and pallets were made and fitted in America, and in that country they certainly understand how to make better wire for the purpose than I found I could buy in London without giving a special order, and yet I went to the best shops. My experience of so-called spring brass wire extends over nearly forty years. My earliest acquaintance with the matter was being sent to shop after shop to get suitable wire for a pipe-organ my father was building, under the guidance of a now well-known London organist. A few years ago I was told by one of the principal music-wire dealers that it was not kept in stock—that is, the quality I mean—but that they drew it down a size at the rate of, I think, 2d. a pound, which, if the brass is good, makes admirable springs. Say, No. 14 drawn down to 16. These personal matters are, however, tedious; but I mention them to show that it is just possible I may know something of the matter. To those making American organs I say, then, see that you get the best hard-drawn brass wire springs (not tinned by the mercury process, for mercury spoils all brass), and if possible buy them ready made—at a shilling a set, if you can get them at that price, which I may still, I suppose, be permitted to doubt.

Organon.

[75076.]—**Heating Garden Frame.**—In reply to "Shipsmith," I send method of heating a frame, which I found in a gardening magazine dated 1850, in which the writer says:—"The above is a sectional drawing of an apparatus I have invented for warming a large two-light frame, as a forwarding pit to a small conservatory, and as I am sure that my success warrants my recommending it to other amateurs who have the same dislike to manure-beds as myself, I send you an explanation for working the same, and I am satisfied that no mode can beat it for economy, both in first cost and in keeping up a cheap and regular heat. In the first place, the stove is a mere cylinder of sheet iron riveted. It is 4ft. long, and has a ring inside at 1, for the fire-bars to rest on. 2 is a small sliding-door to admit air under the grate-bars, or to draw up higher than the bars if required; 3 is the cylinder itself, 4ft. long by 8in. wide, inside; 4 is the first cover with a draught-hole in it, to be regulated by a sliding-shutter or regulator. The cylinder has a ring round it outside, 4in. from the top, with a tapering edge that the conical top 5 may fit close on; 5, Fig. 2, has a 2in. pipe to conduct the gas out of the pit. This stove is fed with charcoal by removing the lid 4, and filling the cylinder 3; and I may here say that this stove will burn thirty-six hours, but I work mine for twenty-four hours. It will sufficiently heat the air of any large two-light frame, and serves for heating the bed, or, rather, the under part of it. 6 is a 1in. copper pipe, conducted through the cylinder's side, bending, and placed 4in. above the grate-bars at 1. This copper pipe is joined to lead pipes about 6in. from the cylinder's sides, the lower one, 7, coming from the tank 8—a box 18in. by 10in., by 8in. deep, covered with a slate. The other pipe, 9, makes the circuit, or, rather, is traversed backwards and forwards, and finally is led into the tank at 10. Here, then, is an apparatus complete; and now for the main secret to be carefully observed by anyone wishing to erect one. The pipe from 9 to 10 must on no account be below the level of the pipe 7, 6. This is the grand secret; all the rest is plain. Set the cylinder stove in one corner of the bed, or frame and bed; the tank 8 on bricks, as well as the pipes 7 and 9; make a hole in the slate over the tank 8, and set a draining-pipe upright, 11, so that the top of this pipe will be above the soil of the bed. This will give moisture and a gentle steam, which, if not desired, can be stopped with a slate or sod-cover. The drain-pipe, also, is the place to feed the tank with fresh water. I filled up my pit with broken bricks, about 6in. above the pipes, and then laid sods and bark on them, and thus obtain a nice bottom-heat. I have placed my two-light frame on brickwork 2ft. high, 12, and placed a small door at the part nearest the stove-door, as shown by the dotted lines at 13, for the purpose of admitting the draught to the fire, and removing the ashes when required. The firebars must not be more than ½in. apart, or the fuel will be greatly wasted by dropping through before it is consumed."

Cheshire. H. S. C.

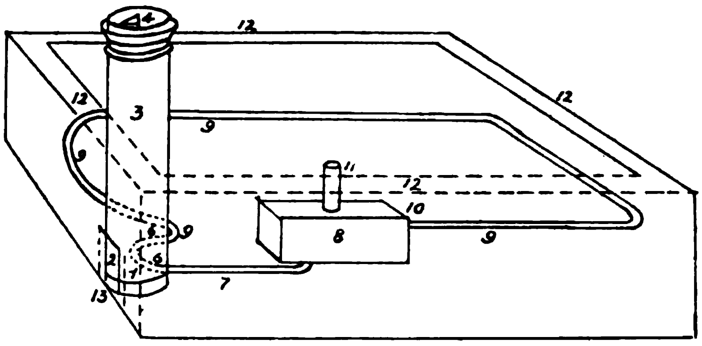


Fig. 1.

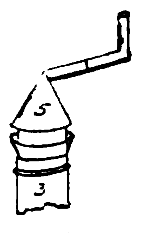


Fig. 2.

[75120.]—**Harmony.**—You are right: it does seem as if the numerous works on Harmony speak too much on theory, and too little on the practical method of using the knowledge obtained by the study of theory. The only way you can proceed is by reducing the flesh and blood of good music to a skeleton, thus finding out how it is built. I think it would be of great service to you if you were to scan closely the first few pages of a pianoforte primer. The tunes are generally arranged very simply, and easily understood as to their harmony. Your question as to when to use triplets, and when to strike the chord at once? depends, first, upon the time signature; secondly, in the words of the immortal Sam Weller, "upon the taste and fancy of the speller, my lord." That's just it: there is no rule to follow, provided you do not break the laws of progression of parts. Two extreme kinds of accompaniments are "Scenes that are Brightest," from the opera of Maritana, and Gounod's sacred song, "Nazareth." The first is an example of arpeggio, the second an example of close, solid writing, and, I may add, both equally effective. You will therefore see that there are no hard and fast rules to follow, except your own bent and inclination of mind, free and untrammelled. You say that you can find out the right chords to play by ear. Well, then, all you have to do is to train the eyes and mind so that when you *see* a note you will at once fancy what it ought to sound like, then go to the piano or harmonium and verify your guess. By schooling yourself in this way you will soon be able to write without the help of any musical instrument. The chord that you inquire about is one that is very commonly used, not in the key of C, but as a stepping stone between C and that of its right-hand relation G, and its best form is D, F sharp, A, and C; it is resolved on the dominant chord thus: D would rise or fall to G, F sharp would rise a semitone to G, A would fall a note to G, while C would fall to B. You will find numberless illustrations of this chord in Sankey and Moodey's Songs and Solos, also in many other simple tunes—in fact, you can hardly pick anything up in the shape of music that does not contain it; but you must learn to recognise this chord in other keys than that of C. The same chord is treated in other ways than that I have shown; but that above is the most commonly used. I will not write any more now, since you are advertising your address, only it occurred to me that perhaps others of "Ours" may be interested in the same question.

D. G. Jones.

[75137.]—**Casting in Cuttle-Fish.**—"T. L. C." is to some extent in error. Cuttle-bone (in powder) is considerably used in Birmingham for casting. It is moistened and rammed precisely the same as sand. Will "T. L. C.," or someone else who knows, kindly give some information as to casting in plaster moulds, more especially as to the proper temperature of mould to get a good impression? I find the metal will not properly fill a cold or slightly warm mould, and a very hot mould gives a scabby sort of casting; besides, great heat makes the mould very soft and tender. Information would be esteemed.

M.

[75170.]—**Engraving.**—This querist does not say what he wishes to engrave—whether wood or metal. There are not many works on either branch, and such as there are necessarily only give general directions. There are many hints to be picked up in looking through the back volumes of this paper; but wood-engraving is a trade scarcely worth learning nowadays, unless the engraver has artistic taste and gets some of the best work.

S. R.

[75172.]—**Engine Query.**—This querist must clearly look for the "grating noise" to something wrong with the expansion arrangement. I do not see how anyone can help him without examining the engine. The noise, it appears, stops when the expansion is, as the querist puts it, "shut up," but he does not give any description of the expension gear, so it is as imposible to guess as it is to give any useful information.

W. P.

[75174.]—**Terebene Driers.**—Allen says that terebene has a faint thyme-like odour, and is optically inactive; in density and other respects it much resembles terebenthene. It is probably a mixture of solid camphene with an unknown liquid. It is prepared from the crude turpentine; but I never heard that it was patented.

L. M.

[75194.]—**Colouring Steel.**—Does this querist mean the blue temper colour, or a blue lacquer? The blue of the tempering process is that caused by an oxidation of the surface, and is readily removed if rubbed against a stone or a file. Even a blue lacquer or varnish would be soon removed if treated to much friction. If properly tempered, the colour does not rub off without considerable friction being applied.

M. T.

[75196.]—**Model Yacht.**—Instructions have been given in back volumes as to the construction of model yachts, but the numbers are most likely out of print. Messrs. Norie and Wilson, Minories, E.C., publish a useful little book on the subject.

W. M. T.

[75203.]—**Red German Polishing Paste for Metals**.—This is most likely jeweller's rouge mixed with fat; or it may be colcothar mixed with ammonium carbonate and coco-nut soap in a liquid state; or perhaps oxalate of iron mixed with coco-nut soap—the last named most likely, perhaps with the addition of a little rouge.

Nun. Dor.

[75206.]—**Decorated Tin-Plate.**—I do not know what the querist means by the "pearline finish" on sheet tin, but I do know that several methods of giving tin-plate the crystalline appearance have been given in back volumes. L. T. L.

[75217.]—**Petroleum Furnace.**—I should advise this querist to procure one of Mr. Fletcher's catalogues, and see if there is not something that will suit him. He might also look in the number for June 5 last, and also refer to the indices of his back volumes.

S. R.

[75269.]—**Harmonium Reeds.**—The reeds referred to by Mr. Schofield on p. 138 were, I think, introduced to the London harmonium makers some years ago, when Mr. Munro was over here with the late M. J. Matthews. If I say they are "no good" for harmoniums, you will understand what I mean. They will do, but that is all. Like the Frenchman who couldn't find "that'lldo" in his dictionary, you will find that harmonium reeds won't do on American organs, and A.O. reeds won't do on harmoniums. "That'll do" answers our purpose in colloquial language. They will "do" in a sense, but not for good work, and we should all aim at producing the best work. When the Mason and Hamlin Co. wanted to make their orchestral organ, an instrument which (*pace* our friend the "Country Solicitor") competes with the masterpieces of the late M. Mustel, they sent to Estève for his reeds, and, I understand, used them. Yet they can make reeds of the kind as well as anybody; I think I have mentioned that before, but this advice is good: Don't use harmonium reeds on American organs, and don't use American-organ reeds on harmoniums. All the same, make as many experiments as you can; there is a pleasure in making them, and who knows what you may find out? But if you want merely to make an instrument, follow the track already beaten out for you. Mr. Schofield might, however, explain how to fit those couplers on harmoniums. Readers want something more than bald statements.

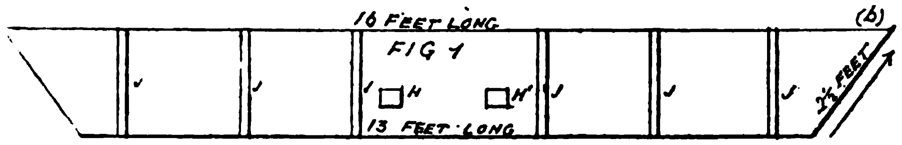
Organon.

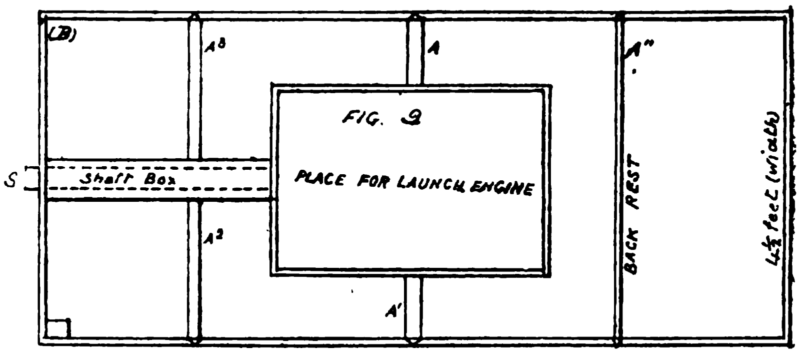
[75270.]—**Carbonising Wool.**—If "Fibre" will refer to my previous reply (75276) he will see that I need to know more than he has told me. I should probably mislead him if unaware of the quantities and class of material he wishes to operate upon.

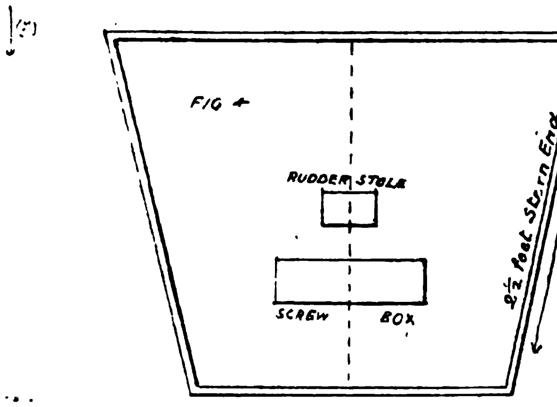
Sea Side.

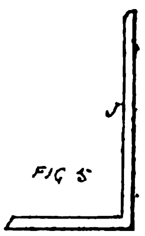
[75256.]—**River Punt.**—To "Brewer."—Having studied the appearance of the punt, go on as follows:—Fig. 1, side of punt; holes H and H' are steam outlets; sloping end C 2½ft.; J's are brackets to keep the sides well fixed to the bottom of punt, shown in Fig. 2, and marked B. I have made the place for the launch in the centre of punt, and from there to the stern I have made a shaft-box, so as not to expose the shaft to view; S, shaft. The length of the bottom of punt is 13ft., corresponding with narrow end of side in Fig. 1. A, A', A'', A^3, A^2 are seats or back-rests fitted into the side of punt; they run in grooves. Breadth of punt 4½ft. K is a hole made so as to let the water out of punt when cleaned; this water outlet is different from any other, as it is one of my own design, which I will explain and send sketch next week, as I am afraid I have imposed upon the space allowed for my sketches this week. Fig. 4 is stern end of punt, showing rudder-hole and screw-box (explained in last number); Fig. 3 showing angle-bracket mentioned as J in Fig. 1.

C. G. M. Bennett.







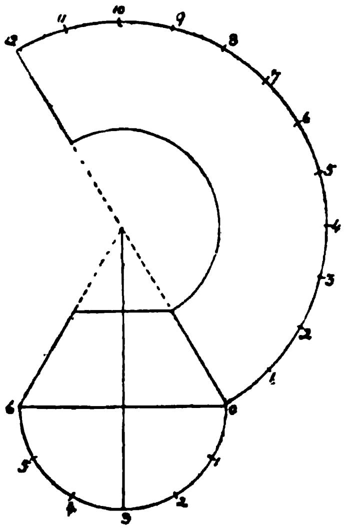


[75273.]—**American Organ.**—In order to deal with this matter in a satisfactory (that is, useful) manner, it will be necessary to refer to the query, which is printed on p. 73. The querist said, "I cannot make some few of the reeds speak at all in their proper cavity; they belong to the upper octave of the 8ft. row. . . . if placed in a cavity of the same size in another row they speak at once." I said on p. 96 that the query was incomprehensible, and that an expert must examine the instrument, for the "speechless" reeds spoke in another cavity, and other reeds spoke in the cavities properly belonging to the so-called "speechless" reeds. Obviously there could be nothing the matter with the pallets nor with the reeds, and the matter was, and still is, a puzzle which only an expert examining the instrument can solve. Mr. Schofield (p. 96) said the tongues were probably too thick, and advised filing them down, and seeing that the "tongue is clear of slot in block." Now, if the tongue is not clear of the slot it certainly cannot speak (at any rate, properly); but these reeds did speak in other cavities, so their tongues must have been clear, and to "file down" reeds which the querist said had been "voiced and tuned," would be to spoil them. On p. 116 I said that "such comments are absurd"—and so they are. I also said that reeds from "a good maker are milled to a proper thickness, and all the tuner or voicer has to do is to bend them and just take off the burrs of the mill—not even that sometimes." Now, does not that imply that, as a rule, the voicer and tuner has to do some filing? As a matter of fact every reed has to be filed up to pitch (a little above really) before it is voiced, for you must not do much filing (or scraping rather) after voicing. Mr. Schofield asks me (p. 138) who is the maker of "such splendidly finished reeds" that do not require filing, and together with the "Practical Organ Builder" kindly informs me (by implication) that it is necessary to file down the reeds of the upper octave of the 4ft. set. Yes, but the reeds in question belonged to the 8ft. set, and as to American-tuned reeds having the milling marks filed off, I say that some of mine still contain a few of the milling marks, which is exactly what would be understood by anyone acquainted with the subject. If a reed fresh from the factory is nearly up to pitch, the tuner or voicer will file only the tip of the vibrator. If he filed over the root of the vibrator, he would make it flatter. Mr. Schofield has, however, afforded me much amusement by referring me to "back vols.," and to (I am afraid the late) "Elève," and the late Mr. Mason J. Matthews. I owe my knowledge of the American organ mainly to those gentlemen, and if Mr. Schofield will look in Vol. XXVII. he will find a letter in which "Elève" corrected some little slips in what I believe were the first explicit instructions given in the English language as to how to make an American organ (see Vol. XXVI.) If Mr. Schofield looks back a little further still he will find a capital letter by the late Mason J. Matthews, on the method of voicing reeds (with illustrations), showing, in fact, how to hold the file, and yet, you see, I am "half a century behind time," and am asked "Who is the maker?" &c. Well, I don't know whether Mason and Hamlin sell reeds (it is easy to ascertain by inquiring at Metzler's); then there is the Munro Co., and Hammond—all of whom make a reed about as good as it can be made, and one which, as I implied, requires the least amount of filing. Now, if the original querist will give us a little more information—after making a few experiments—I will do my best to assist him (or any other reader); but, as I mentioned before, his query as it stands is a regular puzzle, and some one ought to "see" the instrument. As I have not "advised" anyone to "make" pallet-springs, I am not concerned in Mr. Schofield's other remarks; but perhaps he will tell your readers how pallet-springs are made to sell at 1s. per set. I fancy he won't. ORGANON.

[75276.]—**Carbonising Wool.**—The following method, used on a large scale, may be of interest and help to "Fibre." The rags, consisting of a mixture of wool and cotton, or other vegetable fibre, are steeped in a cold solution of sulphuric acid, 10° Twaddle, until thoroughly wet. Excess of acid is then removed, either by squeezing, pressing, or in a hydro-extractor, and the material thoroughly dried at a temperature of 110°—120° C. until the cotton becomes charred and can be shook from the wool, which is very little, if at all, affected. The rags are then steeped in a cold solution of sodium carbonate (soda crystals) to neutralise any acid on the wool, and finally washed several times with water, to remove excess of alkali. The last wash-water should be neutral to litmus paper.

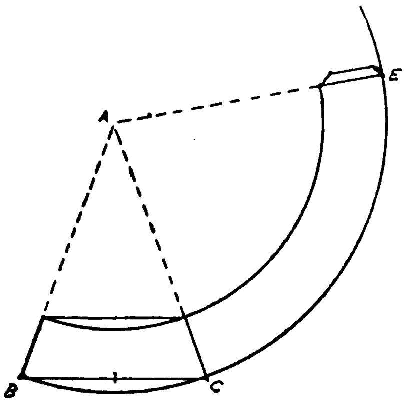
W. A. G.

[75357.]—**Striking Out Plates.**—From the accompanying sketch I think you will be able to see how the plates are struck out. All laps must be added on after you have marked out as in sketch.



E. A. A.

[75357.]—**Striking Out Plates.**—Perhaps the following sketch will suit "Fred A.," as it is the method I have used for lantern flues and other taper sheet-metal work. The required shape is drawn and the sides continued until they meet at the point A, which is used as the centre, and with compasses B C E is struck from it; then set the compasses to B D, which is half-way between B C and B E, is marked six times the distance B D plus $\frac{1}{10}$ of B C, and the edge as at E is added.



H. ROBINSON.

[75357.]—**Striking Out Plates.**—"Fred A." will find an easy way to do it thus. Take a piece of thick paper, or thin cardboard, and strike, say, a 3in. circle on it. Now strike one larger, say, 6in. or 8in., or any size. Now cut out both circles, taking care to keep nicely in the lines. You now have a ring with a 3in. hole. Now draw a line from edge to the left of centre; now shift it round a little to the right hand, and draw another line from edge to the right of centre. Now cut the piece out, and bring the two edges together, and you will have something nearly the shape of your sketch. The wider the piece you cut out, the smaller will be the bottom, compared with the top. Now rivet the edges together in their proper relations to each other, and you will have an article straight and true. Now open it again, and use it as a pattern. MALLETT.

[75360.]—**Gilding Solution.**—Put ½oz. 95 per cent. cyanide of potassium into one pint of distilled water. Stand a porous cell in the centre of this, filled levelwith the outer solution with cyanide-of-potassium solution at the rate of 1oz. to the pint; into this place a strip of gold connected to cathode; hang another strip of gold in outer solution as anode. Place the whole in a pot of hot water, and keep at a temperature of about 140° F.; connect up battery until 1½dwt. of gold is dissolved off anode. The contents of porous cell must not be thrown away; but put one-third into the gilding solution; bottle the rest, cork tightly, and use from time to time as solution requires, replenishing with cyanide. If this solution should give a smoky gold, add a little fresh cyanide, but cautiously, until you get a nice yellow gold. If too much is added, the gold will be red "foxy" colour. One Daniell cell will be sufficient for this.

S. ROBERT BONNEY, Electroplater, &c.

[75367.]—**Slotting Metal.**—This would be best done with a small circular saw (about 1¼in. in diameter) running in the lathe, the work fixed in the slide-rest, and the piece of brass "fed up" with the face to the saw, until the saw passed about ⅓ through—i.e., until the slot was long enough, the saw being of such thickness as to cut the slot the required width.

Walsall. F. RUSSELL.

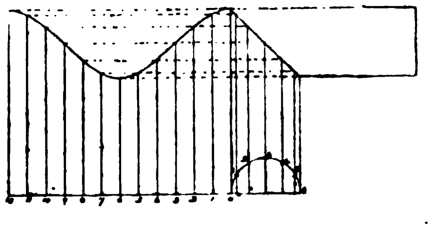
[75368.]—**Support in Water.**—"Golconda" has not given the most important part of his question—namely, the weight of the two persons and the material of the pontoons; but if he likes he can reckon it up for himself by simply allowing 62lb. for every cubic foot of water displaced. If he makes them 12in. or 15in. in diameter he will be on the safe side, and a lot to spare, as 15in. in diameter would support a total weight of about 1,280lb., and only be immersed about half their diameters.

Walsall. F. RUSSELL.

[75369.]—**Brazing and Soldering.**—This is another question no one can answer; for our good friend. "S. R. H." does not say if he intends brazing heads on pins or the trunnions on 100-ton guns. For general work, up to, say, bicycle backbones, I should advise him to have a portable hearth with bellows underneath, and blowpipe fed from same bellows if he likes, as he can then apply heat above or below his work, or, what is more important, both. I know of no book on the subject; but it is a very simple matter. Spelter (brass), borax, a clean surface, heat, and sense are all that he requires. F. RUSSELL.

[75371.]—**Gas-Furnace Casing.**—When an inquirer seeks for information, an incorrect and misleading reply, such as that of T. C. Smith, in your last issue, is to be regretted. Asbestos is most certainly not used in any furnace casing, for the very simple reason that it is not only very fusible alone, but it also increases the fusibility of refractory clays. The materials used in Fletcher's gas furnaces is a mixture of refractory fireclay with twice or three times its bulk of sawdust; both are ground together with a little water, and rammed in a mould. When dry the block is burned in a kiln until all the sawdust is burnt out, leaving a spongy mass of fireclay. The same mixture, made with common clay, is used for bricks for inside partitions and sound-proof courses, and in addition to its great resistance to the passage of sound and heat, it has the very curious property of allowing nails to be driven into it without cracking; it can be sawn, planed, and two slabs can be screwed together with common wood-screws. 999.

[75376.]—**Geometrical Drawing.**—I have inclosed a sketch which I think will explain itself.



Whatever laps you require for joint at mitre, and pipe seams, must be added on after being marked out, as in sketch. E. A. A.

[75373.]—**Moulding Gas-Carbon.**—What does "W. L. R." want his carbon for after he has moulded it? One might say mix it with Portland cement and water and let it set; but the probabilities are that such an answer would be useless. If he wants it for electrical purposes he can mix it to a stiff paste with sugar, flour, and water; ram it into the mould, close it air-tight, and submit it to a red heat for a couple of hours, when he will have something which will answer first class. Don't forget to whitewash your moulds first.

Walsall. F. RUSSELL.

[75377.]—**Blower for Gas-Generator.**—I beg to ask what size of holder would be required to generate gas for one burner for four hours, and what kind of burners, and where to get them, as I find the ordinary burners will not do?

F. W. BRIGGS.

[75394.]—**Varicose Veins.**—To "W. W."—See reply to 74907, July 31. QUILP.

[75402.]—**Harvest Moon.**—Allow me to suggest to Mr. Wake that explanations of astronomical phenomena require to be based upon accurate definitions. Slovenly statements do not help anyone. It is rather staggering to be told that "the monthly path of the moon in its orbit is identical with the apparent yearly course of the sun called the Ecliptic," even though later on we find the lame correction that "the moon's orbit is inclined 5° 8′ on an average to the Ecliptic." Pray, will Mr. Wake favour us with the extremes of inclination of which this is an average? Also it is puzzling to be told that "the moon's motion in its orbit is not in the plane of the earth's equator, but inclined 23½° to it," and then to learn subsequently that its inclination to the equator may be as much as 28°, or as little as 18½°. Mr. Wake also needs to be informed that the ascending node is not "that point of the moon's orbit where it crosses the equator going north," but the point where the moon's orbit crosses the plane of the Ecliptic as the moon passes from the south side of that plane to the north. His whole discussion of the matter is quite futile. But is there not something a little queer about the statement of our "F.R.A.S." that "the moon traverses the First Point of Aries at every lunation"? I thought a lunation was a *period*, not a *point of time*, and how does his statement square with the fact that the nodes of the moon's orbit retreat over a whole circumference of the Ecliptic in a little more than 18 years? Sir John Herschel puts the matter thus: "The full moon which happens on or nearest to the 21st of September is called the Harvest Moon. . . . Suppose the full moon to happen on that day (the time of the autumnal equinox), the sun is then entering Libra, and the moon Aries, the former setting due west, the latter rising due east; the southern half of the Ecliptic is then entirely above, and the northern below the horizon, and the Ecliptic itself makes then the least possible angle with the horizon. In advancing then 12°, or one day's motion along the Ecliptic (or along its own orbit, which is not much inclined to it), it will become less depressed below the horizon, and have, therefore, a less hour-angle to travel over by the diurnal motion after sunset the next night to bring it into view than at any other time. The most favourable harvest moon is when the full moon, falling on the 21st of September, happens at the same time to be in the ascending node of her orbit, which then coincides with the vernal equinox." ("Outlines of Astronomy," 8th edition, 1865.) C. P. M.

[75408.]—**Organ Light.**—I advise "W. S." to use an oil-lamp of a special kind with a parabolic reflector, one of which I use myself for the purpose he requires it for. The Silber Light Co. is the maker, and he can get one at any respectable oil-shop or ironmonger's for 2s. 6d., these lamps giving a better light than the ordinary reflector candle lamps. They look very neat, have a firm bottom to stand on, and a hole with a slot in the handle, so that the lamp can be fixed with safety on a nail from the wall. Two can be used with excellent effect (one each side of the performer) on the large oblong form in which church organ music is published. If ingenious enough, he might attach the lamp to a piano sconce. I place mine on a chiffonier at the side of my organ, and can see to "read" with infinite ease. "W. S." can so place the reflectors until they both focus on the music.

CHAS. H. FRIDY.

[75411.]—**Weather Indicator.**—Chloride of cobalt. S. BOTTONE.

[75411.]—**Weather Indicator.**—The chemical solution is cobalt chloride dissolved in water. The paper, or other material, is saturated with this, and then dried. It merely acts hygroscopically, and shows nothing more than a variation in the amount of moisture present in the atmosphere.

H. EBBAGE.

[75412.]—**Burnt-wood Work.**—The work mentioned by "Foghorn" is known as "Poker work," and if your correspondent is in London he could obtain tools for it and every information about it at a shop in Queen Victoria-street, City. I do not remember the name. MRS. CHAMBERS.

[75412.]—**Burnt-wood Work.**—This work can be done by small iron rods shaped like a pencil, but the difficulty of keeping them red-hot and of holding them is very great. There is a convenient apparatus advertised in the Sale Column this week. A small indiarubber bellows blows air through a bottle containing benzoline, thence the air charged with benzoline vapour goes through a flexible tube to the hollow platinum point or pencil. The point having first been made red-hot in a spirit-lamp, the benzoline vapour burns therein and keeps the pencil at any heat between dull red and white heat, the blowing being gentle or more vigorous according to the heat required. The point-holder is covered with cork, this being a good non-conductor of heat. The platinum point is used for sketching, shading, &c., in exactly the same way as a blacklead pencil.

S. E.

[75415.]—**Smokeless Coal.**—I have been using anthracite coal for 18 months for electric engine, which is obtained from Swansea, as this is smokeless; but is of no use in house, as there is not sufficient draught. ARCHER.

[75416.]—**Dynamo to Light Space 15ft. by 25ft.**—To light a workshop 15ft. by 25ft., three or four lamps of 10c.p., each taking about one ampère at 25 volts, will be ample. A dynamo to work these will cost about £3 to make, if home-made. Full instructions for making such a dynamo, with illustrations, &c., will be found in my book, "The Dynamo: How Made and How Used." See Sale Column under my name. S. BOTTONE.

[75416.]—**Dynamo.**—To light your workshop you would require a 100-candle power machine, which I should recommend of the "Manchester" type. You can purchase castings and fit them yourself. 10lb. of 22 d.c.c. wire on fields, and 4lb. of 20 d.c.c. on armature, shunt-wound, will give the desired result. Five incandescent lamps (50 volts and 1 ampère) giving 20c.p. each should be used, and machine driven at 2,000 revs. per min. Cost about £2. F. ASKEW.

[75417.]—**Phonograph.**—You can rivet on pole-pieces without making much difference to the working of the motor, if the two surfaces are quite true, and rivets large, say about $\frac{1}{10}$in. diameter. You might use single cotton-covered wire for the field-magnets, but I could not advise its use on the armature, as there is no space to spare.

W. GILLETT.

[75419.]—**Asthma.** — Has "Grateful" tried Himrod's cure or citrate of caffeine? The latter he can carry with him. I have been a sufferer of the complaint for three years, and found both give me relief, although I am not cured. AMATEUR.

[75419.]—**Asthma.**—1st. Consult a good medical man. 2nd. Eat nutritious food, do not over-feed, and abstain from stimulants. 3rd. When a bad attack comes on, you may find relief by smoking cigarettes made with the dried leaves of the thorn-apple (Datura stramonium), sold under the name of Cigarettes de Joie. S. BOTTONE.

[75419 and 75455.]—**Asthma** is a troublesome complaint, but not very often fatal, unless complicated with other diseases of the lungs and heart. Sudden changes of temperature must be avoided. The diet must also be attended to, and only light and nourishing food taken, and the bowels kept gently open. There are several remedies which may be used during the paroxysm or to prevent it. Give Savar's or Joy's cigarettes a fair trial, and take care to inhale the smoke. Nitre papers may also be useful. Any of these may be ordered from a chemist. DELTA.

[75420.]—**Motor for Boat.**—The best and most reliable motor is, of course, a steam-engine and boiler; but you might adapt one of the oil-engines in the market. There is a special type made for boats, or you might use an electro-motor and accumulators if you have the means of recharging them. I should be pleased to send you sketch and description of a simple oil-engine if you intend making one yourself.

Brighton. T. C. SMITH.

[75420.]—**Motor for Boat.**—A boat is being constructed of mahogany 25ft. long, and fitted with a battery that can be recharged in half an hour. The solution costs 8d. per gallon. An order has also been given by the Government for launches 1H.P. for 12 hours. I hope shortly to show a small one at work. An electro-motor has been invented which can be attached to a small boat in a few minutes, or taken off. Hot-air and petroleum engines are also coming into use for small boats. E. R. DALE, Assoc.Inst. E.E.

[75421.]—**Dynamo to run 16c.p. Lamps in Series.**—To S. BOTTONE.—Premising that it is very unusual to run incandescent lamps in series, I give the following proportions of wire as suitable for this particular purpose on your dynamo. Wind the armature with 5lb. No. 24. This on a ring or drum armature (you do not say which yours is) will give, at a normal speed of about 1,250 revs. per minute, 400 volts, and have a resistance of 9 ohms. Wind the field magnets with 10lb. No. 26, and connect up in shunt with the brushes. This dynamo should, if carefully made, and thoroughly well insulated (and this is the point that renders the high voltage required for running the incandescent lamps in series so risky and inconvenient), light 9 lamps of 16c.p., each taking 48 volts, and 0·9 ampère. The dynamo will take nearly ¾H.P. to drive it.

S. BOTTONE.

[75423.]—**Electric.** — The crust you mention results from the zinc not wearing uniformly, which allows the deposit of crystals thereon. Remedy, weaker solution, or amalgamated zincs.

F. ASKEW.

[75423.]—**Electric.**—The white, hard substance which formed on the zincs of the battery was caused by the salammoniac solution being too strong. Therefore, the surest preventive would be to use less when charging the cells. You will do no harm by scraping the zincs when corroded by the salammoniac; but the battery will be eaten away sooner than by having less strength of salammoniac solution. ALFRED TAYLOR.

96, Plough-road, Wandsworth, S.W.

[75423.]—**Electric.**—The white substance found on the zinc is chloride of zinc, and is formed while the cell is being used, owing to the zinc dissolving in the solution of salammoniac, forming two gases, hydrogen and ammonia, and this substance, zinc chloride, which deposits itself on the zinc, therefore prevents the action of the salammoniac on it, which proves fatal to the working of the battery. Practically, this cannot be prevented. I should advise "Leumas" to clean zincs and carbons once in three or four months if bell is used much. No SIG.

[75424.]—**Plating.**—Silver may be "stripped" from old plated goods by placing them in hot sulphuric acid in which a few crystals of saltpetre have been dissolved. The silver is recovered from the above solution by precipitating with common salt. The chloride of silver thus formed must be well washed and dried, when it may be fused with a little saltpetre as a flux.

Brighton. T. C. SMITH.

[75424.]—**Plating.**—Strip the old electro-plated articles with solution made as follows:—Sulphuric acid, to which is added a few crystals of saltpetre. Supposing you want one pint of stripping solution, take one pint of sulphuric acid, to this add six grains of saltpetre. This solution must be contained in a vessel such as the porcelain evaporating dish, or acid-proof stoneware; the stripping solution must be warmed and kept warm during the stripping operation. The articles to be stripped are placed in this solution, and moved gently about now and again until the silver has disappeared. If the solution does not act fairly quick, add cautiously a few more grains of saltpetre. Start with a small article first, and when you think the pickle has done its work, remove and plunge in water; then examine. You will soon perceive if the work is done. Don't let it remain in the pickle too long: otherwise the surface of the article under the plate will become very much pitted. Care must be taken of the clothes and hands, as this preparation is rather dangerous to both. Use copper wire to sling each article for immersion. To recover the silver from stripping solution, dilute with water to about three times its quantity. To this add scraps of zinc or hydrochloric acid. By this means the silver will be thrown down out of solution as a precipitate which can be fused with carbonate of soda.

S. ROBERT BONNEY, Electro-Plater, &c.

[75425.]—**Coal-Dust Bricks.**—The bricks seen by your correspondent, G. Riley, were probably "briquettes," as his letter describes them exactly. I think they are patented, as I have seen them sold under the name of "patent sanitary fuel." There is a manufactory at Cossall, near Nottingham, but I do not know by whom they were patented.

WM. CHAMBERS.

[75426.]—**Dynamo.**—Type, Manchester or Simplex. A machine giving 10 amps at 55 volts most suitable. Armature, cogged ring. These are better suited for amateur construction. F. ASKEW.

[75426.]—**Best Form of Dynamo.**—The best dynamo for electric-lighting purposes is undoubtedly one having a drum armature running between normal pole-pieces, as in the Kapp or Alliance types (not consecutive poles). Poles upwards are better as regards freedom from leakage of magetism, since when the poles are downwards, and they are near an iron base-plate, there is great loss from this cause. Poles downwards are better as regards freedom from vibration. S. BOTTONE.

[75429.]—**Electric Lighting.**—Unless your shop is but 6ft. square, your two 8c.p. lamps are useless for the purpose, twenty such lamps being nearer the mark; and to attempt to light these by any primary battery at present in the market would be madness. Leave electric lighting on a large scale alone, unless you can lay down a dynamo and engine for the working thereof. F. ASKEW.

[75429.]—**Electric Lighting.**—You can do this best and cheapest by a dynamo; but presuming you must get a battery, your best plan will be to employ double-fluid chromic-acid cells, with a little chlorate of potash added to the chromic acid, to increase its staying powers. If you run the two lamps in parallel, and are using 25-volt lamps, 13 quart cells will be sufficient. The fluids to be used are: dilute sulphuric acid 1 to 12 of water, in the zinc compartment; and a solution of 3oz. chromic-acid, 3oz. sulphuric acid, ¼oz. chlorate of potash, to each pint of water in the carbon compartment. The solution will cost about 3s. for each charge, which will last about eight hours.

S. BOTTONE.

[75429.]—**Electric Lighting.**—Should advise this querist not to attempt lighting his lamps by primary batteries, being very expensive, to say nothing of the trouble of changing solutions, cleaning connections, &c.

Twickenham. J. J. B.

[75431.]—**Calculating Speed.**—Multiply speed required to be produced by the diameter of driven pulley; divide by speed of line shaft; result will be diameter of driving pulley. BRITISH BULLDOG.

[75431.] — **Calculating Speed.** — To obtain diameter of driving pulley—

$$(1)\quad \frac{\text{dia. of machine pulley} \times \text{rev. of machine per min.}}{\text{revs. of shaft per min.}}$$

To obtain revs. of shaft per minute—

$$(2)\quad \frac{\text{dia. of machine pulley} \times \text{revs. per min.}}{\text{dia. driving pulley.}}$$

Thus, supposing dia. of pulley on machine is 3in., making 250 revs. per min., and shaft 80 revs. per min., then—

$$(1)\quad \frac{3 \times 250}{80} = 9\tfrac{3}{8}\text{in.} = \text{dia. of driving pulley.}$$

also—

$$(2)\quad \frac{3 \times 250}{9\frac{3}{8}} = \frac{750}{75} \times 8 = 80 \text{ revs. per min.}$$

Twickenham. J. J. B.

[75433.]—**Defective Magneto Machine.**—To MR. BOTTONE OR OTHERS.—The coils should be so connected to each other that the wire in passing from one bobbin to the other should form a letter ∞. The two free ends of the wire should connect, one to one end of the spindle and one to the other, if the machine is a medical or shocking machine; or, one to one cheek and the other to the opposite cheek of the commutator, if the machine is a continuous-current magneto. See my book "Electrical Instruments" for full details and illustrations of mode of constructing these machines. S. BOTTONE.

[75433.]—**To Mr. Bottone or Others.**—If you will give fuller details I can no doubt put you right, but with present meagre description it is impossible to say what is wrong. F. ASKEW.

[75434.]—**Accumulator.**—To MR. BOTTONE.—You will do well to refer to my book "Electrical Instruments." Procure four 2lb. plum-jars. Procure also eight plates of sheet lead, 2ft. long, 6in. wide. Score these all over with close lines by means of a bradawl or other sharp point. Make a paste of red lead and oil of vitriol about as thick as putty. Fill in the scoring with this paste. Let the plates dry in a warm place. When dry, put one plate on the table, then a strip of stout flannel same size as plates, then another plate, and lastly another strip of flannel. Now roll up tightly into a cylinder. Serve the other three sets alike. Place in glass cells along with dilute sulphuric acid, connect in series, and charge by means of six bichromate cells.

S. BOTTONE.

[75435.]—**Phonograph.**—You will find a reply to a somewhat similar query as your first on page 436 of the last volume. The reason why the stylus is set at $\frac{1}{10}$in. from the surface of the mandrel when putting pin in slot, is because the wax cylinders can be used until they are between ⅛in. and $\frac{1}{10}$in. thick, and therefore the stylus must be able to approach within that distance of the metal surface. In using thicker cylinders the stylus can of course be raised by the adjusting screw until the pin touches the end of the slot. If you care to write to me direct, you will find my address in the Exchange Column. W. GILLETT.

[75436.]—**Magic Squares (Nasik Variety).**—I answered this question (or a similar one) in the "E. M." for Oct 10, 1890, p 150 (72393), and gave a specimen of a nasik square of 36 cells (i.e., a six-square), with the summation of 312. Nasik squares of 6 cannot be made to sum the number 111, because $1 + 2 + 3 + 4 + 5 + 6 = 21$, which, being an odd number, is indivisible by 2, an important factor of 6. If the querist desires to know how to construct nasik squares of 6, with summations greater than 111, I will tell him on his saying so.

T. S. B.

[75436.]—**Nasik Squares.**—The series in the second and fifth columns clearly have a difference $= 9$, as can be seen by the subtraction of the totals one from the other. For $120 + 102 = 222$; therefore the two columns together contain the right figures, and $120 - 102 = 18$, which divided by the number of columns $= 9$, and adding each column and each row, we find $\Sigma\ 36\ a^{6} = 666$. From this it is obvious that a nasik square of 36 cells is possible if the columns add up to 111, and there are also, consequently, the correct numbers in every row, but not in every column; for let each column be represented by a, b, c, &c., and each row by m, n, o, &c., then clearly $\Sigma\ a^m$, b^m, &c., to e^o

$$= \int 36\ \frac{a\,b\,c\,d\,e\,f}{m\,n\,o\,p\,q}\ \sqrt{9};$$

and if $a = 8$, $b = 21$, $c = 22$, $d = 11$, and $e = 33$, then $\Sigma\ a\,b\,c\,d\,e\,f = 111 - 16$. Therefore 16 should be substituted for 25 in the square made by "Arithmetic." The same reasoning can be applied to the fifth column, for

$$\int 666\ \frac{a\,b\,c\,d\,e}{n\,o\,p\,q\,r}\ \text{and} \int 36\ m\ \sqrt{9}$$

are similar functions, and in the fifth column 25 must be substituted for 16, and 16 for 25 in the second column; the ratio of changes in the two magnitudes being governed by the same function, retain the same value. If we add the variable to the index, and divide by a hypothetical index, say—

$$\frac{3\,a\,x^2 + 1}{n + 1\,y}$$

f and n neutralise each other; thus—

$$\int \frac{d\,x}{\log.\,x} = y + x = 111\,x.$$

The nasik square of 36 cells will, therefore, appear thus—

8	19	24	35	10	15
21	23	7	12	14	34
22	27	29	13	18	2
11	9	4	20	36	31
16	32	30	25	5	3
33	1	17	6	28	26

In this diagonals, rows, and columns will add up to 111.

Sneintor Dale. S. J. Burton.

[75437.]—**Hot Water.**—Your pipes from the top of hot-water cistern to bath and sink are either stopped up with dirt or otherwise air-bound. Examine pipes and see if there are any dips; if so, put straight, connect force-pump to top end of exhaust, open bath and sink taps, and force water through. Russell.

[75437.]—**Hot Water.**—In your sketch where pipe is fixed in top of hot-water cistern, pipe projects inside of cistern. Keep it flush with inside of cistern, and carry your steam pipe straight up through roof or along side of chimney stack. In sketch pipe is turned down into cold-water cistern. Does the end of pipe dip under water, as it is the only air-pipe you have. Ex-Mechanic.

[75439.]—**Screw-Cutting.**—The exact depth of thread, at the rate of 24 threads per inch, is ·053, and the diameter at bottom of thread on a ¾in. tap is ·697. The proper number of threads for ¾in. is ten, the depth is ·184, and the diameter at bottom of threads is ·566, Whitworth standard.

Harry.

[75439.]—**Screw-Cutting.**—"Fossil" no doubt refers to a thread of Whitworth form; but he seems to be unaware what that form is. To produce it the tool must have an angle of 55°, and have its point rounded so that the depth of the thread to be cut will be reduced by ⅙th, the thread is cut to such a depth as to leave the top of thread of such thickness as will round to the same form as tool point above described. The depth of thread is thus ⅔rd that of a sharp thread of same angle, and is ·64 the pitch. A tap with a pitch of 1in. will be 1·28in. less in diameter at bottom than at top of thread. To find the size at bottom of thread for any tap of finer thread, divide 1·28in. by the pitch, and subtract quotient from diameter of tap. Example:—1·28in. ÷ 24 = ·053, ·75in. − ·053in. = ·697in. which is diameter of your tap at bottom of thread.

British Bulldog.

[75441.]—**Sparking Dynamo.**—Consecutive pole machines do certainly spark more than normal pole machines, because there is generally a little inequality in the field. The low resistance of the outer circuit in a shunt machine would not cause sparking—rather the contrary. I do not think that higher voltage lamps would improve matters, and carbon brushes will soon short-circuit the commutator sections. Try copper gauze laid flat on commutator, not endwise, and report results.

S. Bottone.

[75443.]—**Repairing Incandescent Lamp.**—To Mr. Bottone.—Make up a Daniell cell large enough to take the lamp in the copper compartment; connect up the zinc to the unbroken loop of the lamp by twisting a piece of fine copper wire round it; cover this connection over with a dab of wax, or any other non-conductor, being most careful to leave the ends of the loop that is broken perfectly clean. Now immerse the broken loop portion into the copper sulphate solution. A nice little knob of copper will soon form on the ends of the broken loop. When this is big enough, remove the lamp, and disconnect it, wash, and solder neatly a fine copper wire loop to the knob. This is the best way. S. Bottone.

[75444.]—**Sulphuric Acid for Accumulators.**—It matters little whether it is prepared direct from sulphur, or indirectly from pyrites. The best rough test for the undiluted acid is its specific gravity, which should be 1·840. The specific gravity of the acid when mixed with water for use should be 1·21. S. Bottone.

[75445.]—**Abyssinian Pump.**—Depends on what supply of water you get. I know a pump driven into gravel that has never been short in the driest summer. Ex-Mechanic.

[75445.]—**Abyssinian Pump.**—An Abyssinian tube-well would pass through the strata mentioned well enough. Depth attainable would depend on strength of tubes and quality of ground; success as an artesian well depends entirely on whether the beds are water-bearing or not. In favourable ground the smallest useful size (1¼in.) can be sunk upwards of 200ft; but *per contra* a comparatively thin layer of hard rock would damage shoe, or stop progress. The top water from the quicksand would probably be unfit for drinking purposes, and if "Abyssinian" wishes to go deeper for purer water, he had better obtain opinion from a geological expert before he is involved in, perhaps, resultless expense. Gravel or coarse sand are perhaps the best to drive to for screening purposes.

Well-borer.

[75448.]—**Electrolysis.**—Hang two platinum plates in your solution, connect one to the positive and the other to the negative poles of a dynamo or battery; the gold or silver will be deposited on the plate that is connected to the negative. I do not think that it is possible to recover all the metal from a cyanide solution by electrolysis. Why not precipitate with acid in the usual way? You will find it much the cheapest and simplest way.

Brighton. T. C. Smith.

[75449.]—**Incandescent Lamp.**—You can break away the glass round the platinum with a small pair of pliers, taking care to break only a small portion away, and then solder a small piece of wire on to platinum tip. You must be very careful, and not get the soldering iron too hot.

G. T. W.

[75449.]—**Incandescent Lamp.**—By filing, carefully remove a little of the glass from the broken leading-in wire. Take a piece of fine platinum or copper wire, and tin one end with a little solder. Now, put a little chloride of zinc on the platinum wire of lamp, and hold the tinned piece in a gas flame, touch the lamp wire with the former, and let the solder set. Cut off to about ¼in., and job is done, after turning up this attachment into a ring. It is a job which requires care, but easily done by a jeweller or those used to small soldering. F. Askew.

[75449.]—**Incandescent Lamp.**—Make up a cell as follows:—Place a porous pot containing a zinc rod in an outer jar of glass, charge the jar with solution of copper sulphate and the porous pot with water 10 parts, sulphuric acid 1 part. Attach your lamp, by means of the unbroken wire, to the zinc rod, and place in such position that the broken wire just dips in the sulphate of copper. Let stand until a copper bead has been deposited to which the new wire must be soldered.

Twickenham. J. J. B.

[75450.]—**Fire Balloon.**—Have made a number of these in the following manner:—Procure some thin tissue paper (it may be coloured with advantage), cut it into pieces the shape of the peel taken off the quarters of an orange and as long as the balloon is to be high. Five of these will probably be required for each balloon. Now lay two of these flat on the table, the under one projecting about half an inch; paste this edge round lightly, and fold over on the top sheet. Continue thus until the five are joined up, when the two remaining edges must be pasted in same way. Let dry and put top on, which will not be very large if the sheets have been neatly joined. A light wire ring must now be sewn on the bottom to carry the sponge. In cutting out the pieces lay several sheets together and cut same time so as to insure their all being same size; also have the paste thickish, or the seams will be soaked through and the balloon will not fill out properly.

Twickenham. J. J. B.

[75450.]—**Fire Balloon.**—Say it is required to make one about 4ft. high. Cut out ten canoe-shaped segments of white or coloured tissue-paper; their length may be one-fourth longer (5ft.) than the height of the balloon, and their greatest width, which must be one-third from the top, may be one-sixth of their length (10in.) The bottom end should be one-third of the greatest width broad (3⅓in.) to form the mouth. Cut these segments ½in. wider on both sides to allow for seams. This will leave the top end 1in. broad, instead of pointed, and the other end 4⅓in. broad. Join the segments by means of paste side by side. It is convenient to join them first in pairs, and then two pairs together, to save time, as each seam must be allowed to dry before continuing. Paste a circular piece of card about 2in. in diameter inside the balloon at the top, and let this have a loop of thread attached as a means of suspension during inflation. The mouth will require distending with a ring of thin wire, kept in place by pasting round inside and turning up the paper. This ring should have two wires stretched across at right angles to each other, at the centre of which is attached a piece of sponge saturated in methylated spirits, the balloon being previously inflated over a tin vessel containing burning rags and spirit. The proportions will enable "J. B." to make other sizes if desired.

H. Ebbage.

[75452.]—**Baron Cells.**—To Mr. Bottone or "Sigma."—I have no personal acquaintance with this battery, and consequently prefer not to give advice on a subject in which I may be only leading astray. S. Bottone.

[75455.]—**Asthma.**—See my reply to 75419.

S. Bottone.

[75456.]—**Lighting Lamp for Short Intervals.**—To S. Bottone.—Supposing you want only a 5c.p. lamp of about 8v. for periods not exceeding five minutes at a time, with long intervals between, you will find a dozen E.S. dry cells will give satisfaction. When they are spent they can be re-charged, like accumulators, by connecting up to dynamo or primary battery; but if not overworked they will serve your purpose for six months at a stretch without requiring recharging.

S. Bottone.

Mr. S. P. Sticker, an engineer of Buffalo, N.Y., claims to have discovered a method of making ice by means of illuminating gas, which may be returned to the mains after use without deterioration. By experiments in the works of the Provincial Gas Company at International Bridge, Ontario, he produced a temperature of 80° below zero by the use of water and gas only, without chemicals.

Cycling and Health.—"Health and happiness for the middle-aged" is the thesis we set out to prove. The chief trouble of the average middle-aged man of the City class is what is known as a "sluggish" or "torpid" liver. We need not enter into any of the niceties of pathology here; the man in the street, as well as the doctor, has a fairly clear idea in his mind of what is meant by a sluggish liver. Now, the bicycle or the tricycle, when properly used, converts the sluggish into an active liver—and that in double quick time. It is quite easy to understand why this should be so. The sluggish liver is the liver in which the blood circulates too slowly, and remains too long before it is passed forward into the lung circulation. The effect of cycling upon the liver is the same as that of flooding a still and stagnant lake with innumerable mountain streams after a heavy rainfall. The whole of the water in the lake is violently moved, and the outflow at its lower extremity is increased tenfold. It is precisely this flooding effect which is produced upon the liver by the rushing currents of blood from the legs as the result of their energetic activity in pedalling the bicycle or tricycle. The stagnant lake in the organ is moved in every part, all its minutest ramifying vessels are washed out, and its bile-secreting cells are stimulated by fresh blood.—*The Hospital.*

A New Coalfield in Derbyshire.—After a most prosperous period so far as sinking operations are concerned, the Barnsley seam, or the "top hards," will in all probability be reached in the course of next week at the new colliery belonging to the Bolsover Colliery Company, at Bolsover, near Chesterfield. The event will mark a new era in the history of Bolsover, which is described as a decayed market town about six miles from Chesterfield. Two 14ft. shafts have been put down to the coal, which is expected to be reached at a depth of 350 yards. Early in the present week a depth of 346 yards had been reached, and 75 yards of metal tubing had been inserted in each shaft. The shafts are sunk on the estate of the Duke of Portland, from whom alone something like 5,000 acres of coal has been leased on somewhat easy terms. The shafts are within about a mile and a half of the Manchester, Sheffield, and Lincolnshire branch line which runs through Sutton Park, and near other means of communication. The plant, on which no expense has been spared, will rank amongst the finest in England. A splendid row of workshops, stores, &c., in the Gothic style of architecture, with a large clock in the centre, have been erected. Already 46 cottages are nearly completed, and arrangements are being made to erect a number of others, so that the district in the course of a few years will be a busy one indeed. —*Engineer.*

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

74965. Adjusting Mirror of Reflector, p. 510.
74980. Townley's Electric Bells, 510.
74982. Preparing Accumulator Cells of Red Lead and Litharge, 510.
74989. Grain in Steel, 510.
75008. Spectroscope, 511.
75017. River Steamers, 511.
75025. Musical Bells, 511.

75130. Expense of Mail Steamers, p. 21.
75153. Electric Tramway, 22.
75186. Induction Coil, 22.
75190. Detecting Oil in Jute, 22.
75192. Small Arc Lamp, 22.
75205. Kola and Cocoa Manufacture, 22.
75207. Peroxide of Hydrogen, 22.
75210. Harp Making, 22.
75215. Galvanometer, 22.
75219. Rope Gear.

QUERIES.

[75459.]- **Nitrogen in Sulphuric Acid.**—Can any reader give me a simple method of removing compounds of nitrogen from sulphuric acid without introducing other objectionable bodies? The acid is required for dissolving indigo in a laboratory operation, so that a process adapted for small quantities, say 5lb., would greatly oblige.—W. A. G., Huddersfield.

[75460.]—**Iris Diaphragm.**—Will some kind friend kindly inform me how an iris diaphragm is made, and works, with a diagram if necessary—a diaphragm such as is used for photographic lenses?—Evil.

[75461.]—**Astronomical Driving Clock.**—Will some astronomical reader kindly send a sketch of a conical pendulum and escapement for a driving clock for imparting continuous motion to the telescope?—Regulus.

[75462.]—**Cool Chamber without Ice.**—A few months ago you gave an illustrated article on "How to Build a Cold Room" (to be cooled by ice). Of what use is this to those who cannot procure ice without great trouble and expense? I have a room very similar to the one you described, and want to convert same from an ice-room into an ammonia-cooled room or any other process whereby I can obtain like result (30deg. Fah. in summer). Will someone oblige me with illustrated instructions on how to cool a room without the use of ice?—Wag.

[75463.] — **Brazing Copper.**—Can any of your numerous readers assist me in the following matter? I want to braze a copper tube 6in. diameter, made of metal 1-16in. thick. I have one of Fletcher's blowpipes and foot-blower, stated to be sufficiently powerful to do this class of work, but I am unable to get up the metal to a sufficient heat. Is it necessary to stop up the ends of tube, and if so, with what substance? Will they also state the best composition of which to make a block on which to braze smaller articles?—Blowpipe.

[75464.] — **Making Charcoal Soluble.**—What should I do or add to charcoal powder to make it soluble in hot water? If a chemical is necessary, it must not be a poisonous one.—Telhara.

[75465.]—**Tartaric Acid or Cream of Tartar.**—Will tartaric acid or cream of tartar produce a perfect assimilation of fatty matter with a syrupy liquid, and how much should be used?—Telhara.

[75466.] — **Oxidising Small Silver.**—Can any reader tell me of an easy method of oxidising small silver?—Admetus.

[75467.]—**Continental Trains.**—Will some of our railway correspondents kindly say what is the fastest train running between Paris and Marseilles, the average speed for the whole journey, and the fastest portion of the journey, with average and maximum speeds for that portion?—Northern.

[75468.] — **Hot-Air Engine.**—Could some kind reader of the "E. M." give me instructions as to making a ½-man power hot-air engine, and probable cost?—Hot Air.

[75469.]-**Mullein-Charcoal.**—Can any readers of "Ours" give some information on "growing the Mullein plant," also how to make charcoal for forge work? There is plenty of red willow at command, but what I have tried has burned into a white ash principally. Perhaps "Ess" would be so kind as to help?—Lotus.

[75470.]—**Polarisation of Light.**—I have begun to work at this subject, and encounter a difficulty which I should be obliged if some of your correspondents can remove. I place a crystal of Iceland spar over a black dot on a sheet of paper, with the two dots pointing towards me if a line were drawn through them. Then, when I examine these dots through a Nicol prism, I find that when the Nicol is rotated so that the line joining the dots intersects its principal plane at an angle of 44°, both dots are seen at once. How does this happen, if, as the books say, the Nicol is so constructed as to reflect off the ordinary ray and get rid of it altogether?—D. Traill.

[75471.]—**Self-Toning Photo. Paper.**—Will any reader oblige by informing me how the self-toning printing photographic paper is made?—H. Howard.

[75472.]—**Roller.**—Would someone well acquainted with mangle rollers kindly say if beech-wood is as good for mangle rollers as sycamore?—Roller.

[75473.]—**Salt Bath.**—Can any reader inform me how to make a bath most nearly resemble sea water? Should anything besides sea salt be used, and is not borax too drying?—W.

[75474.]—**Clock-making.**—I would be obliged if any of your readers would kindly tell me if it is practicable to turn the brass and steel for a small clock with a mandrel, or if a lathe is necessary, and what size it ought to be? Any information would be very acceptable.—A. H.

[75475.]—**Diffraction Spectroscope.**—Will any reader kindly give details of this form of spectroscope, how the different orders of spectra are obtained, the relative dispersion of each, and how the instrument is applied to the telescope? What are its advantages over the glass prism for star work?—W. S. P.

[75476.]—**Dubbin.**—I should be very much obliged if some reader would give me a recipe for making a good waterproof dubbin for shooting and other boots. I have tried various kinds of oils, but without much success.—O. S. W.

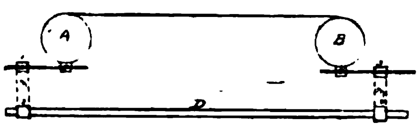
[75477.]—**Electric Light.**—To Mr. Bottone.—I am a newsagent, and about to adopt the electric light in place of gas. I think that eight lamps of 50 candle-power each will meet my requirements. Will you please say: (1) What type of dynamo, and probable out-put? (2) Horse-power of gas-engine? (3) Probable cost of installation complete?—Newsagent.

[75478.]—**Tea Culture.**—Can any of your readers give me the names (with publisher and price) of the best scientific books on tea, covering, if possible, the following: (1) Origin and geographical distribution. (2) Botanical, giving complete account of all different kinds of teas, explaining soil and climate required for each. (3) Chemical, giving complete account of constitution and methods of analysis. (4) Manufacture of commercial tea, and differences caused by different methods.—Tokio B.Sc.

[75479.]—**Slide-Valve Setting.**—Will some of our engineering readers of the "E.M." kindly give me a few hints how to set engine slide-valve correctly, say an ordinary traction engine with link motion and reversing gear? I have been informed that I must allow more valve opening on back side than I do on front side to obtain a correct stroke from the exhaust. Eccentrics are right on crank-shaft, so I only get the valve to set correct on face. What is the rule laid down? Any hints will kindly oblige.—Engine-Driver.

[75480.]—**Astro. Telescope.**—Would "F.R.A.S.," or some other of your numerous readers, kindly give me instructions how to make an astronomical telescope with 4in. object-glass? Will the following dimensions suit?—Body tube, 5ft.; eyepiece tube, 8in. At what distance from o.g. should the disc with aperture be placed in body tube, and at what distance are the eyepiece lenses fixed? Would a 3in. achromatic be better than a simple 4in. o.g.?—Ganelon.

[75481.]—**Reversing Gear.**—A B rollers, driven by worm-wheel C; worm-spindle driven from shaft D by leather bands E; 1, 2, 3, 4, pulleys; roller A winding up a cotton cloth from roller B. After 30 revolutions of A I wish to reverse, drawing A out of gear and starting roller B. After 30 revolutions of B to reverse again, starting roller A. One of the rollers to work only at the time, drawing the cloth from one roller to the other, and changing alternately after every 30 revolutions. How can I make up reversing gear?—Trebla.



[75482.]—**To Mr. Bottone.**—I have three 10in. square zinc plates, with carbons equivalent, and should feel obliged if you will kindly tell me how I can get the most power—the three zincs with carbons in single fluid cell, or cut them up 7in. by 3in., making 12 cells to light an eight-candle-lamp? Single fluid cell, bichromate battery.—W. H. F.

[75483.]—**Metallic Compound.**—Will anyone tell me what is the composition of the metallic fittings of gazogenes, and how are they worked to shape? What is the tensile strength of the composition? In other words, what should the thickness of the sides of a vessel be to withstand 100lb. per square inch internal pressure?—Many Years' Subscriber.

[75484.]—**Milking Machines.**—Has there been a trial of milking machines before any of the great agricultural societies? Any information as to these machines will oblige.—B. C.

[75485.]—**Byng Coil.**—I shall be glad if some reader could explain to me the mode of winding a Byng coil for 12 degrees of strength, the B.W.G. of primary and secondary, and the amount of turns on coil for each? Also if the secondary wire is wound in the same or opposite direction to the primary? It is the smallest type of Byng coil I refer to.—John E. Lawton.

[75486.]—**Jumper Flies.**—I am a provision curer. This year I continued curing through summer, but have suffered great loss from the jumper fly laying their eggs on the hams whilst drying. Could any of your correspondents suggest anything to cover the face of the hams with—a non-injurious matter, but which would prevent their lighting upon or laying their eggs on the hams, which would be a great boon to a—Sufferer.

[75487.] — **Detective Camera.**—Will any reader kindly tell me how to make a simple Detective camera to carry 12 quarter-plates. I want it arranged so that I can change the plates easily by pulling a knob, or something like that.—G. A. H. M.

[75488.]—**Screw-cutting.**—Will some correspondent kindly inform me what wheels would be required to cut a screw 9-16 and 1-32—i.e., one thread in 9-16 and 1-32in. pitch, leading screw of lathe ½in. pitch, or two threads to the inch? also what the reason is that press screws (square threads) are in nearly all cases thicker at the top of the thread than what they are at the bottom. I have calipered the screws of new presses, and have found them vary as much as 1-32in. from top of thread to bottom.—E. E. Hardy.

[75489.]—**Style of Sundial.**—Would "F.R.A.S." kindly tell me if a small tube through which I can see the Pole-star makes a good style of a sundial? How can I correct for standard Pacific time. There is no map or survey of the country, and I cannot find out exact lat. and long.—B. C.

[75490.]—**Pitch Leading Screws.**—Will some correspondent kindly inform me what the advantages are (if any) of using ⅝in. pitch leading screws on screw-cutting lathes. I have myself used this class of lathe, but never derived any advantages over the ordinary lathes fitted with ½in. or ¼in. pitch leading screws. I have also asked practical men's opinions on this matter, but I have never had a satisfactory reason given me why such an odd pitch as ⅝in. is used?—E. E. Hardy.

[75491.]—**Speed Indicator.**—Can anyone kindly give me any information concerning the construction of speed indicators such as I have seen on the dynamos at the Naval Exhibition? They look much like a Bourdon's pressure gauge, and have a hand indicating the number revolutions made per minute; they are driven by a belt from the shaft. Also, is there a simple form of the instrument which I could make for myself?—F. H. C.

[75492.]—**Cement.**—I shall feel obliged if anyone will give recipe for the special cement used for cementing the German cream-coloured razor hones to dark slate. I saw it mentioned recently in a notice on Hones that they were cemented. I have been on the look-out for a cement for this purpose for a long time—one that could be applied by a paint-brush, similar to varnish, but have failed to find one that will stand the water test. Marine glue is not suitable.—C.

[75493.]—**Resistances.**—Could any of "ours" kindly supply me with a table of the resistances and safe-carrying capacities of iron wires? I want to make use of some for electric light.—Brilliancy.

[75494.]—**Glass-Blowing with Oil-Lamp.**—Could any of our readers give me particulars of the way to use paraffin in the place of gas for the purpose of glass-blowing?—Amateur Blower.

[75495.]—**Lift.**—I want to make a lift to run a load of about ½cwt. up, and at same time have corresponding empty cage running down. Will a brother reader kindly help? Conditions are these: The lift to run from ground to first floor (about 13ft.) and stop on reaching floor level for unloading, and remain safely there until unloaded. I have a gas-engine working on the ground floor, and shafting runs close to proposed lift, which can be used for the lifting power. My difficulty is in reversing motion.—S. J. B.

[75496.]—**To Mr. Bottone or F. Askew.**—Would double cotton-covered wire do for an induction coil if I paraffined it well? What quantity of primary would I require (and its number B.W.G.) to a pound of secondary No. 34 B.W.G.? What diameter and length would I make the paper tube? Would it be advisable to wind the secondary coil in two sections, and how shall I do this—horizontally or vertically. I wish to use the coil for physical effects, and as cotton-covered wire is much cheaper than silk-covered, I could afford to wind on a larger quantity of it for the secondary coil. What length of spark would such a coil give, and what is the nature and use of the two primary coils in large induction coils, such as Mr. Spottiswoode's?—W. J.

[75497.]- **Magnetic Oxide.**—Can any reader inform me how to make this?—Delta.

[75498.]—**Electric Lighting.**—Will Mr. Bottone or others help me in the following? I have a coal wharf in constant use, with stabling and office; but no light except lamps, candles, and coal fires on wharf to see to unload boats and to load carts by for about four hours on winter nights and mornings. My house is about a mile away from wharf, and is supplied with gas, the winter quarters costing 25s. for gas, besides lanterns and candles used in outhouse and stable. Can I profitably light wharf and my house from same source by electricity? What would be best and cheapest way to do it? I have no motive power, but plenty of cheap fuel. Three lights for wharf, two on at once; eight for house, four on at a time.—Darkness.

[75499.]—**High-Pressure Boiler.**—In our kitchen range there is a high and low pressure boiler. In consequence of the high pressure failing twice, they are about to put a large high-pressure boiler, and do away with the low pressure. In what way will the supply and draw-off be connected to the high-pressure boiler, and will it make any difference in the amount of hot water to be got upstairs if there is liberal supply drawn off on ground floor?—Archer.

[75500.]—**To Mr. Bottone.**—I have constructed a small dynamo from the instructions given in your book, but I cannot get it to work. The insulation is good, and the brushes seem to be all right. I can only get 6oz. of No. 20 s.c. wire on the armature. The field-magnets are wound with 7lb. No. 16 c.c. wire. If the fault is in having too much wire on the field magnets, please say how much I must take off, and I shall be much obliged.—A. Swallow.

[75501.]—**Hydraulic Pump or Ram.**—Will any of our numerous correspondents kindly give me full instructions how to make a hydraulic pump or ram, for testing cylinders, &c., up to three tons pressure (required to be portable)? Working drawing would greatly oblige.—G. W. de M.

[75502.]—**Charging Constant Current Battery.**—Will some reader please tell me how to charge a constant current battery—one of Harness's, with 12 fixed cells? Is it possible for me to charge it myself?—W. S. G.

[75503.]—**Extracting Zinc from Lead.**—Kindly state the easiest way to extract a small quantity of zinc from lead (whilst in a molten state, heated by gas if possible), as I have about 1½cwt. of lead, which is useless whilst the zinc is in it.—Metal.

[75504.]—**Space of *n* Dimensions.**—Writing on the above subject, "F.R.A.S." speaks of the Mediæval discussion about angels standing on the point of a needle. Would "F.R.A.S." kindly say where any trace of this discussion may be found, if it is anything more than a myth?—Needle.

[75505.]—**Steam Tricycle.**—Can any one tell me what speed steam tricycles make, if they are noiseless and smokeless, and cost of fuel per mile?—La Vapeur.

[75506.]—**Phonograph Motor.**—To Mr. Gillett. —Will you please state if I can use No. 24 silk-covered wire instead of 26 for motor. and if so, how much? as, by an oversight, I read 24, and purchased a quantity which I have no other use for at present.—G. T. W.

[75507.]—**Locomotive Colours.**—To R. Bruce.—Will you kindly answer the following questions:—1. What are the colours, including number, plate, and picking-out colours of the North-London Railway locos.? 2. The following companies' engines are painted green, but I should be glad to know what the relieving colours are beneath the foot-plate—viz., G.N.R., N.E.R., L. and S.W.R., H.R., and G.N.S.R. 3. Would be glad of the colours, &c., used by the chief Irish lines, if possible to give them?—Loco. No. 2.

[75508.]—**Medical Coil.**—I have made a coil the size of paper tube, $\frac{3}{8}$in. diameter, and have wound two layers of No. 20c c. primary (B.W G.), and 30c.c. wire for secondary, but fail to get any magnetism in the iron bundle or wire. I have also wound primary with No. 18 c.c. with the same result. Will any reader tell me where I am wrong?—Arthur B.

[75509.]—**Telescope Optics.**—I am greatly obliged to "F.R.A.S." and Mr. A. Gadd. The rule kindly given by "F.R.A.S." for finding power of eyepieces evidently does not admit of general application, as I have lately had a telescope in my hands in which the ratio of the lenses forming eyepiece corresponds closely to Fraunhofer's formula on p. 89, but the calculated power differs from the actual power of the instrument. And I am unable to discover the rule for estimating the power of 4-lens eyepieces, from the figures and power given on the page above quoted.—Tyro.

[75510.] — **Electric Model Motor.** — To Mr. Bottone.—I having made one similar to that in your book, and described in "E.M.," Vol. XLVIII., with soft iron cores $\frac{3}{8}$ by $1\frac{1}{4}$ long, with box-wood bobbins wound with No. 26 s.c.c. wire, using three No. 2 Leclanché cells, which works well, inasmuch that when armature in revolving passing its poles, makes a little bumping noise, and shakes the whole stand. I have an intention making another similar if practicable, by putting for armature four iron cores and bobbins, size smaller than the two fixed electro-magnet cores. Would this design be to any advantage for working steadier and self-starter, and what difference in size of wire, if required, to that put on armature and fixed magnets? And also would there be any advantage by putting on small fly-wheel on end of shaft? I have the intention for driving small model articles.—Somerset Lad.

[75511.]—**Sign Writing.**—Could any reader tell me the best and quickest way of learning sign-writing—how to get best samples for different kinds of letters? —Richard Foster.

[75512.]—**South-Eastern Railway.**—I should be glad if "St. Aubyn" or some reader of the "E.M." could supply me with sketch (with tender, if possible) of the 7ft. four-coupled bogies on this line—by Mr. Stirling—or of six-coupled goods, either tank or tender engine?—Loco. No. 2.

[75513.]—**Casting in Lead.**—Would some reader describe the best method of casting lead wheels? The kind of wheels which I wish to cast are solid wheels all through; diam., when finished, to be $1\frac{1}{2}$in., with $\frac{1}{8}$in. flange; no spokes.—Loco. No. 2.

[75514.]—**Lighting Showroom.**—Will some one please advise me as to the best system of lighting showroom by gas, light to be pendent, and as near ceiling as may be? Present light is smoky, which fault I want to remove. I would prefer electricity, but fear I have not power to spare.—British Bulldog.

[75515.]—**Pulley.**—Will any kind reader please tell me if I can run two pulleys at right angles to each other with a strap? The top pulley is 1ft. diam., and bottom one 2ft. diam. The top one is 6ft. above bottom one. If it is possible, please say which is the right position to place them in?—C. G.

[75516.]—**Chromic Acid.**—Will any reader inform me how to make chromic acid, as, being a large user and retailer of it, I think it will pay to make it? I have plenty of time and space. I do not mind a little outlay.—H. Hall.

[75517.]—**Scrap Copper.**—Will some fellow reader kindly give me a plan for easily converting scrap copper into copper sulphate for electrotyping. I imagined that, by having a jar of sulphuric acid near my work-bench, and dropping in the copper scraps as they occurred, I should ultimately have a crop of crystals. My judgment is evidently at fault, as the metal does not appear to dissolve.—Tinker.

[75518.]—**Collecting Leaves.**—Could one of your readers kindly inform me as to the best method of preserving leaves and arranging them in an album? Would the best plan be to obtain skeletons, and, if so, how may this be done?—A. Smith.

[75519.]—**Mnemonics.**—I have a very bad memory, which I wish to improve, and thought of trying either Mr. Stokes's or the Loisette system. Can any reader tell me if there is any difference between them, and if they have tried them, which they found the best and most reliable?—T. S.

[75520.] — **Electrical Indicator.**—Will someone kindly give me details of the construction of an electrical indicator for showing the water level in a reservoir about a quarter of a mile distant?—Waterworks.

[75521.]—**G. N. S R. Locomotives.**—Will some reader kindly oblige me with a sketch and dimensions of (engine and tender) of one of the locomotives built for the G.N.S.R. by Robert Stevenson and Sons, Newcastle-on-Tyne, in 1890?—Admirer.

[75522.]—**Power and Heat Calculation.**—Will any generous reader, having the data at command, kindly say exactly how many indicated H P. are contained in 10,000c.ft. of air at 50° Fahr., after isothermal compression to 7 and 10, and 13lb. per square inch respectively; and also how many centigrade units of heat would be evolved when 1,000c ft. of air are adiabatically compressed to 1 and $\frac{1}{2}$, and $\frac{1}{4}$ and $\frac{1}{8}$c.ft. respectively?—Thermos.

[75523.]—**Logarithms.**—In the computation of the values of a certain function, the reciprocals of such integers as 107 374 1824 frequently occur. Query: How are their logarithms true to twelve decimals best to be found? True to twelve decimals, because it is desired to tabulate results true to eight decimals, to the attainment of which degree of accuracy it appears necessary to proceed as far as the twelfth decimal in the computations, since several (sometimes as many as thirteen or fourteen) such fractions enter into each result.—Esse Cabalita.

[75524.]—**American Organ.**—I am thinking of building a two-manual, with pedals, of following specification:—Great Organ: Diapason, 8ft.; Clarabella, 8ft.; Harmonic Flute, 4ft. Swell Organ: Bourdon, 16ft.; Gamba, 8ft.; Principal, 4ft; Vox Humana. Pedal Organ: Bourdon, 16ft.; Violoncello, 8ft. Couplers: Swell to Great, Swell to Pedal, Great to Pedal, Octave on Great. Would purchase cavity boards with reeds, also keyboards and bellows. Am entirely at a loss to know how I am to set about the construction. Would be much obliged if any reader can recommend any work or articles on subject, or give any hints.—Four Years' Subscriber.

[75525.]—**Boring Holes through Glass.**—1. What is the easiest and cheapest way of boring circular holes through plate glass? 2. How can the edge of plate-glass discs be neatly rounded off?—A. B.

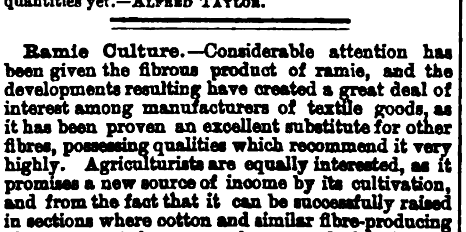
[75526.]—**Lung Protector.** — Can any of your readers tell me of a simple appliance to keep flour and other dust off the lungs?—Young Miller.

[75527.]—**Charging Accumulators.** — Will Mr. Bottone and others kindly answer this query? Can small accumulators be charged by an alternating current at 100 volts pressure? If so, kindly state the best way to charge same. I ask this, as I have been told that a small accumulator can be charged by an alternating current, 100 volts, by inserting a lamp in the circuit, which reduces the alternations. Is this possible?—W. T.

[75528.]—**Taking Out Quantities.**—Will some kind reader give full instructions, and calculations worked out, for the roof shown in sketch? The roof is 30ft. span, and 9ft. rise to apex (ridge cap). The roof truss consists of as follows:—

2 T-iron rafters (A) section $3\frac{1}{2}$in. by $3\frac{1}{2}$in. by $\frac{3}{8}$in.
2 L-iron struts (B) ,, $2\frac{1}{2}$in. by $2\frac{1}{2}$in. by $\frac{3}{8}$in.
2 flat-bar struts (C) ,, $2\frac{1}{2}$in. by $\frac{3}{8}$in.
2 flat-bar ties (D) ,, $2\frac{3}{8}$in. by $\frac{3}{8}$in.
Also 2 apex plates (E), and two shoes (F).

Kindly give fully worked-out calculations to each item, and show quantities for the whole roof truss, as per sketch. Also allow for a few bolts and rivets required, saying how many you calculate for, and any little plates I may have forgotten. I shall be obliged to any reader for this information, as I have been in drawing office as draughtsman for about six years, and cannot master quantities yet.—Alfred Taylor.



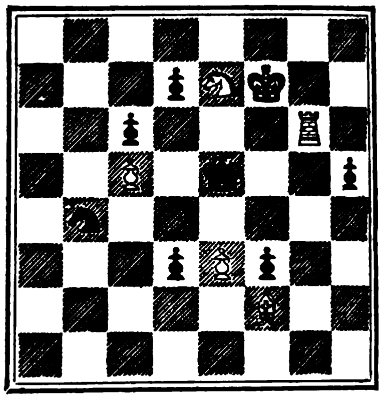
Ramie Culture.—Considerable attention has been given the fibrous product of ramie, and the developments resulting have created a great deal of interest among manufacturers of textile goods, as it has been proven an excellent substitute for other fibres, possessing qualities which recommend it very highly. Agriculturists are equally interested, as it promises a new source of income by its cultivation, and from the fact that it can be successfully raised in sections where cotton and similar fibre-producing plants cannot be grown because of the climatic conditions. As the industry is practically a new one, a few hints as to the best methods, kind of soil and care required may not be out of place. Ramie, to be successfully grown, ought to be planted in rows $2\frac{1}{2}$ft. apart, and the plants about 1ft. apart in the row, thereby requiring some 12,500 plants to the acre. The object is to get a thick stand as soon as possible. If the plants are further apart, they branch out too much in making side shoots, and such stems do not produce valuable, long fibres. Ramie plants require damp soil, which may be by natural or artificial means, so as to produce stalks of from 5ft. to 6ft. in height in six weeks. By such a quick growth the stems grow of almost an even size, and in decorticating by a good machine the fibre comes off in nice, even ribbons. Of course, ramie will grow almost anywhere, but to obtain the best results good, strong, damp land is required. Ramie culturists differ regarding decorticating. Some favour doing the work when the stems are in a green condition, and others dry. A noted writer on the subject states that when they work the stems green, and de-gum the fibre, it produces a more silk-like fibre, with a more lustrous gloss, and thereby requires no bleaching.

CHESS.

All communications for this department must be addressed to "J. Pierce, Knollside, Yawl, Lyme Regis, Dorset."

PROBLEM MCCLXXV.—By W. Timbrell Pierce.

Black.



White. [6 + 7

White to play and mate in three moves.

Solution to 1278.

White.	*Black.*
1. Q-B 6	1. Kt takes Q (*a*)
2. R-B 5 (ch)	2. K-K 3
3. Kt mates.	
	(*a*) 1. K takes R (*b*)
2. Kt takes B (ch), &c.	
	(*b*) 1. Kt-K 3 (*c*)
2. R takes B (ch), &c.	
	(*c*) 1. P takes R, &c.
2. Q-K B 6, &c.	

NOTICES TO CORRESPONDENTS.

Correct solutions to 1278 by T. Guest (3 duals), F. H. Guest (ditto), T. H. Billington (3 duals), W. T. Hurley (2 duals), and G. Collins (1 dual); to 1272 by F. H. Guest, Biène, R. W. Houghton, and J. Johnston.

H. F. L. Meyer.—Your leviathan is too large for our small hook. Many thanks.

T. Guest.—The sole question is, what were the rules on starting the tourney, not what each competitor may think fair? As a matter of fact, we know that it is not done in one of the first solution tourneys now being held. Your five duals shrink to three, as (*d*) and (*f*) are the same as (*g*).

W. T. Hurley.—(*b*) and (*d*) are the same duals; the others do not count, as they involve short mates.

R. W. Houghton, T. H. Billington, and J. Nield.—Many thanks for the problems.

"The Chess Player's Annual and Club Directory for 1892" will shortly be issued by the authors, Mr. and Mrs. T. B. Rowland, 11, Victoria-terrace, Dublin. They, therefore, invite the following particulars of chess clubs: Town, club name, year established, place of meeting, days, hours, number of members, annual subscription, laws, president, hon. secretary's name and address. Printed forms will be had on application. The work will be, as hitherto, a ready book of reference on almost all subjects of interest to chess players; price 2s. 6d.

Surrey Mirror received with thanks.

Liverpool Weekly Mercury.

CHESS COLUMN.

The second Problem and Solution Tourney will be commenced in November. It will be divided into two sections for two and three-move direct mates respectively. All classes of competitors are invited. The prizes will be of a substantial character in cash or chess works at the option of the winners. For rules see the October issues of the *Weekly Mercury*.

The *Liverpool Weekly Mercury* will be sent, post paid, for 1s. 8d. per quarter.—[Advt.]

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Advertisements must reach the Office by 1 p.m. on Wednesday to insure insertion in the following Friday's number.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, OCTOBER 16, 1891.

PRACTICAL ELECTRIC-LIGHT FITTING.—VIII.

By F. C. Allsop.

Author of "Practical Electric-Bell Fitting," "Telephones: their Construction and Fitting," "Electric-Bell Construction," &c.

Holders.

THERE are three forms of lamp-holders that may be employed: we have (1), the "bayonet joint" form, for brass-capped lamps, (2) the "screw-socket" for Edison screw lamps, and (3) the "spring" for bottom loop lamps. The first-mentioned form is the one most extensively used, and which is, undoubtedly, entitled to take rank as the most efficient and reliable. The "spring" holder may have a less heavy appearance, and the "screw socket" a more extended surface of contact; but for general excellence and convenience the "bayonet-joint" form is unsurpassed. It takes its name from its close resemblance to the method employed of attaching the bayonet to the rifle, and has two curved slots adapted to receive the two projecting studs on the lamp. Originally introduced by the Edison and Swan Co. (who still retain the sole right to manufacture), it passed through several shapes, receiving sundry improvements at the hands of different manufacturers, till it assumed its latest form, as shown in the illustrations.

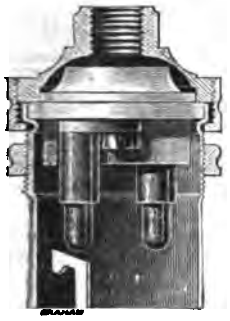


Fig. 47.

Fig. 46 shows the holder dissected, Fig. 47 in section, and Fig. 48 the external appearance. It consists, as will be seen from Fig. 46, of a brass shank (seen on the extreme left of the figure), a porcelain disc, with two insulated contacts on it, a brass body, with two curved slots in it, and, on the right-hand side, a clamping ring. The brass shank, body, and clamping ring can be seen in section in Fig. 47, the porcelain discs and contacts being shown in elevation. The contacts on the porcelain disc consist of two small metal tubes provided with semicircular feet, and in each of these tubes is a plunger that is kept forced outwards by a small spiral spring within the tube. These tubes are perfectly insulated, both from one another and from the metal framework of the holder, and the ends of the two conducting wires are connected one to each of the semicircular feet, a screw being provided for this purpose in each of the feet. To put the holder together, the porcelain disc carrying the contacts is first placed inside the wide part of the shank, care being taken to see that it seats itself firmly, and also that the notch in the side of the disc corresponds with that in the shank. Next the brass body is slipped over and rotated round until the projecting stud at the bottom fits in the notch in the disc and shank, and when this is so the clamping-ring is passed over the body and screwed up on to the shank, thus gripping the whole firmly together.

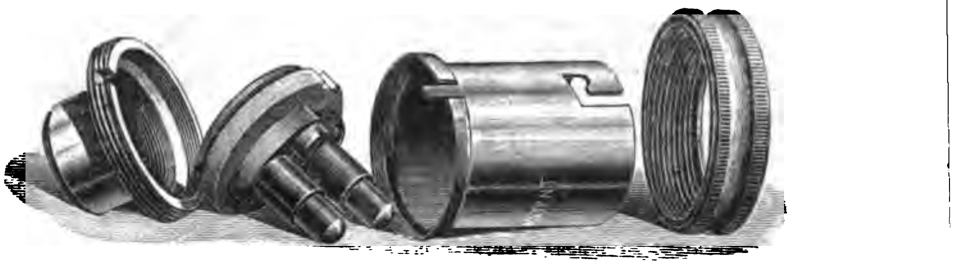


Fig. 46.

To insert a lamp in the holder, the lamp is held in one hand and the holder in the other, and shifted till the studs on the lamp-collar correspond with the slots in the body of the holder. The lamp is then pressed into the holder and given a slight turn, when the studs on the lamp-collar immediately fall into the curved slots, the lamp being retained in that position by the pressure of the plungers in the tubes. To take off the lamp, all that is necessary is to give it a slight twist in the opposite direction, when it will at once drop out. The ends of the plungers press against the contact-pieces in the bottom of the lamp-collar as described in the last article, the independent spring pressure insuring their seating firmly and properly, and the twist at putting up and taking off a lamp giving a rubbing action to the points of contact that keeps them clean. The holders are usually of brass, polished and lacquered, but they can be obtained bronzed, or, as is sometimes required (when necessary to match plated fittings) silver plated.

Although not absolutely necessary, it will be found best when wiring these holders to take them to pieces, as this greatly expedites matters, as well as enabling a much better job to be made of it. The time occupied in fiddling about with the screw-driver, trying to wire it from the front, is often sufficient to and allow it to have been taken to pieces put together half a dozen times. If the holder is to be fitted on to an electrolier or bracket, the proper way to wire and fit it is as follows:—First take the holder to pieces, slip the ends of the wire through the shank, and screw the shank home on to the fitting. Next, cut off the surplus conducting wires, and bare and clean the ends. Now slip these ends through the two holes in the porcelain disc, fasten them down under their respective screws, place the body in its proper position, run up the brass clamping ring, and the holder is fixed. Great care must be exercised in fixing the ends of the wires under the screw heads to see they do not touch one-another, and thus short-circuit the holder. If the holder is wired without being taken to pieces, it must, previously to being attached to the fitting, be twisted two or three turns in the opposite direction; this will leave the wires inside the fitting untwisted when the holder is screwed up.

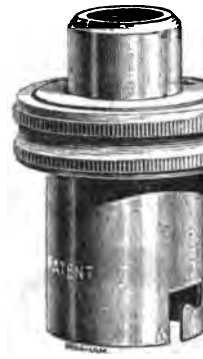


Fig. 48.

Holders are either fitted with a screw-nipple for attaching to fittings, or with cord grip for suspension, and these may be either with or without shade carrier. The holder with screw-nipple, but without shade-carrier, is shown in Fig. 48, and can be obtained with either a male or female thread. They are almost exclusively, however, fitted with a ⅜in., ½in., ⅝in. female thread to suit the male thread on the fitting. The screw nipple-holder with shade-carrier is shown in Fig. 49, and the difference between this form and the preceding consists, it will be seen, in its being fitted with a second ring that holds the shade. The holder is, of course, only intended to make that class of of shade that has a small opening, those with a large opening requiring a special suspension gallery. To fix the shade the bottom ring is unscrewed, the shade slipped on over the body of the holder, and the ring replaced and run up firmly. This grips the glass securely between the two rings. Fig. 50 shows the suspension-holder with cord-grip and shade-carrier. It has a somewhat more extended shank than the preceding forms, on the top of which screws a conical cap. Inside this cap is a wood plug split into halves, the face of each half being cut with two grooves. In wiring the holder the two ends of the flexible cord pass in at the top of the cap, through the two halves of the plug, and fit into the two grooves, so that when the

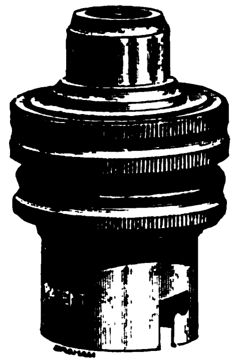


Fig. 49.

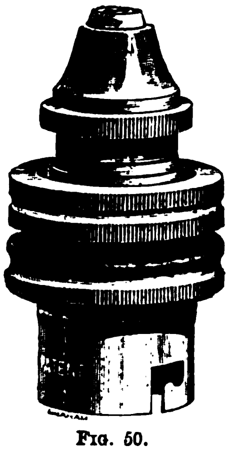


Fig. 50.

cap is run down it compresses, the halves of plug causing them to clasp the wire. It will thus be seen that the holder being supported by the grip of the plug on the wires, all strain is removed from the connecting screws, the cap, moreover, giving a finish to the holder.

In Fig. 51 is shown a suspension-holder combined with a switch, this form being called a "switch-holder." Switch-holders are very convenient in places where it is desired to be able to extinguish and relight the lamp without having to move away from it. By their use also a considerable amount of wire can be saved, as the quantity of wire used for dropping down to a separate switch bears in some installations a rather large proportion to the whole of the wiring. Owing to the necessarily restricted room and other considerations a switch so reliable and efficacious as a separate one cannot of course be obtained. The switch-holder shown in the figure is, it will be noticed, a suspension one, and the handle of the switch is on the left-hand side.

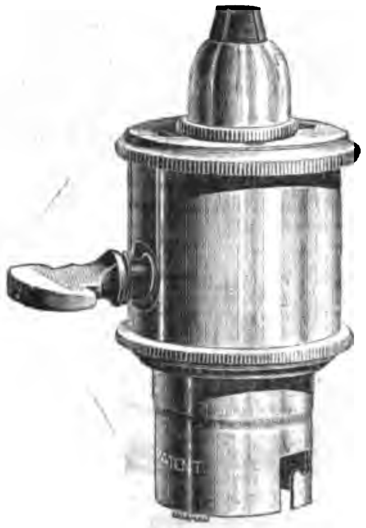


Fig. 51.

One of the most recent improvements introduced into the bayonet-joint holder is that of providing a porcelain ridge between the two contact plungers on the insulated base. This gives a higher insulation to the holder, and by separating the two contacts makes it much less liable to be short-circuited by a slovenly fitter. In the ordinary holder (and more especially in the suspension form) this short-circuiting is no uncommon occurrence, being caused by some of the ends of the connecting wires (which usually consist of 35 strands of No. 40 B.W.G.) reaching across between the two contacts, and thus making a connection right through, and cutting out the lamp. By employing the improved form with the dividing ridge, this short-circuiting is very unlikely to occur, as the ridge separates the ends of the one wire from those of the other. This improved form of porcelain disc is shown in Fig. 52, and also in Fig. 47, the ordinary shape being shown in Fig. 46, which illustrations are perhaps sufficiently explanatory as to need no further description.

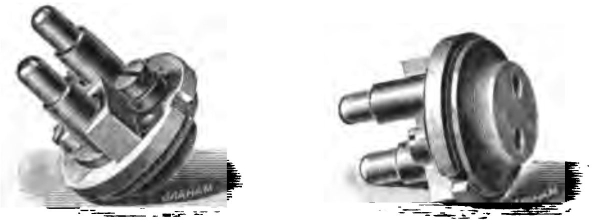


Fig. 52.

A form of the "screw-socket" lamp-holder is shown in Fig. 53. This form of holder is designed to take the lamps with an "Edison screw," and the method of making contact between the holder and lamp is the same as that employed in the Edison universal cut-out, described in Article VI. The holder has a central contact at the bottom, to which one wire is connected, and a metal thread at the side to which the other is attached. These two contacts are insulated both from one another and from the metal framework of the holder. The lamp is fixed into the holder by turning it round and round, which causes the threaded shank to screw in, contact being made at the side and bottom of the holder. It will thus be seen that a large surface of contact is obtained; but since in the "bayonet-joint" the contact surfaces are all that is necessary, it is very doubtful if this is much advantage, or at least that this large surface of contact quite makes up for its rather ungainly appearance. The form of holder shown in the figure is fitted with a nipple for attachment to a bracket or electrolier, for which, in fact, they are more used than for suspension. They are also to be obtained combined with a switch similar to the bayonet-joint form shown in Fig. 51.

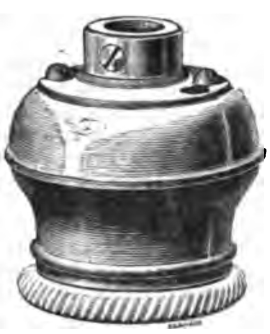


Fig. 53.

The "spring" holder for bottom-loop lamps is shown in Fig. 54, the form shown being only one of a great variety. The great disadvantage of this form of holder is that its very small points of contact offer a rather high resistance to the current, and moreover, the strain put on the loops of the lamp by the constant pressure of the spring-hooks causes them very frequently to break. It is also a somewhat difficult operation to hook on a lamp which cannot be done with one hand, as is the case with the two previously described forms. Further than this, with the "bayonet-joint" holders the lamps can, in places out of reach of the hand, be readily taken off and replaced by a simple spring clip arrangement at the end of a rod, thus doing away with the necessity of dragging in a ladder to replace perhaps one lamp. To fix a lamp in the holder shown in Fig. 54, the bottom of the lamp containing the loops is passed through the circular part of the wire standard, and the two spring-hooks on the base inserted one in each loop. These hooks draw the lamp against the wire standard, keeping it in place and maintaining a firm pressure upon the two loops. The ends of the connecting wires are brought through the hole in the centre of the base, and connected directly on to the two screws seen in the figure. In the first forms of these holders the hooks were fixed, and a spiral spring projected out from the base, pressing the lamp away from the holder and maintaining a constant pressure of the loops on the hooks. Since this numerous other forms of this holder have been brought out, all of which are open to the objection mentioned above, though the one redeeming feature in holders of this class is that they are the least conspicuous of any—a matter of considerable importance in certain places.

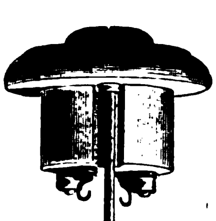


Fig. 54.

(*To be continued.*)

REVIEWS.

Pictorial Astronomy for General Readers. By George F. Chambers, F.R.A.S. London: Whittaker and Co.; George Bell and Sons.

This is an excellent book to give to anyone commencing the study of astronomy, though it is not intended as a student's text-book, but it gives a general idea of the subject, and, being freely illustrated, as its title implies, it will form an admirable present for a boy or girl given to what is sometimes termed "star-gazing." Those who are blessed with good eyesight, and can afford the cost of even a binocular, may obtain many hours of pleasure from the assistance which Mr. Chambers's work will render them, and if they cannot do much in "observing," they will, at least, derive considerable enjoyment from merely perusing its pages, which are really crowded with pictures of the wonders of the heavens. Mr. Chambers commences with a short "history," as it may be called, of astronomy—though he deals with that at greater length towards the end of the work—and then proceeds to deal with the Solar System, the inferior and superior planets, comets, meteors, the stars, nebulæ, and instruments used for observing them — each chapter being so fully illustrated by diagrams and pictures that any reader of average intelligence must obtain some knowledge of the heavens as we see them, and may be induced to study the subject further. That is one of the objects of the work, which is an excellent prize-book or gift-book for the young.

Solutions. By W. Ostwald. Translated by M. M. Pattison Muir. London: Longmans.

This work is a translation of a portion of the "Lehrbuch der Allgemeinen Chemie," written by the well-known professor of chemistry in the University of Leipsic, and it has the advantage of having been translated by a distinguished chemist whose work has been revised by the author. As all chemists know, the subject of solutions has always been a difficult one; but within the last few years a new theory has been put forward which promises to explain all the difficulties previously existing, but also to account for the existence of many other facts. Prof. Ostwald says in his preface that the publication of a portion of a larger work seems to be justified by the consideration that a comprehensive survey of the advances which have been made during recent years must be useful to all who are unable to make themselves acquainted with the numerous memoirs on the subject, which have, for the present, been eclipsed by the theory founded by Van 't Hoff. There are points still to be explained; but the theory is now generally accepted. The different chapters treat of solutions in gases, of solution of gases in liquids, of liquids in liquids, and of solids in liquids, with others on osmose, diffusion, vapour-pressure, freezing-point, salt solutions, &c., with reference notes and an index to authors' names, besides a general index.

The Electromagnet and Electromagnetic Mechanism. By SILVANUS P. THOMPSON, D.Sc., B.A., F.R.S. London: E. and F. N. Spon.

IN this work Prof. Thompson does full justice to William Sturgeon, who first publicly exhibited the electro-magnet in a practical form in 1825; and in an appendix he gives a short biography of the erstwhile private in the Royal Artillery, whose invention led the way to important discoveries. This volume, which is one of the Finsbury Technical Manuals, will take a leading place amongst works dealing with the electro-magnet and its many uses, and is an amplification of the series of Cantor Lectures delivered by the author before the Society of Arts in 1890, a series extensively quoted and much appreciated in all English-speaking countries. Avoiding as much as possible contentious matter, it will be appreciated by the student, as it certainly will be by the practical workman who has to deal with the electro-magnet and its applications in every-day work. It is for the latter just the sort of technical education he requires; and there is no doubt it will become the chief textbook in the classes held at technical schools. As we have so recently reproduced portions of this series of Cantor Lectures (Vol. LII.), which form the substance of the work, we need only say that the volume is well printed, is provided with an index, and contains a chapter on permanent magnets, and one by the author's brother, Dr. J. Tatham Thompson, of Cardiff, on the electro-magnet in surgery—a subject which is interesting to many.

Engineering Chemistry. By H. JOSHUA PHILLIPS, F.I.C., F.C.S. London: Crosby Lockwood and Son.

THE author of this work is the analytical and consulting chemist to the Great Eastern Railway Company, and it is intended as a practical treatise for the use of analytical chemists, engineers, ironmasters, iron-founders, and others employed in the valuation of the principal materials used in engineering work. It comprises chapters on metals, alloys, &c.; ores, limestones, &c.; fuels, solid, liquid and gaseous; and sundry others, such as water and lubricants, which enter very largely into engineering work, especially railway running. Mr. Phillips uses Reddrop's "equivalent system" of reagents as far as possible—a system which, after seven years' experience, he considers pre-eminently the best for adoption in analytical chemistry. It will be found a very useful book in works' laboratories.

The Adjustment and Testing of Telescopic Objectives. York: T. Cooke and Sons.

MESSRS. T. COOKE AND SONS have done a service to workers with the telescope by publishing this useful manual on objectives, by the aid of which anyone of average intelligence can form a good idea of the quality of an objective for himself. Written in a concise style, and illustrated with diagrams, it gives a great deal of information in a small compass, and is at once a guide to the optical principles of the object-glass and to the defects which may be found in many telescopes. The frontispiece is a photo.-print showing the various appearances presented by a star through defective objectives or by lenses out of adjustment, and a careful study of it with the explanation given in the text will enable purchasers to ascertain whether they have obtained a good telescope, a bad one, or one in which the objective merely requires proper adjustment. Messrs. Cooke, while giving its due to the reflector, believe the refractor to be the "most convenient and generally reliable form of telescope," and they have some remarks comparing the "knife-edge" method of testing with the direct focussing method which they advocate. To opticians and workers with the telescope it is an interesting little work, and the practical information it gives will be found of great value to them. We commend it to the attention of our optical correspondents.

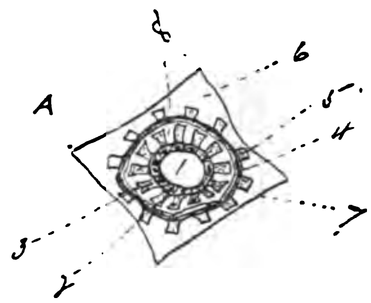
We have also received *Thomas Sopwith, M.A., C.E., F.R.S.*, by BENJAMIN WARD RICHARDSON, M.D., F.R.S. (London: Longmans), which is the biography of a famous engineer well known to a wide circle of friends by his remarkable diary, a work he had duly entered up for fifty-seven years. Dr. Richardson was intrusted with this diary, and with its aid has produced a most interesting and readable work, for Mr. Sopwith was a keen observer of men and things, and was, in many senses, a very able man—with tools, as well as with designs for important works. In fact, Sir Joseph Whitworth said: "I was quite as good with my hands, when I was young, as Tom Sopwith."——*Economies of Iron and Steel*, by H. J. SKELTON (London: Biggs and Co.), is a treatise describing the leading principles and practices of the British Iron and steel trades, which will be of much interest to all who have a connection with those metals, and should be perused by all engaged in constructional engineering. It is nicely illustrated with reproductions from photographs taken in some of the most important iron and steel works in Britain.——*The Stonemason and the Bricklayer* (Ward, Lock, and Co.) is a work for home study and self-instruction, the matter being contributed by "various practical writers."——*Geodesy*, by J. HOWARD GORE (London: William Heinemann), is a "sketch" of the history of Geodesy, for which it seems Mr. Gore, of the Columbian University, has special materials. As a "sketch" it is a useful and an interesting work.)——*The Shilling Book of Interest Tables* (London: Saxon and Co.) will be found handy for reference, as it gives interest at 3, 4, 4½, and 5 per cent. on £1 to £10,000 for from 1 to 365 days.——*Everybody's Writing-Desk Book*, by CHARLES NISBET and DON LEMON (London: Saxon and Co.) will be found useful by those whose education has been neglected as well as by those who may have forgotten.——*Principles and Practice of Plumbing*, by S. STEVENS HELLYER (London: George Bell and Sons) is one of the Technological Handbooks edited by Sir H. Trueman Wood, and will no doubt be found valuable by the rising generation of plumbers.——*Magnetism and Electricity*, by J. SPENCER, B.Sc. (London: Percival and Co.) is a class-book for the elementary stage of the Science and Art Department.——*The Modern Machinist* (London: Ward, Lock, and Co.) is by "various practical writers and machinists," and is adapted for what is called "self-instruction.")——*Physiography*, by J. SPENCER, B.Sc. (London: Percival and Co.), is another class book for elementary stage students, by the Headmaster, Science Department, Bradford Technical College. It is well adapted to its purpose.)——*Mechanics for Beginners*, by the Rev. J. B. LOCK, M.A. (London: Macmillan and Co.), contains the more elementary parts of the "Dynamics of a Particle," and of the "Statics of Parallel Forces." It is a book for the higher classes in schools, or for students going up for the Science and Art Department's examinations.

PRACTICAL MICROSCOPY FOR STUDENTS.—III.

By FREDERICK DAVIS, B.Sc.

PROGRESSING to the exogenous formations of the dicotyledons, and examining the roots, taking as our type the "bean-plant," we see the main portion or axis, and branching from this a number of rootlets. At the extremity of each rootlet we find the so-called root-sheath or cap, termed the pileorhiza. The best plant for the study of this formation is the duckweed (Lemna); it may be fully studied by means of the 1in. objective.

The Stem.—Cut a thin transverse section of the stem, preferably through an internode, and examine carefully with the 1in. power. In the centre we find the pith or medulla, around it stand the pith cells comparatively very large and rounded, consisting of parenchyma; outside these we have the soft wood or alburnum (there is no duramen in a plant one year old); external to the alburnum, the cambium layer or merismatic or fissiparous tissue, followed by the three layers of the bark—the epiphlœum, or outer layer; mesophlœum, or middle layer; and the endophlœum, or inner layer, termed the bast. Note particularly the bast fibres and sieve-tubes.

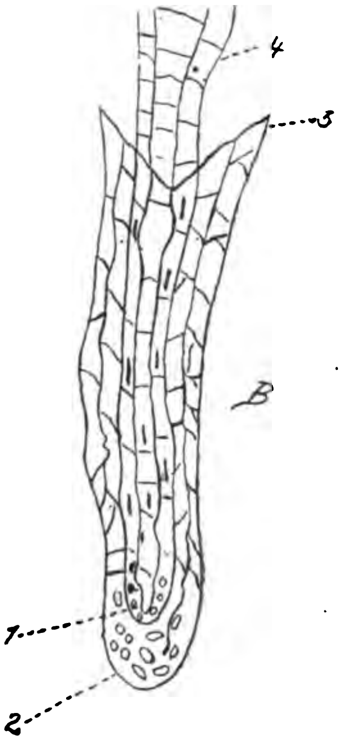


A.—Section of a Bean Stem. 1, Hollow Interior; 2, Medulla or Pith; 3, Inner Fibro-vascular Bundles; 4, Cambium Layer; 5, Woody Bundles of the Cortex; 6, Parenchyma of Cortex; 7, Epidermis; 8, Medullary Rays.

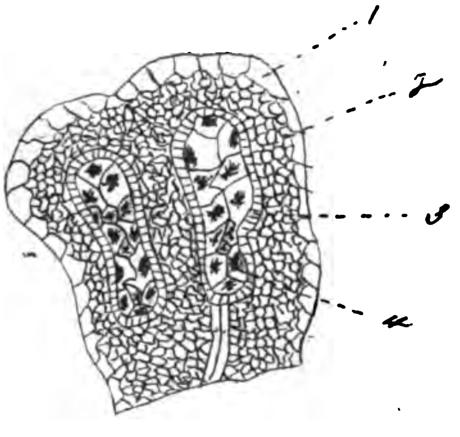
The student should now compare very carefully a longitudinal section, and make out the parts as described in the transverse section. For this purpose imbed a portion of the stem in paraffin (prepared in the manner previously described), and cut a very thin section, mount in water, and examine with the 1in. objective. Proceeding from the outside inwards, we find the cells of the epidermis colourless, cubical, and perforated with stomata, the layer within consisting of a mass of parenchymatous cells. The bast fibres are fusiform, whilst the bast vessels are elongated, and show very distinctly the relation of the sieve tubes. The cambium, made up of partially opaque small irregular cells, shows clearly why it is named merismatic, the division of cells termed fissiparous being very apparent. Coming to the dotted ducts, we find the thickened portion is not deposited in the spiral manner, and thus differs from the spiral vessels; the wood cells and spiral vessels are composed of elongated cells. The pith-cells occupying the centre have been previously described, and exhibit very little difference in appearance longitudinally than transversely. If now we stain the section, by soaking in iodine, we can discern, by the aid of the one-eighth power, the cell-walls, the nuclei of the cells, and the starch granules, which latter, by the action of the iodine, strike an intense blue colour.

In examining the leaf we shall find it to be essentially the same in structure as the frond of the fern; it will not, therefore, be necessary to again describe its parts.

An interesting experiment may, however, be performed by the student to satisfy himself that starch granules are produced from chlorophyll by the action of the sun;—the method was first elaborated by a French scientist, and consists in taking any leaf upon a growing plant, preferably one from a species of Aristolochia, carefully covering the under-surface with a piece of black quite opaque paper, and having perforated or stencilised a second piece, stick it firmly to the upper surface, and expose to the sun's rays or strong daylight for a few hours. After this treatment the leaf is removed from the plant, the papers washed off by the aid of warm water, and the leaf steeped in boiling alcohol to dissolve out the chlorophyll. If now we take the leaf and immerse for a moment in solution of iodine, we shall find an intense blue coloration produced by the union of the iodine with the starch, upon the portion of the leaf left bare by the stencil plate (i.e., the black opaque paper). The accompanying illustration gives a fair idea of the results obtainable.

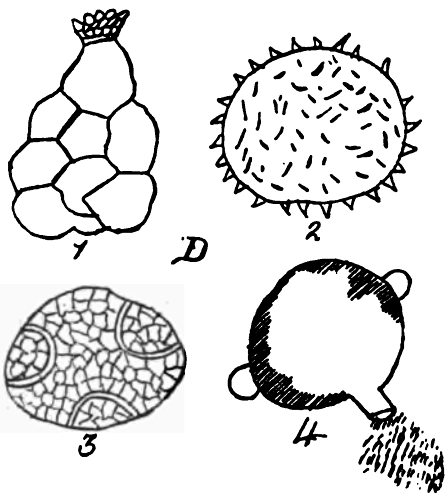


B.—1, Growing Cells in Rootlet, turned the growing point; 2, Root Sheath; 3, Root Cap; 4, Rootlet.

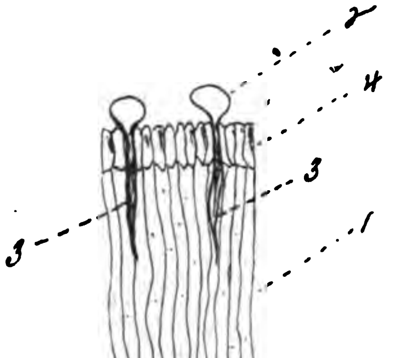


C.—Anther. 1, Epidermal Layer or Exothecium; 2, Parenchymatous Cells, forming Mesothecium; 3 and 4, Mother Cells, surrounded by special layer of cells, forming Endothecium.

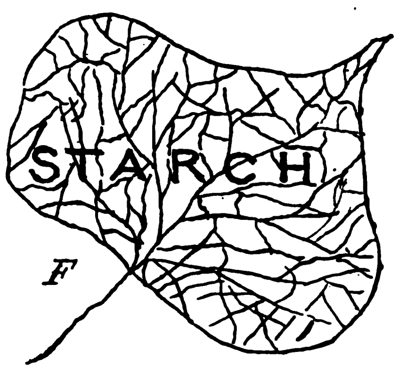
Examining the flower, we notice at the summit of the peduncle, or flower-stalk, we have the calyx; within this the corolla, composed of the vexillum, alæ, and carina; the stamens, consisting individually of the filaments, and the anther; constituting the male organ of generation. And in the centre we find the pistil, consisting of the style, stigma, and ovary, forming the female portion of the flower. We will confine ourselves principally to the organs of reproduction, because to the microscopists they are the most interesting. In the bean plants we observe the filaments form a stamen tube; in these filaments may be seen the spiral vessels of which they are partially composed. By examining with the ⅛in. the knob which surmounts it—the anther—we find it to be possessed of three coats: an outer termed the exothecium, a middle layer of cells termed the mesothecium, and an inner layer termed the endothecium. Within this a number of minute bodies exist, called the pollen grains. Each pollen grain has two coats, called respectively the extine and the intine, and within this the fovilla. It is this substance which, being shed upon the stigma, makes a passage down the style, and fecundates the ovules contained in the ovary; in fact, the seed is nothing more than the matured ovule. The illustrations give a good idea of the foregoing description, and should be studied most carefully. To discern the various parts, the anther of a tiger-lily should be taken, and, having made a transverse section by imbedding in paraffin, the cells forming the coats and the pollen grains may be studied with greater facility than in the bean plant, on account of its larger size. The pollen grains of various plants differ very materially in form, although the structure may be regarded as the same. In the Marshmallows and most of the order Malvaceæ we find the pollen is echinated—that is, the extine is provided with spinose excrescences. In the snowdrop it is covered with small dots. In some some species of Erica the pollen grains are compound. There are, however, so vast a number of examples, that the student will do well to examine the pollen from every flower that may cross his path, not omitting to make a sketch of each, because by this means the beauties of nature will be fixed upon his mind indelibly. In some cases, be it observed, the pollen grains are possessed of minute holes, called pores; in others of little lids, through which the fovilla is shed. When a pollen grain is shed upon the stigma, the intine, being elastic, grows, and forcing its way through the extine, sends down a prolongation through the tube in the centre of the style and enters the micropyle of the ovule, fecundation taking place. In examining the pollen grains it is advisable to first mount them dry, afterwards in water, and finally in oil of cloves, and the respective appearances compared. It is clear, then, from the above, that fertilisation cannot take place unless the pollen grains fall or be placed upon the stigma. This process is termed pollination. It may occur in one of several manners—viz., be carried by the wind, by insects, by birds, or by creeping things, such as snails. In our first example it is called anemophilous, in the second entomophilous, in the third ornithophilous. A self-fertilising flower is an exception, and should it occur the seeds generally produce poor plants. In entomophilous pollination the hymenoptera (or bees), the diptera (or flies), and the lepidoptera (or butterflies) are very active, the moths working at night being guided by the delicate perfumes of the flowers.



D.—Forms of Pollen Grains. 1, Pollen of "Inga Anomala"; 2, Pollen of Althea rosea, showing echination; 3, Pollen of Passifloræ, showing little lids; 4, Pollen of Cherry Shedding Fovilla.



E.—Vertical Section of Stigma. 1, Style; 2, Pollen Shed on Stigma; 3, Pollen Tube; 4, Stigma.



F.—Leaf of Aristolochia, showing results of special treatment to demonstrate formation of starch.

HOW TO CONSTRUCT A PHONOGRAPH.*—VIII.

By W. Gillett.

31.—Switch.

THIS is fixed to the base-board between the two end pillars near the motor, connections being made to the motor by means of flexible covered wires. The lever of the switch need not be more than 1½in. or 2in. in length, and provided with a small bone handle or knob at one end, fixed by a screw passing up from below. The fulcrum of the lever may consist of an ordinary screw, or better still, a milled-head thumb-screw, which screws into a small circular plate of brass, fixed to the board by a stem projecting beneath, on which is screwed a nut. The two extreme positions of the lever may be indicated by small brass studs very similar, in fact, to drawing-pins. The fulcrum of the lever is connected by flexible wire to one terminal of the motor; and a wire carried below the board makes connection between one of the studs and a binding post; while a second binding-post is in connection with the other terminal of motor. These binding-posts may of course be fixed in any convenient position on the board, and the necessary connections made by wires carried beneath the board to their respective places.

32.—Finishing.

The instrument, being now completed, may have the finishing touches put on it, and finally polished up and lacquered. The base-board will look well if French-polished, the metal-work being of course removed to facilitate this process. Small round gut-bands, with the ordinary hook and eye, can be used for transmitting the power, the size of the bands being about 16 B.W.G. wire gauge. Both hooks and eyes will require to be rather short, in order to pass easily round the small pulleys, and if too much noise is caused by them clicking on the wheels, they can have a small piece of silk ribbon fastened round them to prevent their coming in contact with the wheels.

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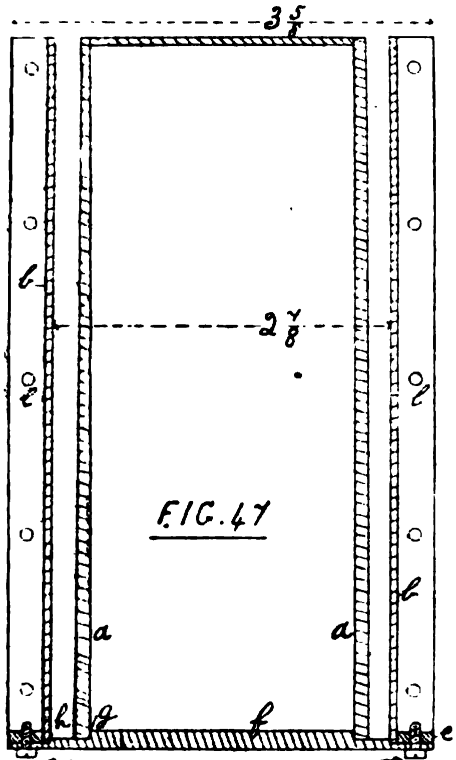


FIG. 47

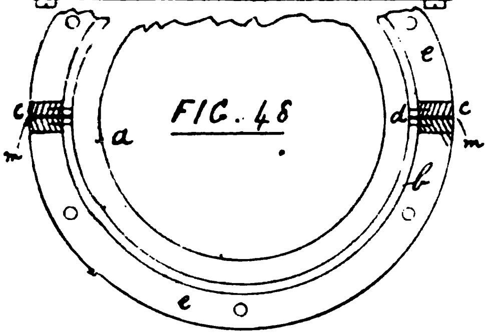


FIG. 48

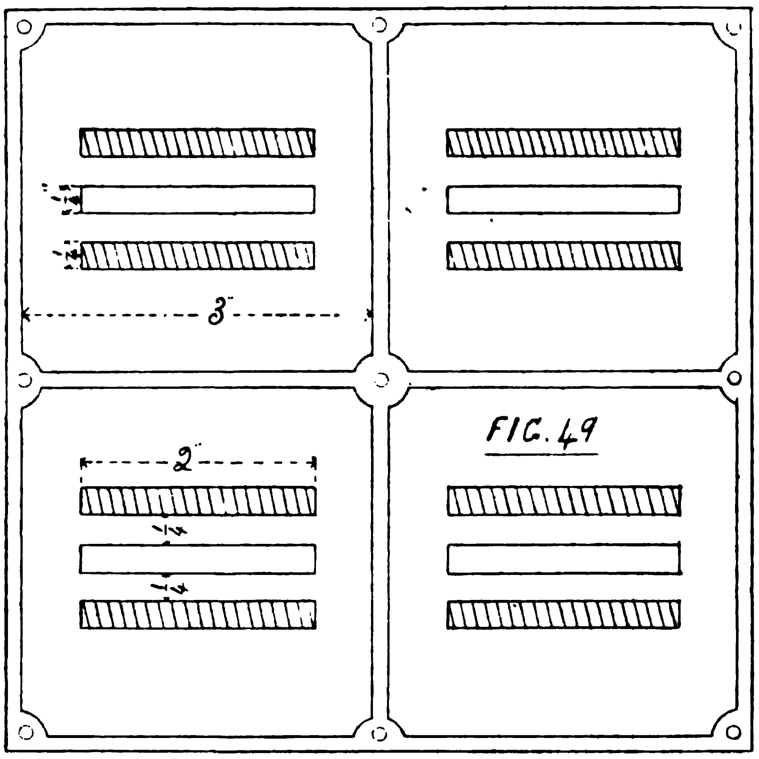


FIG. 49

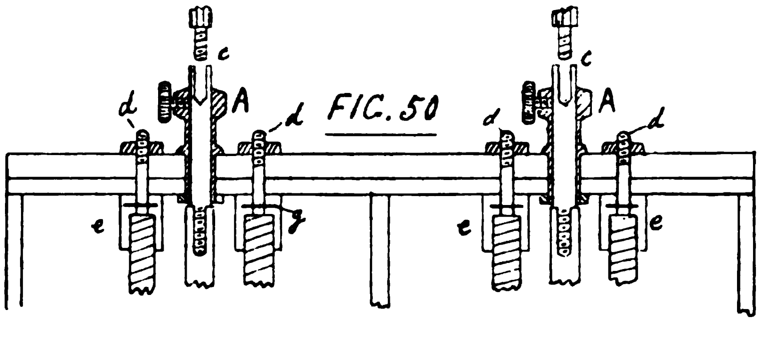


FIG. 50

The bands will probably require to be crossed to increase the grip on the wheels.

The direction of motion of the main shaft, looking at it from the "gate" end, will be in the same way as the hands of a watch. The motor can be easily reversed by changing the connections of the field-magnets with the armature, and turning the brushes round to suit.

33.—Wax Cylinders.

A drawing of the mould for casting the wax cylinders is shown at Figs. 47 and 48. The interior piece or core *a* is made from tube like that of which the mandrel was made, the outside of the core being coned exactly the same as that of the mandrel. Surrounding this core is another tube *b*, having an internal diameter of 2$\frac{7}{8}$in., and a thickness of $\frac{1}{16}$in. On this tube, at the opposite ends of a diameter, two bars of brass *c c* are firmly sweated, reaching from the top to within $\frac{1}{8}$in. of the bottom. At the end of the tube, where a drill can be got to work, two small pins *d* can be driven through the tube into the bar, and soldered there. On the bottom of the tube outside is pinned and sweated a ring *e* about $\frac{1}{8}$in. thick, and of the same width as the side bars. The flange thus formed can be surfaced off with the end of the cylinder, care being taken that it is quite square with the axis of the tube.

A brass disc, *f*, about $\frac{1}{8}$in. thick, has two annular surfaces turned on one side, the shoulders of the top surface *g* fitting accurately the inside of the brass mandrel, and the second shoulder *h* fitting in the outer tube. Both these surfaces should be turned off by one "chucking" in the lathe, to insure that the tubes shall be concentric at all points. The disc can be soldered at the joint *g* to the inner tube, but the outer tube is held down by screws, so as to be easily removable. Several holes, *l*, are also drilled through the bars at the side when drilling the holes from the bottom flange screws. When the tube has been fastened down it its place on the disc, and its position marked, it can be removed and divided into halves by a saw-cut running through the centre of each bar, seen in Fig 48, as the thick lines *m m*. A circular saw is of course much the best for this purpose.

After the side flanges are nicely surfaced off by a file, the holes in the flanges of one half can be threaded to take screws, and the corresponding holes in the other half enlarged to admit of their passing through.

Previous to pouring the wax into the mould, the circular flange must be packed with blotting-paper soaked in oil, and the side flanges with a slip of cardboard, this latter being the same thickness as the metal that was removed in dividing the cylinder. It is also necessary to have the mould rather warm, to prevent the sudden cooling of the wax when coming in contact with the metal. A coil or two of stout, smooth paper, carefully glued round the inner tube before screwing the mould together, serves as a foundation for the wax cylinder, the hot wax penetrating into the paper, and combining them firmly together. It is, of course, the largest part of the coned core that is at the bottom of the mould, and the upper end may, if desired, have a disc sweated in and surfaced off as seen in Fig. 47; but this is not necessary.

In order to keep the cylinder from slipping round on the mandrel when working, and also to insure its being put on in the correct position, a small pin should be screwed into the mandrel at the end nearest to the flywheel, projecting not more than $\frac{1}{32}$in, and the interior of the wax cylinder slightly notched like an ordinary key-way, so that it may fit nicely over the pin. The speed of the mandrel should be about 60 revolutions per minute, and of course exactly the same speed must be used in reproducing the "phonograms" as was used to produce them.

Now as to the composition of the wax on which the "talking," &c., of the machine is so much dependent. Some time ago in these pages I stated that the best wax which I had up to then found for this purpose was obtained by melting down those kind of candles known as "carriage candles" (white). Since then I have not made further experiments owing to the time at my disposal being so extremely limited. As it is only a matter of experiment, perhaps those of our readers who have the time and inclination will continue the experiments, and kindly let us know their results.

34.—Battery.

The best battery for this purpose is undoubtedly the chromic acid, provided with an arrangement for lifting the zincs out of the liquid when not in use, and which also serves as a means of adjusting the speed of the motor. Four cells will be required, each having one zinc and two carbon plates, the zinc plates being 4in. by 2in., and the carbons 8in. by 2in. The cells are shown in plan at Fig. 49, and the ends of the plates with their supports in part section at Fig. 50. They can be made of ebonite about $\frac{1}{8}$in. thick, or from good wood with a fine grain, such as mahogany. The former is of course much the best; but if of the latter they must of course be lined with an acid-proof covering such as gutta-percha. Nine lugs in the position indicated on the plan should be fastened in when making the cells, and in the centre of each lug a $\frac{1}{8}$in. brass pin about 1in. long, and having a thread cut on it, is screwed and pinned through at the side to prevent it twisting round, leaving about $\frac{3}{8}$in. projecting above. The height of the cells should be about 9in. to enable the zincs to be quite clear of the solution when drawn up. The interior of each cell should be 3in. square, so that measuring over all the whole four cells will only be about 6⅜in. square and 10in. high. The arrangement for sliding the zincs up and down is very similar to that on the ordinary bottle bichromate, two of which are shown at A A, Fig. 50. To overcome the inconvenience from the height of the rods when the zincs are drawn up, the top of the rod from just above the set-screw can be removable by means of a screw and socket joint, *c*. The tops of the zinc plates have a hole about ⅜in. in depth, tapped with a ⅛in. thread to take the ends of the sliding rods, which are turned down and threaded to fit. These sliding rods, which are 3/16in. in diameter, move in short pillars, which are fixed to the cover by a nut beneath. In the corners of each zinc plate a small plug of ebonite may be screwed, projecting about ⅛in. each side, to prevent accidental contact with the carbons.

The carbons have lead caps, *e*, cast on them, one or two holes being previously drilled through the plates to enable the lead to have a better hold. Two brass pins, *d*, having a thread at their upper ends should be cast in the lead about 1½in. apart; the stems which are in the lead having a small pin, *g*, inserted to prevent them from turning round in the lead. The thickness of the lead at the sides of the plate should be about 1/16in., and extend down for ½in.

The cover of the cells, if of ebonite, should be backed with a good piece of mahogany about ½in. thick; if of wood alone, it must be about ½in. thick. It is held down on the cells by means of the pins in the lugs already mentioned, which pass through holes in the cover and are fitted with hexagonal nuts and round washers. It can be packed with soft indiarubber.

The cells are connected up in series, so as to give about 8 volts, two binding-posts being screwed on the cover to which the ends of the wire are attached. The zincs should be well amalgamated, and they are easily removable for the purpose. The proportions of sulphuric and chromic-acid have been given many times over in these columns. The cells are, of course, only half-filled with the solution.

35.—Conclusion.

A rectangular glass case should be made to cover the whole instrument, to keep off dust and dirt which would otherwise collect on the oily parts. A wooden case should also be made to keep the wax cylinders in. It should be divided into square compartments, in the centres of which are fixed cones of wood, on which the cylinders may rest.

To make a record without using the automatic turning-tool, first turn off the surface of the wax quite true by adjusting the tool on the supporting column, and then turn the adjusting screw until the recording stylus makes a slight groove on the revolving wax cylinder when no sound is being spoken against the diaphragm; it is then ready for receiving a record. When the automatic turning tool alone is used, both the tool and the stylus will require to be adjusted together, so that when the tool leaves a true surface the stylus makes a slight groove. Once this latter adjustment is made, it will not require to be again altered.

Two or three different sizes of light metal cones or funnels will be needed to slip on the mouthpiece on diaphragm covers, to be used when taking a record. For reproducing, a small cylinder of brass, which also fits on the diaphragm covers, has several pairs of small brass tubes fastened in at the opposite end, on which rubber tubes about ⅜in. diameter can be slipped, the end of these tubes being provided with a short piece of glass tube bent at right angles. A person listening to the sounds will then have one tube in each ear. In quiet places one of the above metal cones can sometimes be used for reproduction.

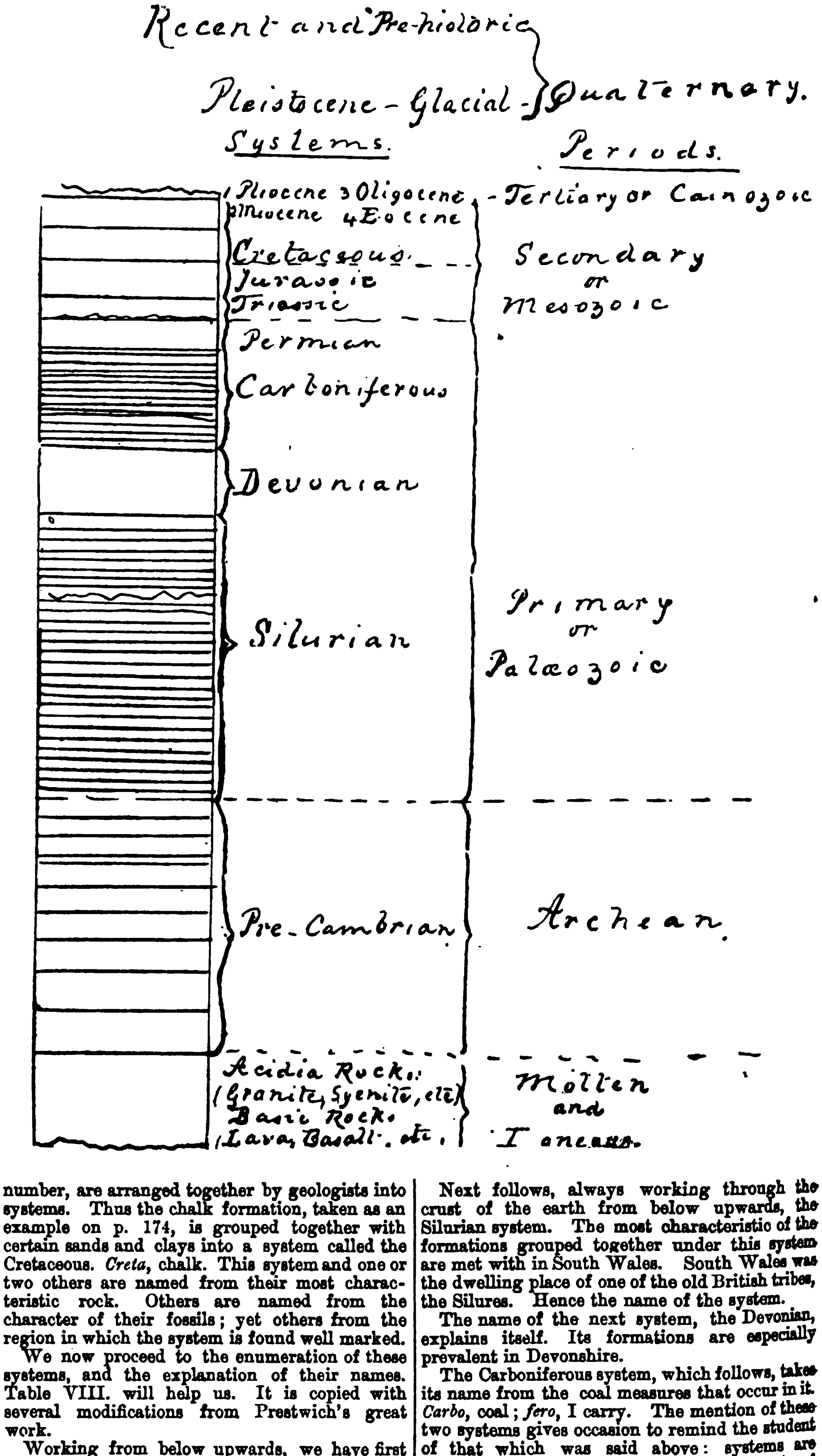
GEOLOGY FOR STUDENTS.

By Edward Aveling, D.Sc. Lond., Fellow of University College, London.

Chapter XVI.—Geological Systems.

A DEFINITE set of strata, having certain common characteristics of composition, age, and origin, is called a geological formation (p. 174). The various sets of formations, some forty in number, are arranged together by geologists into systems. Thus the chalk formation, taken as an example on p. 174, is grouped together with certain sands and clays into a system called the Cretaceous. *Creta*, chalk. This system and one or two others are named from their most characteristic rock. Others are named from the character of their fossils; yet others from the region in which the system is found well marked.

TABLE VIII.



We now proceed to the enumeration of these systems, and the explanation of their names. Table VIII. will help us. It is copied with several modifications from Prestwich's great work.

Working from below upwards, we have first the Igneous rocks. These are represented in Table VIII. as underlying all the aqueous sedimentary rocks above them. Theoretically, this is their original position; but as we have seen, they are, as the result of ejection from within, met with amongst, or even above, all the other and younger rocks. The terms "acid" and "basic" rocks were explained in the preceding chapters.

Reading up the second column, or the systems column, we meet next with the Pre-Cambrian system. *Pre*, before. This system is, in point of time, before the Cambrian rocks that are the lowest members of the Silurian system which lies immediately above the Pre-Cambrian. The Cambrian rocks are not shown in the diagram, as in this latter only the main systems are shown. Their divisions and sub-divisions will be considered later.

Next follows, always working through the crust of the earth from below upwards, the Silurian system. The most characteristic of the formations grouped together under this system are met with in South Wales. South Wales was the dwelling place of one of the old British tribes, the Silures. Hence the name of the system.

The name of the next system, the Devonian, explains itself. Its formations are especially prevalent in Devonshire.

The Carboniferous system, which follows, takes its name from the coal measures that occur in it. *Carbo*, coal; *fero*, I carry. The mention of these two systems gives occasion to remind the student of that which was said above: systems are named from some prominent characteristic of rock, or fossil, or place. The student must guard against imagining that the Devonian system is confined to Devonshire, or that the Carboniferous system consists of nothing but coal.

The Permian system takes its name from Perm, one of the Russian governments lying mostly in Asia, and divided into two unequal parts by the Ural mountains.

Triassic is thus named because the system has three chief divisions. τρις (tris), three.

Jurassic, because it is well marked in, and indeed makes up, the Jura mountain range that runs curving along the north-west frontier of Switzerland, between that country and France, between lakes Geneva and Neufchatel.

The name Cretaceous has been explained.

The five names that follow, all ending in "cene," are founded upon palæontological characteristics. The systems to which the names are applied have, as we ascend through the strata of the earth's crust, a constantly increasing proportion of recent shells—i.e., of shells belonging to animals now existing. The lowest system has only a few fossil shells identical with those now met with in our seas and rivers. Hence, as here we meet with the dawn of recent life, the name Eocene. ἠως (eos), dawn; καινος (kainos), recent. In the Miocene series there are more of these recent shells, but, still less than in the Oligocene, and still less than in the Pleiocene and Pleistocene, which follow. μειων (meion), less; ολιγος (oligos), few; πλειων (pleion), more; πλειστος (pleistos), most.

The Recent and Prehistoric system explains itself.

So much for the names of the systems. The third column, the one most to the right, gives the names of the six great periods of geological history.

Lowest of these, and, therefore, corresponding with the earliest period in point of time, is the Igneous, already dealt with. The Pre-Cambrian system is simultaneous with the Archæan period. αρχαιος (archaios), ancient. Sometimes this period is known as the Azoic, as no traces of fossils, no remains of living things, have been found among its rocks. α (a), without; ζωη (zoe), life. A safer name, perhaps, would be hypozoic. ὑπο (hupo), under. This name would only denote that the rocks formed during the period in question were found under rocks in which vegetable and animal remains occurred, and would not, even by implication, say that in the Pre-Cambrian rocks no fossils have ever been present.

The systems that undoubtedly contain fossil remains are grouped into four periods:—Palæozoic, or Primary, including the Silurian, Devonian, Carboniferous, Permian systems; [παλαιος (palaios), ancient; ζωη (zoe), life]; Mesozoic, or Secondary, including the Triassic, Jurassic, Cretaceous; [μεσος (mesos), middle]; Cainozoic or Tertiary; [καινος (kainos), recent], including the Eocene, Miocene, Oligocene, Pliocene. The latest period is the Quaternary, including the Pleistocene, Pre-historic, and Recent systems.

In the next and succeeding chapters the various formations entering into the various systems from the Pre-Cambrian to the Recent will be studied. They will be studied on the plan already laid down. A. Derivation. B. What; (1) Structure, (2) Composition. C. Where. D. Palæontology. E. How. F. Use.

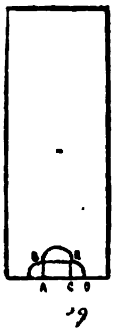
The student must understand that at no given part of the earth will there be found *all* these systems piled in order one upon the top of the other. But wherever any of them are found, they will be in the relative order given in the table. And the evidence, direct and indirect, is overwhelming, that in spite of the non-deposit of particular systems in particular regions, in spite of the denudation that may have taken place after deposit; yet, speaking generally, the succession of events over the earth's surface has been the successive formation of Igneous, Pre-Cambrian, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Eocene, Miocene, Oligocene, Pliocene, Pleistocene, Prehistoric, Recent strata.

THE OPTICAL LANTERN: ITS CONSTRUCTION AND USE.—VI.

By Chas. A. Parker.

Supporting Table for the Lantern—Alternative Support formed of Iron Legs—Polishing the Woodwork—Polishing and Lacquering the Brasswork—Staining and Varnishing the Case and Table.

THE lantern and its containing-case being completed, we now come to a description of the folding table for supporting the instrument when in use, which has already been shown open and closed in Figs. 1 and 2. This table, although of very simple construction, will be found to be a thoroughly rigid support for the apparatus, provided that it is made according to the following description:—The first requisite will be a board to form the top of the table, which should be a piece of well-seasoned mahogany, measuring 36in. by 13in., and about ¾in. or 1in. thick. Having obtained a suitable board, plane both sides until smooth and even, and mark the best side for the upper; then square off the two ends and afterwards plane the edges lengthwise. A small block of wood the same thickness as the legs of the table and 13in. long by 3in. wide, must be glued and screwed to the under side of the top at one end. An old mahogany leaf of a table can frequently be obtained at a second-hand dealer's for less than a couple of shillings. It is needless to say that a board of this description would answer admirably for this purpose. A couple more pieces of wood, preferably of mahogany, will also be wanted to form the legs of the table, each of which should measure 30in. by 11in., and about the same thickness as the top. These two boards should be carefully dressed up on both sides, including the edges, the same as before, the best surface being marked for the outside, after which the arc of a 6in. circle is marked at the end of each leg by means of a pair of compasses in order to indicate the portion to be cut out.



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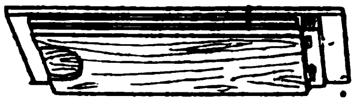

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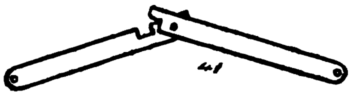

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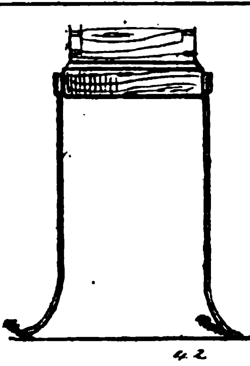

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When ready the cutting is performed by the aid of a bow saw or a panel saw; but, of course, it may be done with a greater degree of accuracy if the reader possesses or has access to a fret sawing machine. If preferred they may be marked out in the manner shown in Fig. 39. Set the compasses from A and draw a quarter circle to B, and at C draw another from D to E. Now join B E by a straight line, and from the middle of this, with the compasses still set at the same, a half-circle is drawn to join B E. All the wood within the curves is now cut out by means of a bow saw, after which the sawn edges are smoothed by the aid of a spokeshave or file and glass-paper. The legs may now be hinged to the under side of the table in the manner indicated in the sectional diagram Fig. 40, using 2½in. iron butt hinges for the purpose. It will be seen from the illustrations that one leg is intended to be hinged to the table at an inch from the end of the wood, and the other to the block of wood A, which thus enables them to fold properly one over the other. After the legs have been hinged, the table is completed by the addition of an edging of wood 3in. deep, which is glued and screwed to the edge of the top all round, as will be understood by again referring to Figs. 1 and 2, the entire surface of the top being finally cleaned up by means of a hand-plane and glass-paper. If the extra trouble involved is not objected to, the edges may be dovetailed together at the four corners; but this is, of course, simply a matter of taste.

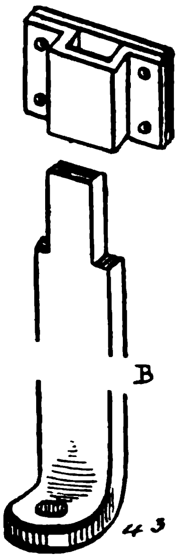
Nothing remains to be done in order to complete the table but to affix four iron stretchers similar to Fig. 41. For each of these obtain a couple of 10in. lengths of strap iron ¾in. wide, and about $\frac{1}{16}$in. thick, through each end of which a small hole is drilled at ½in. and 1in. from the end of the metal. Now file a slot a ½in. deep, and ¾in. wide, at the end of one piece, and at the same time file a projecting arm or tongue at the corresponding ends of the remaining piece (these should be the ends which have the metal projecting 1in. beyond the hole). Thus prepared, these strips should now be riveted together at the filed ends until they move quite stiffly, the rivets being formed by means of a short piece of brass rod inserted through the holes drilled in the iron, after which the two outer ends of the stretcher may be rounded off by the aid of a file; and when this has been done the projecting tongue is slightly bent inwards, in order that it may bed against the bottom of the slot on being opened. If everything has been carried out according to the above directions, it will be found that each stretcher may be screwed at one end to the outer edge of the leg, and at the other to the inside of the wooden edging of the table, at exactly 11¾in. from the axis upon which each leg turns; these four stretchers, if properly adjusted, rendering the table as firm as a rock when opened. Before leaving this part of the subject it may not be out of place to draw attention to the excellent form of support described by Mr. T. C. Hepworth in his admirable work "The Book of the Lantern." This support, which is shown in Fig. 42, is almost self-explanatory. In making a support of this character it will be necessary to first prepare four small cast iron sockets, similar in appearance to Fig. A 43, to take the upper ends of the legs. These may be 2½in. in length, and 1¼in. in width, the metal being of a uniform thickness of ¼in. throughout, having two outer leaves, which are ⅝in. wide, and drilled and countersunk sufficient to take the heads of the screws by which the socket is attached to the woodwork, the central opening of each socket measuring ¾in. by ⅝in. Four 28in. strips of iron measuring 1in. by ⅜in. will likewise be required to form the legs, which are made to fit into the sockets first prepared. The upper end of each leg will have to be reduced in size by filing either side until a slight shoulder is formed, as will be seen at B, Fig. 43; the lower end of the iron being drilled with a hole, and turned outwards in order to form a small foot, the end of the metal being afterwards rounded by means of a file. The back part of the socket may be a loose plate of iron furnished with screw-holes, to correspond with the holes in the two outer leaves of the socket, so that when screwing the latter to the body of the case, this plate may be laid against the woodwork first. It must also be mentioned that the lower part of the case to which these sockets are attached will require to be strengthened by the addition of a bottling of wood, which should be glued and screwed round the bottom of the case. It will, of course, be advisable to dovetail the bottling together at the front corners if possible.

The apparatus is now completed, with the exception of polishing the woodwork and lacquering the brasswork, both of which subjects will now occupy our attention. Previous to polishing the woodwork, it will be necessary to remove every portion of brasswork, and number each piece on the under side, in order that it may be returned to its respective position after lacquering; the various parts being placed on a shelf out of harm's reach until ready to be lacquered as soon as the woodwork has been finished. We will now take the body of the lantern and describe the method to be pursued in French-polishing it. First give the wood a good dressing with the finest glasspaper, in order to effectually remove any little imperfections of surface, and then proceed to fill the grain of the wood in order to prevent the absorption of the polish as much as possible. For this purpose prepare a thin paste composed of plaster of Paris, slightly tinted with rose-pink in order to suit the colour of the wood, rubbing this in well until the grain appears to be properly filled, when the superfluous plaster should be wiped off by means of a piece of old rag before it has had time to harden. By the time that the last side has been filled the first will in all probability be sufficiently dry to commence polishing, which, by the way, should be conducted in a dry atmosphere entirely free from all draughts. If it is desired to darken the wood, this must be done previous to the commencement of the polishing process by staining it with a solution of permanganate or bichromate of potash in water, the strength of the solution depending upon the tint required.

Having obtained a gill of pale orange polish and some methylated spirit, prepare a rubber out of wadding or flannel, of a suitable size to be conveniently held in the hand, and dip this into a small cup containing some of the polish, or, if preferred, it may be fed from the bottle containing the polish; in either case, however, it should not be made too wet. Thus prepared, cover the face of the rubber with a piece of clean linen rag, which will at once become wet by the polish oozing through, and apply it to the wood, moving it forwards from one end of the wood to the other with a circular motion, occasionally stopping to moisten the rubber with a fresh supply of polish whenever it appears to drag or stick, repeating this process as often as may be necessary, until a good body of polish has been evenly but not excessively distributed over the entire surface of the wood, which should now be allowed to become quite dry before it is again touched. In use the rubber should be held in such a manner by the fingers of the right hand as to draw the cover quite tight, thus presenting a smooth and slightly convex surface to work with. On resuming work, the polish will be found to have sunk into the pores of the wood considerably; it will therefore be necessary to first level the surface by means of a piece of No. 1 glasspaper until the bare wood is exposed, when the same process of working over the surface of the wood with a wet rubber is again repeated; the latter should, however, be shifted to another clean part, and, when moistened with polish, the tip of the finger may be dipped in raw linseed oil and then smeared over the face of the rubber. As the polish is partially absorbed by the wood in the course of a few days, it will be found advisable to allow a day or two to elapse before the process is resumed. When sufficient time has been allowed for the polish to sink and harden, it may be levelled with some very fine pumicestone powder, applied by means of a small roll of felt, which should be moistened with water occasionally. After the wood has again become quite dry the polishing process is resumed with a clean rubber, which is this time moistened with a small quantity of methylated spirit in place of the oil, the rubber being skimmed over the surface as lightly as possible until it is nearly dry, when it is again moistened with some fresh polish, and the same process repeated until a good body of polish has been obtained, after which the wood should be permitted to become quite dry previous to spiriting-off. Although the wood will doubtless present a tolerably bright appearance, the surface will, in all probability, exhibit some cloudy marks from the rubber, owing to the presence of the oil, which must now be worked out by the "spiriting-off" process, for unless the oil is entirely removed it will most certainly cause the polish to sink. The spiriting-off may be said to be the most difficult part of the entire process of polishing, as it requires a considerable amount of skill on the part of the polisher in order to produce a satisfactory result. When ready to commence, prepare the spiriting-off rubber in a similar manner to the others—that is to say, with old flannel or wadding and washed-out linen rags. This rubber should be moistened with a small quantity of methylated spirit, but not sufficient to make it feel damp, after which it is passed over the wood as lightly and rapidly as possible, care being taken never to stop for an instant, otherwise the polish would be liable to soften and break up in unsightly patches. It should not be again moistened until absolutely necessary, and then with only a few drops of spirit, this rubber being persevered with until every trace of the oil has been entirely worked out, the final strokes being elongated the way of the grain of the wood, until the surface presents a uniformly brilliant polish. Care should be taken to avoid any creasing of the rubber while in use, as this would necessitate the papering down of the entire surface.

As soon as the woodwork of the lantern body has been polished, it will be necessary to turn our attention to the brasswork, every part of which should be polished and lacquered before it is replaced upon the instrument.

In preparing the stage plates and similar flat surfaces for lacquering, first clamp them securely in a vice between lead or leather clamps, and then proceed to scrape up the straight or curved edges by means of a scraper for metal, until they are quite bright and true, after which a piece of emery-paper wrapped round a thin, flat stick of wood should be used to get rid of any file marks on the flat surface of the metal, care being taken to keep the strokes in one uniform direction, lengthwise of the work. This process being continued until all the marks have been effectively obliterated, when another paper of a finer grit should be employed, until the finest flour emery-paper is used to remove the marks made by the previous paper, and bring the work up to a smooth and even surface, which may be further improved by using a slight trace of oil with this last paper. In order to obtain the best results it will be found advisable to carefully wipe the work before using a finer paper in order to entirely remove all the emery-dust caused by the previous paper. If a still further finish is desired after the last paper, it will be necessary to wipe away all the dust and bring the work up to a fine grain by the use of a piece of water of Ayr stone, which should be rubbed over the surface in the direction of the grain left by the papar, water being used plentifully as a lubricant. After the use of the stone the work may be wiped on a clean rag and then brushed with a soft brush dipped in a paste of whiting and water, or if a still finer polish is desired, it may be rubbed with a buff stick and crocus powder, or better still, a small quantity of the "Universal Metal Polishing Powder" may be substituted for the crocus powder which will speedily bring the surface up to a burnish-like brilliancy. This latter preparation can be obtained from most oilmen and a great many cyclist stores. The outer stage-plates may be figured all over by means of a piece of slate-pencil cut to a sharp bevel, and then worked with a circular motion over the entire surface. If this is done with a little taste, it will add greatly to the appearance of the stages when finished. As before stated, it is of great importance to carefully wipe the work previous to using a finer abrasive material, in order to prevent any grit or dust getting on the work during the latter stages of the polishing. Great care must be exercised to preserve the sharp edges of the work, as there is nothing which looks worse than round edges to an article which should be quite sharp and square.



The work being ready for lacquering, it should be heated on a stove or other source of heat, until it is just too hot to be comfortably borne by the hand, and yet not hot enough to burn the lacquer. A soft, flat brush, about an inch in width, is now dipped into a small pot containing the lacquer, and wiped across a string stretched over the top of the pot in order to free it from any excess of lacquer. The brush is now drawn lightly and rapidly over the surface of the work, and raised from the metal the instant it reaches the opposite edges, care being taken never to go over the same spot a second time while the first coat is yet moist. If the lacquer is found to collect round the screw-holes or edges of the work, it will be worth while to try the experiment of coating it with plain alcohol, or a very weak varnish, previous to applying the lacquer. In lacquering, the great difficulty is to know the exact degree of heat best suited to the lacquer employed, this being a kind of knowledge which can only be gained by actual experience. If the work is too hot it will burn the lacquer, and if it is too cold it will refuse to set. Should it become desirable to remove a coat of spoiled lacquer at any time, it will be necessary to do this by boiling the work in a lye composed of half-a-pound of potash to a gallon of water. Ten or fifteen minutes' immersion in this solution, and a plunge in a bath of cold water, will soon remove the lacquer.

When every portion of the brasswork has been lacquered in a satisfactory manner, the various fittings may be put together and returned to their respective positions on the lantern body; but before doing this, the back of the stage-plate, Fig. 20, including the outside of the condenser-collar and the inside of the outer stage-plate, Fig. 21, and the interior of the front tube, likewise the interior and exterior of the tube of the spring-plate, Fig. 23, will each require a coat of dead black varnish in order to prevent the reflection of light, and also improve the appearance and finish of the stages. This dead black may be readily made by grinding up, on a tin lid or a saucer, a small quantity of vegetable black with any form of spirit varnish, or even French polish, which should be diluted with methylated spirit, and well stirred until a thin, smooth varnish entirely free from lumps is formed. A brush full of this tried on a piece of metal will very soon indicate whether it is of the proper consistence, as it will dry in a few moments with a dull matt surface. If it should be shiny when dry it will need the addition of a little more spirit or black, and if it is too thick it should be further diluted with more spirit; but in the event of it being liable to rub off, it will be necessary to add a little more varnish. A judicious application of this varnish to any other portion of the lantern which presents a reflecting surface will add greatly to the general appearance of the instrument. It will also be necessary to paint the jet trays with dead black varnish, but for this purpose the addition of a little more varnish will be found an advantage.

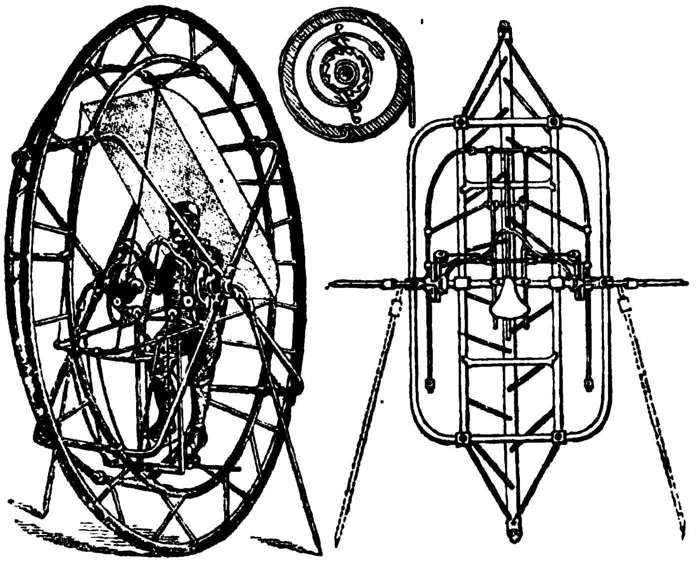
With regard to the finishing of the lantern-case and the supporting table, these may be stained with "Stephen's" stain, and afterwards varnished, or, if preferred, they can be painted with either of the enamel paints which are now sold in a great variety of colours. Notwithstanding the great variety of tints, it may be remarked that a dark chocolate would perhaps be the most suitable tint; but, of course, this is merely a matter of taste. A great many readers may perhaps prefer to stain and varnish in one operation by using one of the combination varnish stains now sold. Messrs. Stevens and Co., the Torbay Paint Co., of 26-28, Billiter-street, London, E.C., send out combination polish stains, in tins, at prices from 2s. per pint (postage 3d.) These stains are obtainable in all the usual tints, including mahogany, light and dark oak, walnut, ebony, &c. One coat applied to the freshly-prepared surface of the wood by means of a soft, flat brush will generally be found to be sufficient. In using these stains, the wood will require no previous treatment in the way of sizing, and they also possess the advantage of drying in a few moments with a glossy appearance.

In concluding the first part of this series on the optical lantern, a hope may be expressed that these instructions have been rendered sufficiently clear and concise, and that all matters of importance have been properly dealt with. Of course, the foregoing is an instrument which to execute in a first-class manner will require a careful workman, but then the same truth holds good with any class of work, no matter how simple. All that is necessary is a careful study and practical working-out of the foregoing instructions, together with a desire—nay, a determination—to finish off every part in the best possible manner.

(*To be continued.*)

A MONOCYCLE.

WE illustrated several years ago (March 26, 1869) a single-wheel velocipede, in which the driver sat within the wheel. A somewhat similar cycle has been recently patented in the United States by Mr. Henry C. Ross, of Ipava, Illinois. It will be seen in the figure that from the rim of the large single wheel short diverging spokes extend to inner parallel rims some distance apart, bent arms attached to the latter rims extending to a hub on each side of the wheel, the hub consisting of a sleeve provided with ball bearings through which the axle extends. Mounted in ball bearings on each of the sleeves is an arm extending above and below, the upper ends of the arms having handles by which the machine is guided, while their lower ends support a framework having a cross-bar to which is secured the seat perch, the frame also affording bearings for an axle on which



are pivoted the pedal levers. Loosely mounted in a hollow circular case at each side of the machine, on the inner end of the axle and sleeve, is a ratchet mechanism for driving the wheel, one of the figures showing a sectional view of the ratchet attachment. A strap held in a groove on the face of the ratchet casing extends downward on each side to one of the pedal levers, to which it is secured, and as the pedals are operated the ratchet-wheel and sleeve are turned to move the main wheel. To the outer ends of the axles are attached rods long enough to extend to the ground, when the axles are turned into position to bring their points down, and at a convenient point in front of the rider is a curved brake bar, connected with the squared inner ends of the axles, so that by raising the brake bar the axle is turned to throw the points of the rods down into the ground, as shown in dotted lines in the sectional plan view, and in full lines in the figure in perspective. When the machine is being operated these rods are held out of contact with the ground by a spring extending from the brake bar to the seat perch. A mud-guard, preferably of perforated or wire cloth, is supported by the framework above and back of the seat. The machine is steered by the handles on the arms extending upwards from the sleeves at each side.

ARTIFICIAL RAIN-MAKING.*

By Prof. Edwin J. Houston.

WHENEVER a large mass of air is cooled below the temperature of its dew-point, the moisture it can no longer hold as invisible vapour becomes visible. If the reduction of temperature be but slight, the vapour appears as fog, mist, or cloud; if the reduction be considerable, as rain or snow. There has been no little attention given lately to the question as to whether or not rain can be caused to fall at pleasure on any given section of the earth—rain machines, or artificial rain producers, consisting essentially of devices whereby explosions of nitro-glygerine, or other similar substances, are obtained at fairly considerable elevations in mid-air, have been tried in different forms. As to the success of these attempts at the artificial production of rain, the testimony appears to be uncertain or contradictory. The idea of rain-making by mid-air explosions is probably based on the rains that are generally believed to attend or follow great battles, Fourth of July celebrations of the Chinese character, and volcanic eruptions. Passing by the evidences produced by either the warlike or the peaceful burning of gunpowder, which at best are but vague, it may be remarked that volcanic eruptions may produce very heavy rainfalls, not only because the force of the eruption and the intense heat cause upward currents in the air, but also because of the vast quantities of vapour of water that escape from most volcanoes during their eruptions. There is a fascination in witnessing man's struggle with the forces of nature; a struggle, be it understood, not made to oppose such forces, but rather to direct them. The former effort would be foolish, the latter must meet with success, if properly directed. Do the scientific facts, as far as known to meteorology, give any encouragement for the continuance of the efforts of the would-be rain-makers? Let us inquire. It is now generally agreed that the lowering of temperature necessary for the production of rain may be obtained in the following ways:—1. By the intermingling of masses of warm and cold air. 2. By the carrying of warm, moist air into a cold place. In any case the cause of the rain is, briefly, the cooling of the air until it is unable to retain all the moisture it formerly held as invisible vapour, and deposits the excess in a visible form as rain. The quantity of the rainfall will, therefore, depend both on the amount of moisture present in the air, and on the extent of reduction of temperature produced. The first method, viz., the lowering of temperature by the intermingling of masses of warm and cold air, can never produce any very considerable rainfall, since, though the warm air is cooled by its mixture with cold air, and the tendency is, therefore, to cause the mixed air to become relatively moister, yet, at the same time, the cold air is made warmer, and therefore relatively drier. Drizzling rains might be produced in this manner, but scarcely ever heavy rainfalls, unless both the cold and the warm air contain large quantities of moisture. There remains, therefore, but the second way of lowering the temperature of the air—viz., by the carrying of the warm air into a colder place. This can be accomplished in three different ways. 1. By a change of latitude, or by a warm, moist air blowing into a colder latitude. In general, the Equatorial currents blowing towards the Poles are the chief rain producers. 2. By a change in altitude effected by an ascending current, due to a heated area. Here the lowering of the temperature is due, not only to the cold of elevation, but also to that produced by the expansion of the air under lower pressure. 3. By a change in altitude, due to a mountain range opposing the progress of a wind, and thereby necessitating its gradually creeping up the sides of the mountain. In any of these ways heavy rains may be produced and, in point of fact, they are probably the only ways in which heavy rains are generally produced. Applying the preceding principles to the case of the modern rain machine, let us inquire as to the probabilities of its successful operation. The simultaneous, or the successive explosion of large quantities of any high explosive, in the upper regions of the atmosphere, must produce, in general, a rapid and more or less thorough mixing or stirring of the surrounding air. The sudden expansion of the air both by the heat liberated by the explosion and by the gases evolved during the explosion, is attended by a rush outward, followed by a rush of air inwards, towards the explosion centre. The direction of this latter rush is generally radially inward. In addition to these inward motions, the heat generated may tend to produce a slight upward motion; the general effect must be, however, to produce a mixing or churning rather than an upward motion. The immediate effect of the explosion is to produce a miniature area of low barometer, caused by the radial rush of air towards the explosion centre, and by whatever ascending current that may result from the liberation of heat. It would be reasonable to suppose that if the explosion produces any direct effect on atmospheric conditions, the area of low barometer should follow immediately, or nearly so, after the explosion. Have such changes in the barometric pressure been noticed to follow such mid-air explosion? So far as the mixing motion is concerned, its action to produce a fall of rain must be slight. The ascending motion might cause a rainfall, but as this motion is slight in extent, its action under ordinary conditions must at best be but insignificant. In either case, any decrease in temperature, and consequent increase in relative humidity, must necessarily be slightly decreased by the dry and heated gases evolved during the explosion of such substances as nitro-glycerine, dynamite, or gunpowder. It might be supposed from the above considerations that balloons containing an explosive mixture of hydrogen and oxygen would be preferable to those carrying nitro-glycerine, dynamite, or gunpowder, since in the former case the vapour of water results from the explosion, and in the latter dry gases. It must be remembered, however, that the explosion of mixed oxygen and hydrogen produces, for the greater part, a collapse, or radial rush inwards towards the explosive centre, while the explosion of gunpowder or nitro-glycerine produces, for the greater part, a radial rush from such centre. A circumstance that appears to have been lost sight of in all the recent attempts at rain-making, is that such attempts have been apparently made regardless of the hygrometric conditions of the air. As rain is but the excess of moisture, which the warm moist air when sufficiently cooled is unable to retain, the amount of the fall will depend, as already stated, on the quantity of moisture in the air, as well as on the extent of the chilling action following the explosion or other cause. To attempt to produce rain by explosions in mid-air, irrespective of the quantity of moisture in the air, is to attempt to cause water to fall from the air when practically none is present. This is not only illogical, but absurd. It may be thought by some that the concussions caused by mid-air explosions might result in such a general movement of the surrounding air, as to cause rain to fall over an extended area. The flash of the explosion is followed by a sudden movement of the air causing the noise of the explosion. The phenomena of lightning and thunder are somewhat similar to those of artificial mid-air explosions. First we have the lightning flash, and subsequently the thunder, which is a violent concussion of air. Does this concussion bring down a heavier rainfall? Popularly it is believed to do so, but the general opinion of the scientific world is that the lightning flash is the effect of a rapid condensation of the aqueous vapour—i.e., of a heavier rainfall, and not the cause of such a fall. That is to say, the high potency of the lightning flash is due to the enormous decrease in the surfaces of the already charged rain drops over that of the surfaces of the thousands of the separate drops that coalesce to form the single drops. Nevertheless, the liberation of heat energy and the rapid admixture of air following the disruptive discharge may slightly increase the rainfall, or may act as a determining cause of rain over an extended area. There is this difference between the lightning flash and the flash of an explosion—viz., the former occurs over a comparatively great length of path—i.e., a space of small breadth and depth, but great length. The latter occurs in a comparatively limited space, the three dimensions of which are nearly equal. Though lightning is not a cause of rain, there can be no doubt that if rain can be artificially produced during a period in which there is much free electricity in the air, the storm will be attended by lightning and thunder. If then, there be any increase of rain due to the presence of lightning, artificial rain-making will be more liable to succeed when the potential of the air, as regards the earth or neighbouring clouds, is comparatively high. The enormous expenditure of energy required to produce a rain-storm over an extended area is a circumstance that would appear to give but little encouragement to man's many efforts in this direction. The amount of energy liberated by the greatest explosion man has yet effected in mid-air is but insignificant when compared to the energy liberated by nature during even a comparatively limited fall of rain. There is, however, an important consideration, bearing on the question of the probable success of rain-making by mid-air explosions, that gives to such attempts a far greater probability of success than would appear to be warranted from the facts already enumerated. Presupposing the existence of a sufficient mass of moist air, at preferably a comparatively high difference of potential as compared with the neighbouring air or the earth, a mid-air explosion might act as the determining cause of rainfall over a wide area, the balance of the energy requisite, therefore, being supplied by the moist air. In a mass of very moist air there exists a store of energy which, if liberated, would suffice to cause movements of the air of vast extent. When the vapour of the air is condensed, the potential energy becomes kinetic, and, being liberated by the heat, causes ascending currents which produce a further condensation of moisture, and further liberation of energy previously locked up in the vapour. There sometimes exists conditions in the air, in which it is, so to speak, in a state of very unstable equilibrium, and a slight determining cause may result in the liberation of the stored up energy with a resulting heavy rainfall. In such cases it would appear that there are no reasons why an explosion in mid-air should not be followed by rain. At the same time it is not unreasonable to suppose that the natural causes, which brought about such conditions, would, in many cases, continue to act, and thus cause rain without artificial aid. There are, however, meteorological conditions that probably frequently exist in certain latitudes in which heavy rains might be artificially produced by mid-air disturbances, when, without such disturbances, no rainfall would occur. Should, for example, a layer of warm, moist air exist between the earth's surface and a higher layer of cold, moist air, separated by a comparatively thin layer of air, and should such conditions exist as to maintain the two layers separate, then the breaking or piercing of the intermediate separating layer might permit such an up-rush of the warmer air through the opening that the liberation of its stored-up energy through the condensation of its moisture, would result in a general up-rush of the warm moist air and the consequent production of an extended area of low barometer. In other words, the artificial rupture of the separating layer would result in the formation of a true storm centre and a heavy rainfall of considerable dimensions. In such cases it would appear: (1) That mid-air explosions will be more effective than explosions on the earth's surface. (2) That directed mid-air explosions—i.e., explosions in which the general effect of the liberated energy is to produce an upward rush of air, would be more effective than undirected, hap-hazard explosions. If in such cases, considerable difference of potential exist between the layers of air, or between that of the air generally and the earth, the lightning flashes would unquestionably be effective in piercing the separating layer, especially if, as would probably be the case, the general direction of the discharge be between the layers of cold and warm air. Since, as we have seen, it is the ascending current that causes the heaviest rainfall, it would appear that mid-air explosions of such a character as to produce in general an upward rush of air would be probably more successful than undirected, hap-hazard explosions in mid-air. Such movements might advantageously be effected by the liberation of rockets with enlarged conical heads, or of any form of firework that would move generally upward. Since success in artificial rain-making is probably dependent on the meteorological conditions, both of the lower and upper layers of the atmosphere, efforts should be made to enlarge our present very limited knowledge of such conditions. Captive balloons, containing registering electrometers, tele-thermometers, tele-hygrometers, tele-anemometers, &c., might be connected by wires with recording apparatus placed on the earth's surface. The cost of maintaining such aërial stations of observation would be but insignificant when compared with the benefit that would accrue not only toward the solution of the problem as to the probable success in rain-making, but also in the aid given to the general operations of the United States Weather Bureau in particular, and to meteorology in general. During the general prevalence of moist warm air, when but a slight cooling is necessary to cause a general downpour, effective rain-making might be obtained by the sudden breaking or opening of cylinders of liquefied gases, where expansion would cause an intense chilling of the surrounding air; such cylinders could be readily opened by means of earth-controlled electro-magnets. The following general conclusions may, in view of the present state of meteorological science, be properly drawn concerning the artificial production of rain:—1. That rain can never be made to fall at will by mid-air explosions on any part of the earth's surface, irrespective of the climatic conditions there existing. 2. That during certain meteorological conditions, mid-air explosions may result in rainfall over extended areas. 3. That the liberation of energy necessary for such rainfalls is due not to the mid-air explosions, but to the energy stored up in the moist air from which the rain is derived. 4. That the meteorological conditions which must exist for the successful action of mid-air explosions would probably, in most, though not in all, cases, themselves result in a natural production of rain. 5. That a comparatively high difference of electric potential between different parts of the air, or between the air and the earth, is possibly favourable when taken in connection with other meteorological conditions for artificial rain-making. 6. That an undirected mid-air explosion is not as likely to produce rain as an explosion in which the main tendency of the energy liberated is to cause a general uprush of the air.

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* A paper read before the Electrical Section of the Franklin Institute, Sept. 8, 1891.

Vineyards in Russia. — The Minister of Imperial Domains in Russia publishes a report according to which the area of vineyards in that country is about 458,250 acres, the average yield of wine from them being 55,300,000 gallons, of which rather more than half is grown in the Caucasus. The districts of Bessarabia, the Chersonesus, and Podolia have about 150,000 acres of vineyards, and grow about 16,580,000 gallons, while the Crimea, with about 120,000 acres, grows 2,800,000 gallons, the rest being grown in the province of Berdinansk, the Tauris, the provinces of the Cossacks of the Don, the district of Astrakhan, the Ural, and Turkestan. The average yield of the last 20 years has been about 180 gallons an acre.

SCIENTIFIC NEWS.

THE position of Wolf's comet on the 30th inst. at Berlin midnight, will be R.A. 4h. 41m. 14s., S. Dec. 1° 35·2'; brightness 11·76, as compared with unity at time of re-discovery.

The position of Tempel-Swift's comet on Oct. 22 will be, according to the ephemeris for Paris midnight, calculated by M. Rossert, of the National Observatory, R.A. 21h. 18m., N. Dec. 8° 4·8'; brightness 10·54, as compared with unity at time of re-discovery. Its period is about five and a half years, and it will pass perihelion in November.

A new comet was discovered by Mr. Barnard, of the Lick Observatory, on the morning of the 3rd inst. in R.A. 7h. 31m., N.P.D. 117° 54', moving towards the south-east.

It is stated that Dr. Hind, who has been superintendent of the *Nautical Almanac* since 1853, is about to resign, and it is possible that some changes may be made in the arrangements.

News has been received of the death of Mr. G. S. Wilkinson, the Government Geologist of New South Wales. Mr. Wilkinson was born in Northamptonshire in 1843. His father, Mr. David Wilkinson, was associated with the Stephensons in designing some of the early locomotive engines. His family went to Australia in 1852, and settled in Melbourne. Seven years later Mr. Wilkinson entered the Geological Survey Office, and was brought into practical service in the country of the Bass Straits, northwards towards Ballarat. At the gold rush on the banks of the river Leigh, Mr. Wilkinson displayed great acumen in the discovery of nuggets, and these discoveries were highly praised by Sir Roderick Murchison and Prof. Ulrich. In 1874 the Government conferred upon him the geological surveyorship of the colony. In 1876 the Geological Society of London bestowed upon him a fellowship, and, later on, the Linnean Society gave recognition to his efforts. From 1884-5 he was nominated president of the Linnean Society of New South Wales, and three years afterwards he became president of the local Royal Society. He published in 1882 a work on "The Geology of New South Wales."

Dr. Edward Polak, who was for several years private physician to the Shah of Persia, died the other day in Vienna, at the age of 71. Dr. Polak went to Persia in 1851 as professor of surgery in the military school of Teheran, and he mastered the Persian language so quickly that in two years he was able to lecture in it, and to write books for the use of his pupils. Among these works were treatises on anatomy and physiology and a medical dictionary. His great work, however, is his description of the Persian kingdom, which contains much information on the flora, geology, and archæology of that country. When the Emperor of Austria, about two years ago, instituted the gold medal for art and science, one of the first recipients was Dr. Polak.

Great efforts are being made in Scotland to establish a sound system of technical instruction, and a public meeting is to be held at Edinburgh on the 29th inst., under the presidency of Lord Elgin.

At the People's Palace, Mile End, a special course of evening instruction for beginners, on "The Differential and Integral Calculus and Its Application to the Practical Problems of Mechanical and Electrical Engineering," will be given by Prof. John Perry, M.E., D.Sc., F.R.S. The lectures are delivered on Tuesday evenings from 7.30 to 9, and they commenced on Oct. 13.

We understand that an endeavour is being made to get up a class of students who desire to take up the subject of geology for the B.Sc. examination of the London University. Mr. E. J. Burrell of the People's Palace, finds that it is impossible to obtain the required standard in the theoretical and practical branches at any evening classes. He therefore consulted Prof. Wiltshire, of King's College, and that gentleman has consented (in the event of enough members joining) to supplement his lectures on geology and mineralogy by a course of instruction in petrology, and also to take the direction of the summer field work. Candidates for the B.Sc. who desire to take up the subject, should communicate with Mr. Burrell, at the People's Palace, without delay, as the first sitting takes place on Oct. 19.

The Fry Manufacturing Co. commence a series of demonstrations at 5, Chandos-street, W.C., on Oct. 16th (to-day), the subject for the evening being "Lantern Slides." They are partly "lecture," partly "demonstration," but always practical; commence at 8 p.m., and tickets can be obtained gratis by sending a stamped directed envelope, or by personal application. The subject for Oct. 30th is "Enlarging (Bromide)," and that will alternate with "Lantern Slides" on Friday evenings, Nov. 13, 27, and Dec. 11.

The photographic lectures at the Polytechnic commence on Oct. 20th, at 8 p.m., when the introductory will be given by Mr. W. E. Debenham.

The Sunday Lecture Society commence the season with seven lectures at St. George's Hall, Langham-place, on Oct. 18, at 4 p.m., when Sir James Crichton Browne, M.D., F.R.S., will deliver a lecture on "Brain Rust." On the following Sunday, Oct. 25, Mr. Frank Kerslake will lecture on "Rabies in Animals and Hydrophobia in Man." During the season (which terminates on March 13, 1892) twenty-one lectures will be delivered.

The Belgian Minister of Public Instruction offers a prize of £1,000 for the best memoir on the meteorological, hydrological, and geological conditions of the countries of Equatorial Africa, regarded from the sanitary point of view, and with special reference to the welfare of Europeans resident in the Congo State.

The Government of the United States intends to establish a reindeer station at St. Lawrence Island, in the Behring Sea, in order to substitute these animals for Eskimo dogs in travelling through Alaska. Samoyedes are to be imported from Siberia along with the deer, to instruct the natives of Alaska in feeding and driving the new beasts of burden.

It is stated that the Corporation of Manchester are about to obtain power to borrow £150,000 for electric-lighting works, the machinery at which will also be used for working the hydraulic power supply, permission for which has already been granted.

The direct-current transmission system of Lahmeyer, which transmits power from Offenbach to the Frankfort Exhibition, has, it is said, been working satisfactorily at a pressure of 2,000 volts.

It appears that it is not true, as has been stated, that the Brighton Railway Co. intend to dispense with the electric light. They cannot use it in some trains which are divided at Croydon, but they are going to substitute gas for oil.

Harper's Weekly for October 3 contains several views of the St. Clair tunnel, and of the opening scenes, with a sketch of the enormous decapod locomotives.

We note that the Royal Microscopical Society commence their evening meetings for the session 1891-1892, on Wednesday, October 21. From the notices, an interesting evening is to be expected. Mr. F. Chapman will read his paper on the "Foraminifera of the Gault of Folkestone," Dr. A. C. Stokes, of New Jersey, U.S.A., sends some "Notices of New Infusoria from the Freshwaters of the United States," and lastly Messrs. W. J. Chadwick and W. Leach will give a demonstration with the latter-named gentleman's lantern-microscope.

Magic Lanterns: how Made and how Used. By A. A. Wood.—The fourth edition, revised and enlarged, of this useful handbook has just been issued by the author, 74, Cheapside, and by Horne, Thornthwaite, and Wood, 416, Strand, W.C.

A PALATIAL car has just been built in Massachusetts for the Montreal and Toronto line of the Canadian Pacific. It is 66ft. long; the central "drawing-room," which is turned into a dormitory at night, is 32ft. in length, 9ft. in width, and 10½ft. in height, and is furnished with a dozen easy-chairs. The ceiling is frescoed with a beautiful design representing the four seasons, and one of the most striking novelties consists of six bay windows. Besides this apartment are lavatories—where a quantity of powdered soap slides into the basin of water on pressing a button—a kitchen, a safe for valuables, an "observation room," a private State room, a library with writing-desk and medicine-chest, and other conveniences. The car is ventilated by compressed air and heated by steam from the engine.

LETTERS TO THE EDITOR.

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[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor *of the* English Mechanic, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

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THE MILKY WAY—THE CANALS ON MARS — THEOSOPHY — LIGHTNING — SCIENTIFIC (?) ADVERTISING — SOLAR MOTION IN SPACE — EYE-PIECE—ORBITS OF THE PLANETS—VENUS ON THE NIGHT OF APRIL 12, 1782 — MARINE TELESCOPE — HARVEST MOON—ASTRONOMICAL DRIVING CLOCKS — MAKING A TELESCOPE—SUN DIAL—ANGELS COMING TO THE POINT.

[32810.]—The paper by Mr. Ranyard in *Knowledge* for the current month, to which you refer in paragraph four of your "Scientific News" on p. 132, only forms one of a series which deserve the most careful study by every one anxious to learn the results of latest discoveries concerning the structure of the sidereal universe. If we open any work on astronomy published five-and-twenty years ago, we shall almost certainly find that it contains the allegation that "these varieties of magnitude (of the fixed stars) are chiefly caused by difference of distance," &c., or by some cognate one; while ingenious calculations are given to show how many equidistant orbs would fill a sphere of certain dimensions surrounding our system, how many more could be contained on the surface of a sphere of double the radius of the first, and so on; the results being plausibly compared with the number of naked-eye stars of various magnitudes. We now know how fallacious all this is, and how comparatively little the mere "magnitude" of a star has to do with its distance from us; and the very remarkable series of essays, with their beautiful illustrations, which are now appearing in the columns of your contemporary, can scarcely fail considerably to modify popular views on the subject of the physical constitution of our visible stellar surroundings. It is on this ground that I commend their perusal to my brother readers.

I do not care to continue a discussion into which such temper and such a spirit are imported as those displayed by Dr. Terby in letter 32766, p. 134. I had the pleasure of being present at a meeting of the British Astronomical Association when Mr. Green exhibited three drawings of a very familiar Areographical detail by three totally independent observers, all of which were in practically identical agreement, and contrasted them with one made by Signor Schiaparelli at the same epoch, which certainly differed from them very notably in respect of even the position of one prominent marking. I have often said, and must here repeat, that I am no believer in "Athanasius contra Mundum," and will not credit, without the most cogent evidence, that three skilled observers and draughtsmen, acting in total independence and ignorance of each other's work, were all wrong, and the Italian astronomer alone right. The famous Milanese observer is not yet a scientific Pope, from whose infallible dicta there is no appeal; and I would venture to suggest that the proper and most philosophical spirit in which to investigate his presumed discoveries is not to "wish" that they may be true, but first to ascertain *whether they are so.*

Re the attempts to introduce the contemptible craze of "Theosophy" into these columns, I would urge everyone who may feel the smallest interest in that form of imposture to obtain and carefully study Part IX. of the *Proceedings* of the Society for Psychical Research for December, 1885, published by Trübner and Co. It may enable them to form an accurate estimate of the truthfulness, honesty, and probity of the High Priestess of so wretched a delusion.

Since writing letter 32706 (p. 89), I have received some most interesting information from a friend with reference to the accident by lightning to the church of which I there spoke, which goes very far to corroborate the theory propounded by Mr. Lesky (in letter 32783) on p. 136. The gentleman to whom I am indebted for these valuable particulars was within two hundred yards from the church when it was "struck," and saw the shingling of the spire driven past the windows of a residence some hundred and fifty yards off, showing from the direction which they took that they were impelled by a force acting, so to speak, from within, and not from without, the building whence they were so violently propelled. That lightning does strike upwards is a familiar fact. I have before stated in these columns how I once was an eye-witness of this phenomenon myself. The late Mr. R. A. Proctor, I know, denied the possibility of my having observed this; but I did see it, notwithstanding. Moreover, I believe that many a man has been killed by the upward discharge. In other words, to employ the popular form of speech, that "the lightning has gone in at his feet, and out at his head."

In the days of our grandfathers, when duelling was so prevalent that there was scarcely a man in society—soldier, sailor, or civilian—who had not "been out" at some time or other, one of the most sturdy and persistent opponents of the practice was that well-known Cambridge professor, the author of "Vince's Astronomy," a work regarded, even now, as a classic in astronomical literature. Well, upon one occasion, a man was arguing on this subject with the Professor, and in the course of the discussion put what he meant to be a poser to him in these words: "Very well, Dr. Vince, admitting what you say to be true, still you must allow that there are circumstances under which a man *must* fight. What, for example, could, or would, you do if anyone called you a liar?" "Well, sir," was the response, uttered with Vince's broad Devonshire accent, "I should tell him to pruv' it. If he did pruv' it, then I should be a liar, and he would only have stated a fact. But if he didn't pruv' it, then he'd be the liar, and not I at all." Now, I propose to adopt rigidly this Vincean form of argument in my treatment of letter 32784, on p. 137, in which I find Dr. Common delicately and gracefully alleging that certain remarks made by me (in letter 32706, column 2, p. 89) "are untrue." Very well, I would beg anyone and everyone sufficiently interested in the question to turn to the February number of the *Monthly Notices* of the Royal Astronomical Society, where, on p. 227, line 12 from the top, they will find the words on which my comment was founded. I will then ask them to judge between Dr. Common and myself. [I must, however, in common fairness add to what I have just said, that, referring to a previous page (208) of the same number of the *Monthly Notices*, I now find that the Council of the Royal Astronomical Society explicitly repudiate all accountableness, in these words: "The following Reports of the Proceedings of Observatories during the past year have been received from the Directors of the several Observatories, who are alone responsible for them." This being so, I can only express my sincere regret that I should (in letter 32706), on p. 89, have charged (or seemed to charge) upon our executive what was, in truth, the act and deed of its writer alone. I had not read, nor, in fact, in any way noticed, the disclaimer of the Council when I penned my original comment. I hope and believe that an overwhelming majority among them would resent as strenuously as I should any attempt to convert our publications into an advertising medium.]

"Anxious to Know" (query 75422, p. 141) puts a question to which anything like a precise answer is impossible, for the simple reason that the apex of the solar motion is placed in different parts of the constellation Hercules by various authorities, and has recently even been shifted out of it altogether into Lyra. But if we say that the Solar System is travelling towards the neighbourhood of ι Herculis, the plane in which it is moving must be inclined some 52° or 53° to the Ecliptic.

I have tried very hard—I have really—to make sense of query 75451 on p. 142, but have failed dismally to understand it. In the course of a far from inconsiderable experience of telescopes I have never in my life come across an eyepiece answering in the least to the description given by "Alpha Beta." He does not say whether the two principal lenses are double convex, plano-convex, or meniscus, or tell us their distance apart, or whether their convexities are turned to the objective or to each other; while as to the "plano-concave fitted to slide together or apart"; this is, and must remain, a mystery of the most impenetrable type. Were the subject one of the slightest popular interest, perhaps our Editor might be induced to give an engraving of this remarkable effort of optical art; but it is not so.

To answer query 75338, p. 98, exhaustively, would require a very great deal more calculation than I have either the time or the inclination to give to it. Both the latitude and longitude of a planet at perihelion are shifting quantities. The latter is always given for a particular epoch, and the latitude may be determined trigonometrically from the planet's declination at the moment of perihelion and the obliquity of the Ecliptic. The dates of the planets' perihelia are given in the *Nautical Almanac*, as are also their longitudes and latitudes at such dates. Thus much premised, I will put the rest of my reply into a tabular form:—

Planet's Name.	Distance from the Sun.			Longitude of Perihelion, 1850.			Secular Variation.
	Greatest.	Mean.	Least.				
				°	′	″	″
Mercury	0·46669	0·38710	0·30751	75	7	13·8	+ 643·66
Venus	0·72828	0·72333	0·71838	129	27	42·9	− 267·60
The Earth	1·01677	1·00000	0·98323	100	21	41·0	+ 1177·81
Mars	1·66579	1·52369	1·38159	333	17	53·5	+ 1582·43
Jupiter	5·45384	5·20280	4·95176	11	54	58·2	+ 663·86
Saturn	10·07350	9·53885	9·00420	90	3	59·8	+ 1943·07
Uranus	20·07272	19·18338	18·29404	170	38	48·7	+ 238·62
Neptune	30·32456	30·05437	29·78418	46	9	13·1	?

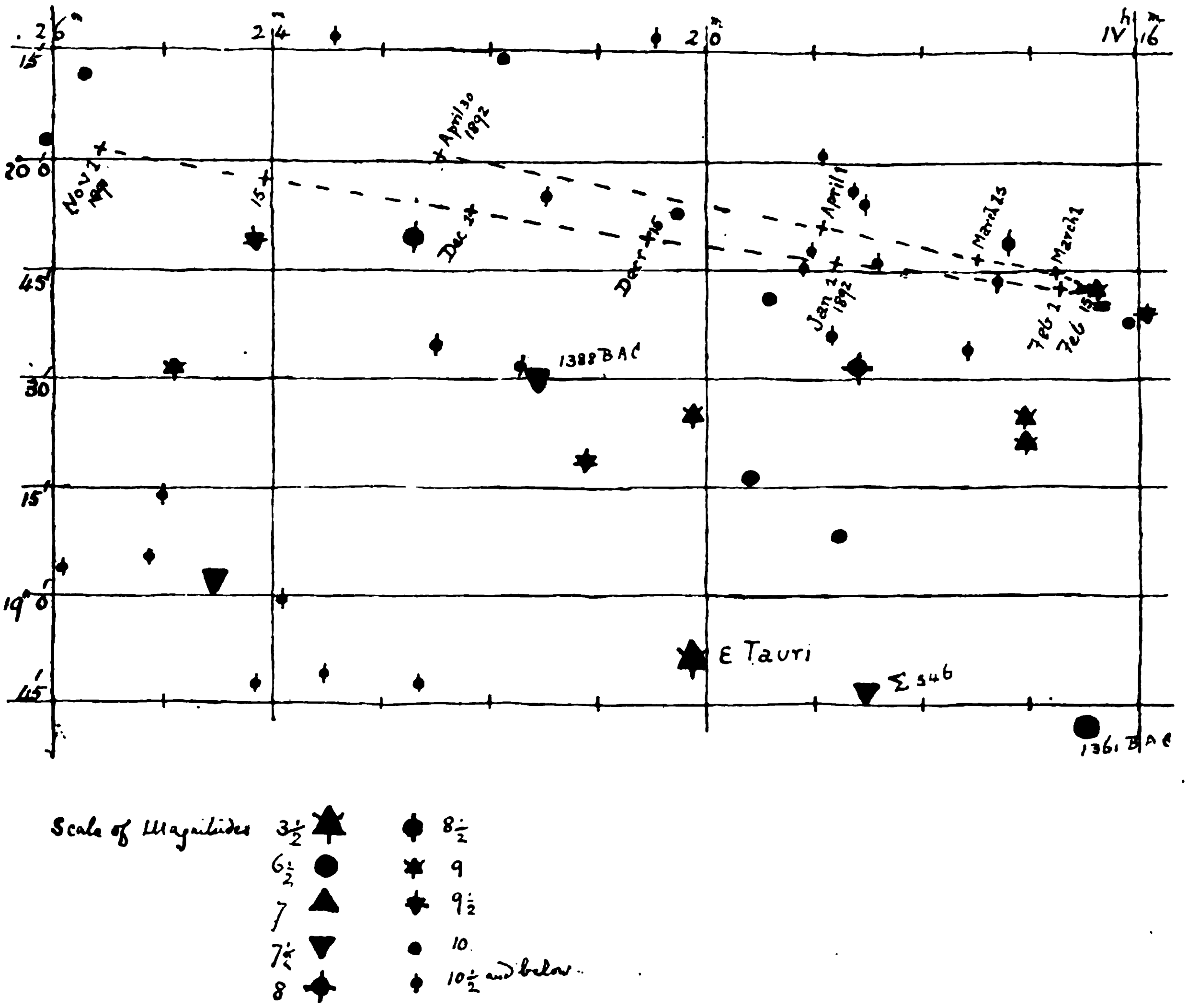
I can now, too, give a rather more definite reply to query 75354, on p. 118. Venus was on the meridian of Port Royal, Martinique, at about a quarter to 11 in the morning on April 12th, 1782, and I think that we may thence assume that she was *not* the evening star to which Mr. Munro alludes. It seems to me most likely that it was Mars, which would then be visible in the west after dark, having transited (in the afternoon), not far from the observer's zenith. Jupiter was a morning star as well as Venus, and hence would be rather less likely to be the object intended, though he would be visible rising in the east before midnight.

My reply to letter 32793 (p. 156) is simply to deny that a "night-glass" and a "marine telescope" are synonymous. I have not only heard of a night-glass, but looked through one many a time. When made purely for night-work, the objective was not even achromatic; the instrument consisting of a simple crown lens object-glass of large aperture, and a Huyghenian eyepiece. The word "marine," "C.M." must excuse me for saying, is used much too vaguely by people who do not know what they are talking about. Pretty powerful binoculars are sometimes now called "marine telescopes," and there is a tolerably common form of opera-glass sold with rotating eyepieces giving three different powers, and labelled "Theatre," "Field," and "Marine," respectively. "C. M." may see an engraving of a marine telescope, properly so called, on the poster advertising the Naval Exhibition, which is displayed all over London, on which a man-of-war Jack is represented as looking through one.

Such a purist as "C. P. M." (reply 75402, p. 160) might at least quote correctly the statements which he criticises. Emphatically I did *not* state that "the moon traverses the First Point of Aries at every lunation." My exact words were these: "Now this part of her orbit lies in the neighbourhood of the so-called First Point of Aries, as, of course, the moon traverses it"—the neighbourhood of the First Point of Aries—"at every lunation," &c. Perhaps "during" might have been a slightly better word to employ than "at," but beyond this I decline to make any concession. Suppose that I were speaking of a constant traveller from London to Dublin, and said that "he passed through Chester and Holyhead at every journey," where would be the solecism? Nothing is easier than to copy from a book, and I only hope that Messrs. Garside and "A. F. C." will find Sir John Herschel's explanation of the Harvest Moon more intelligible to them than mine.

"Regulus" (query 75461, p. 163) should go to some public library where he can consult the back volumes of the R.A.S. *Monthly Notices*. He will find descriptions and engravings of driving clocks for equatoreals in some of them.

"Ganelon" (query 75480, p. 163) must have very recently become a reader of the English Mechanic, or he would scarcely repeat a question which has been put and answered in these columns *usque ad nauseam*. A non-achromatic object-glass is as nearly useless as anything well can be, unless it be of enormous focal length. A good 3in. achromatic objective would be almost infinitely superior. Before replying to his question about a diaphragm and eyepiece, it would be necessary to know the exact focus of his



object-glass. He really should read up your back numbers for the last twelve, or at any rate, for the last six months.

"B. C." (query 75489, p. 163) puts a wholly unanswerable question. *Imprimis*, he cannot even engrave his sundial until he knows his latitude. In the next place, the Pole Star is about 1° 16′ from the actual pole of the heavens, by which amount the edge of his gnomon would be wrongly elevated. Moreover, the cylindrical edge of a tube would not cast a shadow in the way that the edge of a thin plate would. No human being can correct for standard Pacific—or any other—time, unless he knows his longitude.

I cannot answer query 75504 (p. 163) off-hand, nor without an amount of hunting over my library shelves, which I have no time to undertake. By the bye, I have some idea that it was the number of angels that could dance (and not merely stand) upon the point of a needle which formed the subject of the Mediæval discussion.

A Fellow of the Royal Astronomical Society.

PATH OF NEPTUNE.

[32811.]—The accompanying map of the path of Neptune is a continuation, but on a considerably larger scale, of the one given in the English Mechanic for November 15, 1889 (Vol. L. p. 242). The plans are for 1855, the stars chiefly from the *Durchmusterung*, and a few faint ones near the actual path of the planet being added from the Markree zones and Chacornac's map. The magnitudes of the *Durchmusterung* stars below 9·0 have been reduced by the table on p. 356, Vol. XIII., of the Harvard Observatory *Annals*. It will be remembered that a 9·5 mag. Argelander averages 10·5 mag. in the photometric or received scale, and is sometimes very much fainter. Indeed, with the telescope Argelander used (3·07in. aperture), and a higher power (he only employed one magnifying 9 diameters), he might have observed a star of 11·5 magnitudes, and he did, in fact, observe stars even fainter than this. This fact—for fact it is—must somewhat modify certain speculations as to the distribution of stars in space founded on his assumed magnitudes.

The places can be brought up to 1892 by applying a correction of + 2m. 6⅓s. in R.A. and + 5′ 8″ in Decl. to the centre of the map. The only considerable star Neptune approaches is D.M. + 19·716 (9·0 mag. D.M.) 9½ mag. He is about 80″ *n.f.* this star when stationary about the middle of February. This star is underlined on the map. The distance of Neptune at the coming opposition is about 2,680½ millions of miles. The magnitude at near opposition, according to Prof. Pickering's recent photometric results, is 7·7.

Oct. 5. **H. Sadler.**

P.S.—I sincerely trust that the engraver will pay some attention to the size of the discs of the stars on *this* map.

[The map is reproduced by photography, as are all astronomical diagrams sent us, and it is impossible to do more to insure correctness.—Ed.]

NU² SCORPIONIS—HORIZONTAL EQUATORIAL PARALLAX—A GEOLOGICAL "SELL"—GEOLOGY OF BARBADOS—WATER SUPPLY—DRAINAGE: A PRIMITIVE SYSTEM — CLIMATE — DARK TRANSIT OF III.

[32812.]—Could any reader of the "E.M." oblige me with a late measure of ν^2 Scorpionis? I find it elongated with 80 on 3⅛in. refractor, and well divided with 250. I should say that 100 would just divide it. It must now be opened out to at least 2″. It is closer than ε^2 Lyræ, which is easily divisible with a power of 80, and which I can hardly think as close as 2.5″. I have tried Antares frequently, at good altitudes, but cannot glimpse its *comes*. ε Boötis just divided with 80. *Comes* to Vega steadily visible. When showing friends the planets, moon, &c., in my telescope, I find I am often asked what distance the objects are from us at the time of observation. To meet this demand I have devised the following method, which seems to me simple, and quite accurate enough. I have never seen it given in any work on astronomy; but very probably it may be:—

Multiply together the earth's radius in miles, and the number 206,000 (distance in terms of x at which a line of length x subtends 1″). Divide by the horizontal equatorial parallax.

This has one advantage—namely, that the answer can be worked out without logarithms should none be available. But in practice I keep in my logarithm book the log. of E.R. × 206,000 = 8·9119237, which simplifies matters considerably.

As an example let us take the mean parallax of the sun = 8·783″. Its distance, worked out by the log. sin of this angle will be 93,076,210 miles. By the method I use it will be 92,956,722 miles. In either case the distance, 93 millions of miles, is near enough for all practical purposes, and by my method the answer can be obtained without logarithms, which is not the case when we use the method of sines. No doubt all this is as old as the hills; but I have never seen it in print, and so it may be useful to others.

It is seldom wise to jump at conclusions—in science especially. Not long since I was walking along the cliffs of the north-east coast of Barbados, and picked up a beautiful specimen of igneous rock. I showed it to my companion with some pride, as a clear proof of volcanic action, of which, indeed, one would have supposed there was little doubt, seeing that beds of pumice and felspar dust are pretty common. But the Colonial Government has completed the geological survey of the island, and I find my conclusions all wrong. My igneous rock was imported in the guano brought from the west coast of South America; and as for the volcanic dust, that has been carried to Barbados again and again by the counter current to the Trade Wind, which blows in the upper regions of the atmosphere. The last instalment came from St. Vincent in 1812.

Barbados, according to the geological survey, is composed of (1) sandstone, the detritus washed from the mountains of some prehistoric continent; (2) oceanic deposits, containing both Atlantic and Pacific shells, and showing that the island was once sunk close on 2,000 fathoms below the sea, and that even then the volcanic dust settled down upon the ocean floor; (3) coral.

The island is very peculiar in one respect. With an average annual rainfall of over 60in., there is not a single river or stream in Barbados. The coral rock is so porous that the water sinks through it like a sieve, and runs off to the sea by subterranean channels, very often finding their point of exit below low-water level. In one place in Bridgetown Harbour so strong a spring of fresh water bursts forth from the sea bottom that it is possible to dip up a bucketful at any time. This arrangement of nature in the Tropics seems peculiarly adapted to cause the island to be unfit for human occupation, and as the Caribs (who have left many traces behind them in the form of stone axes of the bluntest edge, cut from the coral limestone) had deserted Barbados as a residence, prior to the English occupation, they may very well have been driven away by want of water. In these scientific days the case is otherwise. The subterranean courses of the streams preserve their waters from evaporation; and, by judicious cutting of tunnels, an abundant supply of water can be obtained for the whole island by means of gravitation alone, and without the cost of pumping.

The island is remarkably healthy, as might have been expected, since, in the Tropics, damp ground is an unfailing breeder of fever. Here the soil is dry almost immediately after the fall of heavy rain. The system of drainage adopted by the swarming negro population is of the simplest. They run their slops into cesspools cut in the coral rock, which retain only the solid matters, the liquid percolating away to the sea. One would expect enteric fever to result, but it is rare. The blacks chiefly die of consumption, which arises from their sleeping in huts with every crack and chink that might admit air stuffed up, to keep out mosquitos and ghosts. A most rigid system of quarantine is kept up, which is very necessary, as few of the negroes are vaccinated, and experience proves that they die like flies in an epidemic of small-pox. They have but poor constitutions.

The climate must be one of the most equable in the world. During the six months I have spent in the island I have not seen the thermometer above 90° or below 76° Fahrenheit. The *sensation* of heat varies just as the air is damp or dry. When the N.E. trade wind blows, the atmosphere is dry, bracing, and pleasant. In the hot season, of which the hottest month is September, calms are frequent, and then, after rain, the air is close and damp, and has something the feeling of that in a palm-house. The present season has been the hottest for six years; but I have found the heat quite bearable, and never sufficient to prevent rest at night. The purity of the air is wonderful, and the skies almost always unclouded, the rain falling in short heavy showers.

As for the barometer, it is of no use whatever, except to foretell hurricanes. It has a diurnal motion of $\frac{1}{10}$in. to $\frac{1}{20}$in., and its average height is almost invariable. As a foreteller of rain, it is quite useless.

On the night of the 17th I had the pleasure to see a most beautiful dark transit of Satellite III. I saw it enter bright upon the disc of Jupiter, and then went to dinner. On resuming observations at 7.45 p.m. (11.43 p.m. G.M.T.), the satellite showed up at once as a black dot south of the South Equatorial belt. About twenty minutes later the shadow entered the disc, definition being so perfect that it appeared to cut a semicircle out of the edge of the latter as it gradually entered. I then had the pleasure of watching the satellite and its shadow across the disc and comparing them. III. looked like a spot of Indian ink on white paper, and the shadow like a spot of the blackest writing ink, larger in the proportion of about 5 to 3 on eye estimate; but the satellite was far blacker than any part of the belts; and really, at times, looked almost as dark as its shadow. With 250 eyepiece the difference of shade was more marked than with 80. Fancy being able to use a power of 250 on $3\frac{1}{4}$in. with Jupiter at all!

T. Preston Battersby, Capt. R.A., F.R.A.S.
Barbados. September 26.

THE AUGUST PERSEIDS.

[32813.]—I must plead guilty to Mr. Booth's charge of overlooking the distinction between 5° in R.A. on the Equator and at the Declination of 50° or 60°. Otherwise I should have described Heis's radiant at 25° + 58° for the date of about Aug. 10 as closer to Mr. Booth's and Mr. Sherwen's radiants at the end of July than I did.

But as regards Mr. Denning's radiant for the end of July at 32° + 53°, there is a difference of nearly 5° in Declination as well as in R.A. between it and those recently observed by Messrs. Booth and Sherwen, and this difference is so material that the question of whether there is any change in Declination depends on it.

If, when speaking of the shifting of the Perseid radiant, it is only meant that meteors may be observed coming in considerable numbers, night after night, from points which become more easterly as time advances, I have no quarrel with this conclusion. But if it is meant that these meteors constitute a single connected shower, I do not think this has been proved. For example, if it is the same radiant that shifts continually to the east, it ought to show the same (or nearly the same) degree of diffusion at each stage; and therefore a sharply defined radiant on Aug. 4 is hardly likely to belong to the same shower as a widely-diffused one of a week earlier or later.

Dublin, Oct. 9. **W. H. S. Monck.**

A REMARKABLE METEOR.

[32814.]—A meteor of unusual brilliance was observed here about 6.30 p.m. on Sunday, the 11th inst. The sky was *completely* overcast, though the clouds seemed of varying thickness and presented a mottled aspect, and it was not quite dark. Suddenly to the south, about two-thirds of the way from the horizon to the zenith, a brilliant object moved quickly over perhaps a dozen degrees from east to west. Passing, as it did, behind the curdled cloud-masses, it flashed several times just like lightning, only fainter; but at no point, be it noted, was the sky clear, and the brilliance of the meteor must have been unusual to attract general attention as this object did in semi-twilight and on a sky completely overcast. A friend who was with me, and who has seen many such appearances both here and abroad, said he never saw anything like it.

Arthur Mee, F.R.A.S.
Ammanford, Caermarthenshire.

WOLF'S COMET.—A DOUBLE-IMAGE OBJECT-GLASS.

[32815.]—For the information of Mr. Moore (letter 32791), I wish to say that I can see Wolf's Comet with an aperture of $2\frac{3}{10}$in. But it is very faint, so much so that I cannot be quite sure of its real shape; but it seems to be roundish and to brighten towards the centre. Possibly a very clear-sighted person might see it with an aperture of 2in. My telescope was made by one of the former Dollonds, and, though its object-glass has a greenish tinge when seen by reflected light, yet it is by no means a bad one. As it is provided with circles, I can readily find the place of the comet from the ephemeris given in the English Mechanic.

I have a divided or double-image object-glass which slides on to the upper end of the tube of my telescope, and is worked by two rods which reach back to near the eyepiece end. With one of these rods the observer can rotate the object-glass, and with the other he can bring the two images formed by it into contact. This instrument will measure the angular diameter of the sun or moon; but that can be got for every day of the year from the *Nautical Almanac*, and I do not think that it is very suitable for measuring the distance between double stars. Will someone who has tried this kind of glass kindly tell me whether it be really useful for any purpose? **Zed.**

[32816.]—Several writers in the English Mechanic have expressed surprise that Mr. T. Moore (letter 32768, p. 34) claims to have seen the above object with an aperture of less than one inch. But the question of the visibility of a faint object is, surely, rather one of contrast with the dark background of the sky than of the actual amount of light received from it; and the relation of aperture to the magnification of the image, on which the actual brightness of the object mainly depends, may be maintained in a small telescope until the angle subtended by the faint object is so small as to reduce the apparent diameter to a point—until, in fact, the loss of light, consequent on diminishing aperture, cannot be compensated for by further diminishing the surface over which it is distributed.

Shanklin, I.W. **H. G. Dixon.**

THE TELESCOPE.

[32817.]—If "F.R.A.S." (letter 32762) will refer to page 248 of 15 May last, he will be able to verify the second statement made in my letter, 32713. I cannot at present give him the reference to the first one, as I do not file back numbers and have not access to a set. There is, however, a statement by him in one of his recent letters as to the power necessary to see the components of the double double in Lyra quite as remarkable as that I referred to, in which he says "Fridy" may be able to glimpse ϵ^2 Lyræ with a power of 200 on a $2\frac{3}{8}$ glass. Both ϵ^1 and ϵ^2 are easily divided with a power of 50 on a $2\frac{1}{2}$in.

He states in the letter first above referred to, *re* Finders, that "a negative eyepiece may be used with its imperfect focussing of the fiducial wires." Perhaps he will explain how he can focus fiducial wires with a negative eyepiece. The statement, taken as he puts it, is nonsense. I place the wires inside my negative eyepiece, as I explained before. on the diaphragm. They are, therefore, in the focus of the eye-lens, and when once adjusted no subsequent focussing is necessary. The finder-tube is cut to the proper length to suit the object-glass and eyepiece for parallel light, and when so adjusted the eyepiece never requires to be touched.

"F.R.A.S.'s" reply to Mr. Strother is rather surprising. Mr. Strother's query was, What would be the effect of his removing the middle lens of his triple object-glass. He is told "the object of the third one (is) being to correct what is known as the secondary spectrum, and to render the combination more purely achromatic." Now it is a well-known fact that no telescope object-glass yet constructed combines more than two rays of the spectrum. All the other rays are left out uncorrected; in short, they form what is termed the secondary spectrum. Prof. Abbe has been able, by means of special glass combined with specially constructed eyepieces, to unite three rays in his apochromatic object-glasses; but this has not yet been done, if it were possible to do it, in any telescope object-glass. His answer is not only wrong, but it is no reply to the question put to him.

"F.R.A.S.'s" reply to "Tyro" in reference to the magnifying power of his microscope is, to use a favourite expression of his own, "utterly meaningless." Any schoolboy can easily do the sums in arithmetic in his answer. He has, however, apparently from want of knowledge—it cannot be from oversight—left out the all-important factor in the question—viz., the length of tube. It is of no use attempting to say what the powers of a microscope are unless the length of tube is taken into account.

"F.R.A.S." tells us thrice in the above letter that he is again away from his books of reference and library. Can he be living among the savages to whom he refers, and is he shaving himself with a flint? The sentence in his letter beginning on line 32, p. 134, Oct. 2, clearly shows that it would have been well to have taken with him at least one book—viz., a copy of Lindley Murray.

Wega.

HINTS FOR EXPERIMENTALISTS.

[32818.]—I am glad to see one of my suggestions commented on in letter 32787. As, however, I have no personal experience with inflated tires, I will reply on two points only. Of course, a water-filling would reduce purely local elasticity, and in that sense a tire filled with water would be inferior to one of solid rubber. But, on the other hand, the mobility of the water would insure the distribution of local strains over the whole extent of the elastic rubber tube. Indirectly, by drawing on the elasticity of every part of the tire instead of a few inches of it, the suggested advantage could be obtained. To my mind, the difficulty lies in the great inertia of a mass of water. Many of the lighter fluids which would suggest themselves act injuriously upon rubber. Next as to "chambering" pneumatic tires. The objection, it seems, lies in the difficulty of refilling the separate chambers with air when necessary. I think it might be met by forming one or several minute holes in each rubber partition. These holes should be large enough to permit the circulation of air at a convenient rate through the whole extent of the tubular tire, but small enough, at the same time, to resist any considerable addition to that rate of circulation. Thus, for practical purposes, since the machine runs at a high speed, the advantage of sub-division of the air under compression can be fully secured. With a tire constructed in the manner suggested, it would be possible, by mounting the machine and steadying it in one position, to expel most of the air from the lowermost chamber. But the depression thus produced would disappear completely after two or three revolutions of the wheel. Another modification of this idea would be to inclose a bundle of very small rubber tubes within the elastic tire. The air within and between these tubes would exhibit considerable resistance to rapid displacement. I do not know what pressure of air is used for inflating—I should think the higher the better, within wide limits. Possibly the introduction of a small quantity of some volatile liquid, with high vapour tension, but without destructive action on indiarubber, would be a convenient method for raising the pressure when required. I should add that my proposal would be to try elastic spokes in connection with solid rubber, not pneumatic, tires.

It occurs to me that what one might call a "reversed" radiometer would furnish an interesting study. I think it would be possible, by mechanical means, to give a practically uniform direction of motion to the molecules of a gas. Of course there is a limit to the speed of mechanism—as, for instance, in the case of rotating radiometer arms, there is a point at which centrifugal force becomes equal to the tensile strength of the material from which the arms are made. But a pair of steel-wire arms could be rotated at such a rate that their outer ends would travel faster than the average speed of the molecules of a heavy gas. I may add that I have myself employed a wheel cutting-machine, of which the cutter made some 500 revolutions per second, and I believe that a still higher speed could be easily obtained, by electro-magnetic or other means, in Crookes's nearly perfect vacua. The optical peculiarities of the regions before and behind very rapidly-rotating vanes could be observed by known means. I should look for, possibly, a "dark space" corresponding to almost perfect vacuum behind the vanes, and for a state of condensation before them. Possibly the chemical affinity of certain substances for the residual gas would be increased if those substances were painted on the fore side of such rotating vanes. And again, in connection with this suggested state of condensation, I would suggest lowering the temperature of the instrument, so as to push the effect as far as possible. It would be of advantage to employ fixed annular shields, protecting the circular path of the vanes from rapid inrush of molecules from the central part of the exhausted vessel. I should think that if the vanes were made negative, as in the case of Crookes's electric fly, and if they were rotated at even a moderate rate of speed, there would be a difference of electric resistance between the vanes and the fixed positive electrode, according to whether the vanes were coated on one side or the other with insulating material. Perhaps at a higher speed of rotation the electric resistance of such vanes, uncoated with insulating material, would be greater before and practically infinite behind. Perhaps if coated with mica on the front side, such vanes would no longer conduct at all as negative poles. But would they conduct as positive poles? If so, thus owing to the small electric capacity of the vanes, they would be convenient for experimental purposes, to rectify the alternating currents from induction coils, &c. A. D.

WASTED FOODS AND FAMINE EXPEDIENTS.

[32819.]—The subjects of "Wasted Foods," which Mr. Gerrard's query has brought into discussion, is an important one; but it is only the preface to the greater and more momentous question of famine expedients. I wish, therefore, to lead the readers of the "E. M." to the consideration of this question—viz., What products (other than ordinary food products) would be available for conversion into food in the event of a prolonged stoppage of imports into this country through war? For example, What home products could be turned to account in substitution of flour, tea, coffee, and meat? Are we prepared to withstand a long famine by war, and by what means? I believe there *is* very much natural material which could be utilised as food; but the majority of people are as ignorant as cats about the matter. This subject should be well ventilated in a paper like "Ours."

Istriel.

[32820.]—I would recommend Mr. Gerrard to commence the study of fungi by making carefully-coloured sketches of every species he finds, together with that of a section through the entire plant (*plant* is incorrect, but never mind), showing the character of the stem and its attachment to flesh, also attachment of gills. Notice if gills are forked or simple. If the skin is smooth, hairy, warty, peels easily; presence of ring on stem; odour; taste; change of colour after bruising, or exposure of cut surface to air; habitat; time of appearance. Cut off the cap, lay it on a sheet of paper, either white or black, which has previously been coated with some thin gum. The spores will fall and adhere to the gummed paper, presenting an indelible record of the width apart of the gills and colour, &c., of the spores. If these sketches and notes are placed before a mycophagist, he will probably be enabled to name a great many of them. I would also recommend the purchase of Worthington Smith's pamphlet, entitled "Mushrooms and Toadstools," price 1s., or with coloured plates 6s. A microscope is a valuable adjunct towards the study of this branch of botany, and is indispensable to one who takes the matter up thoroughly. There is also another cheap book named "Popular British Fungi" (I forget the author), and the Scientific Series (red covers) contains a book by Cooke and Berkeley, price 5s., which is decidedly worth having.

Sm.

DIALLING.

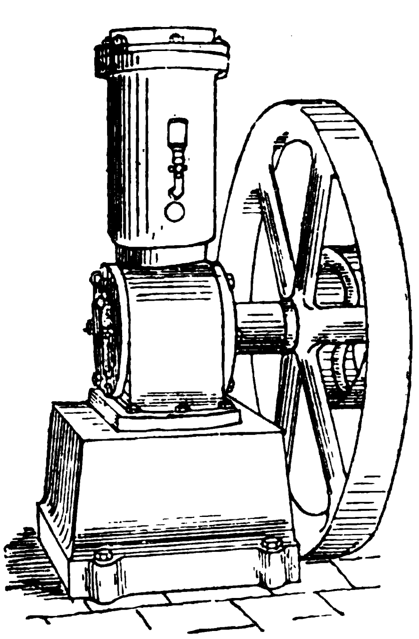
[32821.]—I beg to thank T. R. Clapham (32718) and "Spring Detent" (32772) for their interesting communications. I venture to predict that, before many years, works on Dialling by the ancient mathematicians will be more valuable than "blue china." Although much useful information on the subject is to be found in back numbers, I think a series of articles, elementary and plainly worded, would be much appreciated by the occupant of the "ranch," the "bungalow," the "estancia," &c., who, living many miles away from the nearest watchmaker, are often months without knowing the *right* time. The study of the theory increases our knowledge of astronomy, geography, and mathematics, while their construction is a pleasing occupation for any amateur mechanic. Emerson's treatise on Dialling was printed in 1770; Hawney's work came out soon after Leybourne's in 1702—it is a well-written book, and very clearly explains the subject generally. Did Sir Isaac Newton write anything upon this branch of mathematics?

C. H. T.

A NEW GAS-ENGINE.

[32822.]—I inclose particulars of a new gas-engine built specially for me for driving dynamos, &c., and hope to show one at work for incandescent lighting in a few days.

A very important feature about this engine is that, owing to the plunger working in an airtight space, no leakage of gas or waste products can escape into the air except through the exhaust pipe; thus it can be worked in a living-room without vitiating the atmosphere to the smallest extent. For the same reason all the working parts are dust-proof, and the engine can be worked under conditions hitherto prohibitive, and thus its field of use is enormously extended. Its capability of reversing by simply stopping and turning the flywheel in the opposite direction is also a great advantage for many purposes. There is only one lubricator on the engine, and that is automatic in its action, lubricating all the working parts.



It will be seen from the accompanying price list that, owing to the extreme simplicity of the engine, it is able to be produced at prices hitherto impossible.

Nom. Horse-Power.	Size of Base.	Diameter of Driving Pulley.	Price, including Water Tank.
½	14in. by 14in.	6in.	£20
¾	16in. by 16in.	8in.	£30
1	18in. by 18in.	9in.	£55
2	21in. by 21in.	12in.	£80
3	2ft. by 2ft.	14in.	£100
4	2ft. 2in. by 2ft. 2in.	16in.	£120
6	2ft. 6in. by 2ft. 6in.	18in.	£150
8	3ft. by 2ft. 9in.	22in.	£175
10	5ft. by 2ft. 6in.	24in.	£200
12	5ft. by 3ft.	27in.	£225
14	6ft. by 3ft. 6in.	30in.	£254
16	6ft. by 4ft.	36in.	£280
20	7ft. by 4ft. 6in.	40in.	£320

Above these sizes special quotations will be given.

Sherborne, Dorset. E. R. Dale, A.I.E.E.

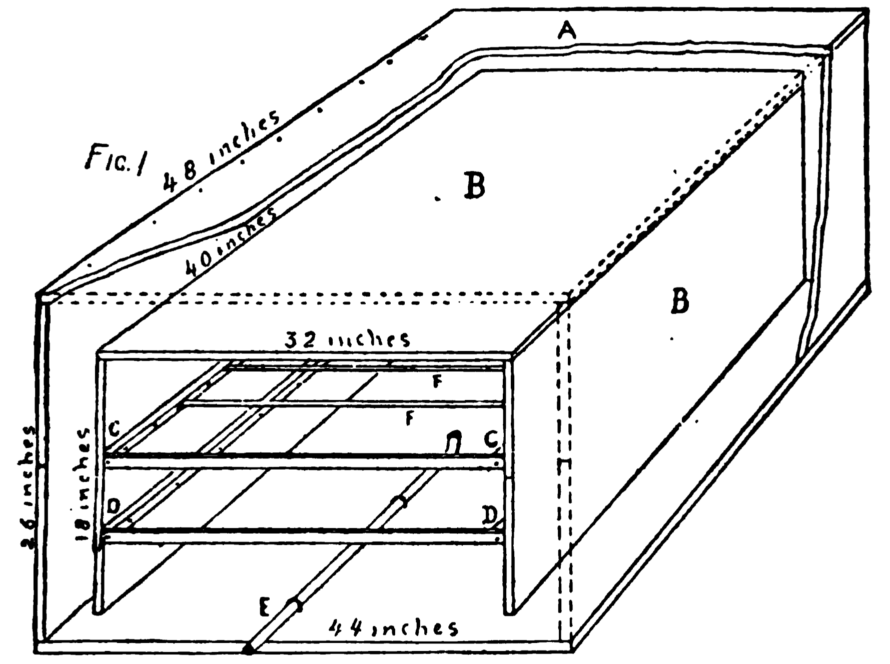
PRACTICAL MICROSCOPY FOR STUDENTS.

[32823.]—The hearty thanks of hundreds of your readers who, like myself, are beginners in microscropy will be due to our esteemed contributor, Mr. Frederick Davis, if he really carries out what he promises in the introductory sentence of his first article in No. 1384. The number of subscribers to "Ours" who are interested in all that pertains to microscopy are surely as numerous as those whose leisure is devoted to the study of matters astronomical; yet I have looked in vain through several back volumes without finding anything of really much interest to the possessor of a microscope who seeks information as to how he should commence a systematic course of study. I have no doubt Mr. Davis will make everything perfectly clear in time: but his intention to plunge *in medias res* is all very well for those who have been grounded in those preliminaries which the advanced microscopist has forgotten he ever was puzzled with, but I sincerely hope that our guide will obligingly carry his memory back to the time when he had no idea of how to cut a section, or what instruments to use in dissection, beyond what he gathered from the usual textbooks. In undertaking the arduous task of contributing the series of articles we are promised, I hope Mr. Davis has primarily in view the intention to afford full instruction to those who, for some reason or other, are unable to avail themselves of the advantages of membership of some society, and also those who have no friend—generally alluded to in the books—who can give them those practical demonstrations in manipulation so difficult to follow from written instructions, as that is the weak point of all the books on the subject. We beginners—I trust Mr. Davis is thinking of us only—want to hear more of the early attempts of our instructors, and how they overcame the peculiar difficulties that constantly crop up to perplex the inexperienced. It is only fair to surmise that those who write authoritatively on a subject have the conveniences and opportunities which ordinary individuals engaged in other ways do not possess; and unfortunately they do not, as a rule, fully appreciate the obstacles that are encountered by those who have no fellow-microscopist to appeal to in moments of doubt. As an illustration of my meaning, I may say that recently I read, in a work devoted to "Microscopical Manipulation," by a well-known member of the R. M. S., that Calvert's solid carbolic acid and glycerine is particularly recommended for clearing. The directions simply state that, after soaking, the object is to be mounted in balsam. Well, after spoiling several preparations—including the proboscis of a blow-fly—I tried the experiment of seeing whether the carbolic acid, held in a state of liquefaction by the addition of a small quantity of glycerine, was in any way affected by the addition of the balsam, dissolved in benzole; and, to my surprise, found that the result was as though a solution of chloride of sodium had been added to one of nitrate of silver. I should much like to know whether Mr. Charters White has tried this plan himself. It is failures of this kind that so discourage a tiro that he desponds of ever being able to mount any satisfactory slides. I hope, Sir, you will not consign this appeal to the waste-paper basket. It is the first time for many years that we microscopical "youngsters" have had a chance. We don't want to let Mr. Davis slip through our fingers without pumping him as dry as we possibly can; and I feel sure he can stand it. We want more minutiæ. Jesma.

INCUBATOR.

[32824.]—Taking the hint of "Threesquare" (p. 157), I will at once plunge into what is called in the classics "medias res," and give a reproduction of the "Home-made Incubator" from the *Rural New Yorker*, which appeared in the number of the "E. M." for Feb. 17th, 1888, as that is probably the incubator which will best suit the requirements of readers who wish to make. There is still plenty of time before starting the actual work of hatching the eggs; for, although the chickens are wanted early, it should be remembered that, if they come early enough but not too early, the better the chances of success. In the mean time, I may say that I do not wish to have a monopoly of this subject. I think that the artificial incubation of eggs may be made to pay; and if any readers who have made experiments of this kind will give reports of their success or want of success—for failures often teach a great deal—we may learn much. Dr. Gerard Smith can, I fancy, tell us something about the methods of artificial hatching, and it would be most interesting if any readers who have tried such devices as have been described in your columns would relate their experiences. I do not see why a good business should not be done in this country by rearing fowls and breeding rabbits; but, leaving the latter subject for other hands, I will for the present confine the subject to incubators, requesting all who have had any experience to kindly make comments on what is published. Some readers, too, who are not interested in the artificial hatching of eggs, may possibly be able to assist in devising a thoroughly trustworthy "regulator" of the temperature—something that can be left to act by itself. In the letter on p. 157 I have, I think, given the principles on which incubators may be made; but a little experience is worth any amount of mere theory. The directions quoted now are from the pen of Mr. P. H. Jacobs, and will at least give a good groundwork on which your readers can expend their inventive faculties and their criticism, which will be, or should be, of much value. Mr. Jacobs says:—

"With the aid of the illustrations but little difficulty need be experienced in making an incubator; and the one here described is in general use—it has been fully tested and found to perform all that may be reasonably be expected. Fig. 1 represents the interior of the incubator. It will be noticed that there are an outer and inner surface, with sawdust between them—chaff or any such material will answer. The outer box is 48in. long, 44in. wide, and 36in. high; the inner box is 40in. long, 32in. wide, 18in. deep, and holds a tank 32in. by 36in. The outside measurements are used in measuring boxes. A is the outer box, and B the inner; C C are strips 1in. wide and 1in. thick, with iron rods ⅜in. thick (F F), upon which the tank



rests; D D are similar strips (but no rods) for supporting the egg drawer; E is a 1½in. tin tube, 2ft. long, which admits air into the ventilator (space under egg drawer). The ventilator is 5in. deep, and is of the same length and width as the tank.

"Fig. 2 shows a sectional plan. A is a tube extending through the incubator into the tank; B is a faucet for draining off water; C is the egg drawer; D is the tin air tube. The egg drawer, Fig. 3, is 4in. deep, outside measurement, and should be made of light material. It is 39in. long and 30in. wide, containing three movable trays, 1½in. deep, and of size to fit in the drawer. The bottoms are thin strips, 1in. wide and 1in. apart to both drawer and trays, over which muslin is tightly drawn and tacked. The tank is 7in. deep. The faucet is detachable, and screwed in when desired on a thread. The tube on top is 7in. high. The front of the egg drawer is also boxed off and filled with sawdust.

"It requires about 115ft. of lumber (inch tongued and grooved boards), and the cost of the tank is about 5dols. The plan of the tank is shown in the sectional view given. When completed, the incubator is simply a box having this appearance. See Fig. 4.

"In building one may follow any plan that may be preferred, as it is not necessary to conform to any particular design. Have the floor close. All that is necessary is to make a warm room for keeping the eggs at a uniform temperature; but do not attempt to have any tubes for the escape of air. Opening the door to turn the eggs provides sufficient ventilation.

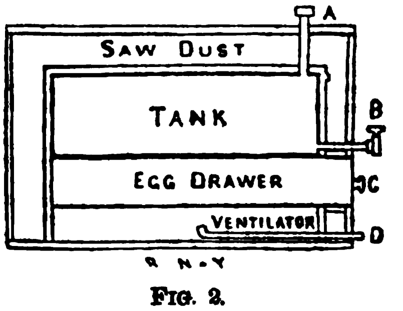


Fig. 2.

"Each tray holds about 80 eggs, laid in promiscuously, the same as in a nest, making the total number for incubator 240 eggs. First fill the tank with boiling water, but never allow it to remain in the tube on top, as it thus increases pressure; hence, when the tank is full to top of tube, draw off a gallon of water. Fill it 48 hours before putting eggs in, and have heat up to 115° before they are put in. As the eggs will cool down the heat, do not open the drawer for six hours, when the heat should be 103°, and kept as near to that degree as possible, until the end of the hatch. It is best to run it a few days without eggs, to learn it thoroughly. Place incubator in a place where the temperature does not fall before 60°. As the heat will come up slowly, it will also cool off slowly. Should the heat be difficult to bring up, or the eggs be too cool, you can raise or lower the trays, using small strips under them. You can also stop up or open the air tube in the front opening of the ventilator whenever you desire. When the eggs are put in, the drawer will cool down some. All that is required then is to add about a bucket or so of water once or twice a day, in the morning and at night, but be careful about endeavouring to get up heat suddenly, as the heat does not rise for five hours after the additional bucket of water is added. The cool air comes from the ventilator pipe, passing through the muslin bottom of egg drawer to the eggs. Avoid opening the egg drawer frequently, as it allows too much escape of heat; and be careful not to open it when chicks are hatching unless compelled, as it causes loss of heat and moisture at a critical time. Cold draughts on the chicks at that time are fatal. Do not oblige visitors. Be sure your thermometer records correctly, as half the failures are due to incorrect thermometers, and not one in twenty is correct. Place the bulb of the thermometer even with the top of the eggs—that is, when the thermometer is lying down in the drawer—with the upper end slightly raised, so as to allow the mercury to rise; but the bulb and eggs should be of the same heat, as the figures record the heat in the bulb, and not in the tube.

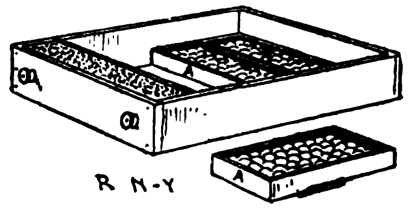


Fig. 3.

"Turn the eggs twice a day at regular intervals —six o'clock in the morning and six o'clock at night. Do not let them cool lower than 70°. Turn them by taking a row of eggs from the end of the tray and placing them at the other end, turning the eggs by rolling them over with your hand. By removing only one row you can roll all the rest easily. Give no moisture the first week, very little the second, and plenty the third week. Do not sprinkle the eggs. For moisture, put a wet sponge the size of an egg (placed in a flat cup) in each tray the second week, and two sponges in each tray the third week. Do not put in sponges until you are about to shut up the drawer after turning. Wet the sponges by dipping in hot water. After the first ten days the animal heat of the chicks will partially assist in keeping the temperature. Be careful, as heat always drops when chicks are taken out. You can have a small glass door in front of the egg drawer, to observe thermometer if desired. Always change position of trays when the eggs are turned, putting the front one at the rear. After the fourteenth day spray the eggs twice a day with water warmed to 100°, using an atomiser, and do it quickly."

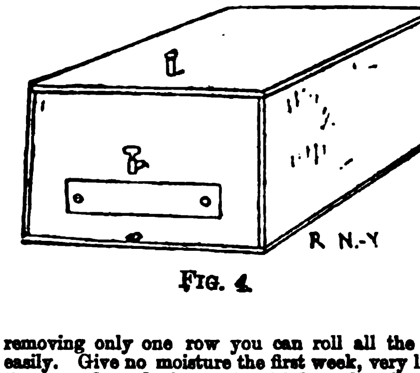


Fig. 4.

Subsequently, Mr. Jacobs wrote:—

"So important a subject as artificial incubation cannot perhaps be made entirely plain to a novice in a few articles; but as interested parties have written for additional information, it may interest others to answer them here. Among the questions asked are: 'Does the incubator dispense entirely with the use of a lamp, using at intervals a bucket of water to maintain proper temperature? I fear this will not be satisfactory unless the incubator is kept in a warm room or cellar.'

"All incubators must be kept in a warm location, whether operated by a lamp or otherwise. The warmer the room or cellar, the less warmth required to be supplied. Bear in mind that the incubator recommended has 4in. of sawdust surrounding it, and more sawdust would still be an advantage. This sawdust is not used to protect against the outside temperature, but to absorb and hold a large amount of heat, and that is the secret of its success. The directions given were to first fill the tank with boiling water and allow it remain for twenty-four hours. In the mean time, the sawdust absorbs the heat, and more boiling water is then added until the egg-drawer is about 110° or 115°. By this time there is a quantity of stored heat in the sawdust. The eggs will cool the drawer to 103°. The loss of heat (due to its being held by the sawdust) will be very slow. All that is needed then is to supply that which will be lost in twelve hours, and a bucket of boiling water should keep the heat about correct, if added twice a day; but it may require more, as some consideration must be given to fluctuations of the temperature of the atmosphere. The third week of incubation, owing to animal heat from the embryo chicks, a bucket of boiling water will sometimes hold temperature for twenty-four hours. No objection can be urged against attaching a lamp arrangement; but a lamp is dangerous at night, while the flame must be regulated according to temperature. The object of giving the hot-water method was to avoid lamps. We have a large number of them in use (no lamps) here, and they are equal to any others in results.

"With all due respect to some inquirers, the majority of them seem afraid of the work. Now, there is some work with all incubators. What is desired is to get rid of the anxiety. I stated that a bucket of water twice a day would suffice. I trusted to the judgment of the reader somewhat. Of course, if the heat in the egg-drawer is 90°, and the weather cold, it may then take a wash boiler full of water to get the temperature back to 103°; but when it is at 103° keep it there, even if it occasionally requires two buckets of boiling water. To judge of what may be required, let us suppose the operator looks at the thermometer in the morning, and it is exactly 103°. He estimates that it will lose a little by night, and draws off half a bucket of water. At night he finds it at 102°. Knowing that it is on what we term "the down grade," he applies a bucket and a half (always allowing for the night being colder than the day). As stated, the sawdust will not allow the drawer to become too cold, as it gives off heat to the drawer. And, as the sawdust absorbs, it is not easy to have the heat too high. One need not even look at the drawer until the proper times. No watching—the incubator regulates itself. If a lamp is used, too much heat may accumulate. The flame must be occasionally turned up or down, and the operator must remain at home and watch it, while during the third week he will easily cook his eggs.

"The incubator can be made at home for so small a sum (about 5dols. for the tank, 1dol. for faucet, &c., with 116ft. of lumber) that it will cost but little to try it. A piece of glass can be placed in front of the egg drawer, if preferred. If the heat goes down to 90, or rises at times to 105, no harm is done. But it works well, and hatches, the proof being that hundreds are in use. I did not give the plan as a theory or as an experiment. They are in practical use here, and work alongside of the more expensive ones, and have been in use for four years. To use a lamp attachment, all that is necessary is to have a No. 2 burner lamp with a riveted sheet-iron chimney, the chimney fitting over the flame, like an ordinary globe, and extending the chimney (using the elbow) through the tank from the rear, ending in front. It should be soldered at the tank. The heat of the lamp will then pass through the chimney, and consequently warm the surrounding water."

I think the above is a very fair start, but more will follow. Incubans.

REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[74945.]—**Gear on Worm.**—I should think that spur wheels would be the best of the two, as they would be cheaper, not so much wear, and there would be no side thrust on shaft. Of course it may be often more convenient to use worm and wheel instead of spur wheels. E. A. A.

[74946.] — **Fastening Covers of Creasote Tanks.**—Would it not be better to rivet the cover on your cylinder, and have a manhole in the cover, which could be kept tight in the ordinary way? If this would not do you could fasten your lid down by putting an angle iron ring on the end of cylinder, and a flat iron one on cover, and bolt together by studs or jet-pins. E. A. A.

[75000.]—**American Organs.**—I can assure "Organon," p. 158, that the springs I refer to are precisely the same as those used in the generality of American organs. I have used thousands of these springs, and have found them satisfactory, and there is no necessity to take the unnecessary trouble to make them. This is my opinion; but "Organon" has a perfect right to differ from me, as this is a free country. As regards his contention in reference to the filing of reeds to pitch, I still hold the same opinion. Taking off the milling marks in the operation of filing the reeds to pitch is a matter of no importance. File the reeds sufficient to suit all purposes, and if you go too far you will unquestionably spoil the reeds. As regards the "voicing," "Organon" is quite correct. I should have used the term "bending" in reference to the reeds at 10s. 6d. per set. They are supposed to be voiced at that price, and that is all. Very few can "voice" reeds, in the strict sense of the term, and very few know when a reed is voiced properly. Bending reeds is a common practice. True voicing is exceptional. Practical Organ Builder.

[75127.]—**Casting in Cuttle-Fish.**—I have cast small articles very fairly well as follows, but hope some correspondent will give us details of how gold rings, ornaments, &c., are cast by those engaged in the trade. The following method is used by jewellers, and requires very litte apparatus, and the mould does not take any appreciable time to make:—Get cuttle-fish in pieces from a dealer in jewellers' requisites. The pieces are nearly as large as a small hand, and are horny on one side and soft on the other; the soft side is much like dry chalk. Take the pattern between two pieces of fish, the horny sides being outward and the soft sides inward, touching the pattern. Grasp in both hands, and press the pieces firmly together; the pattern will then imbed itself in the fish, and be lost sight of. Before separating the pieces and allowing the pattern to drop out, insert some guides to insure the mould going together properly. Some wire or wire nails run through both pieces, and projecting on either side, serve the purpose. Cut a V-shaped passage from the edge of the fish to the mould, through which to pour the metal into the mould. To melt the metal, scoop out a small, saucer-shaped hole on a block of charcoal, and cut a channel to the corner of the block to serve as a spout, through which to pour off the melted metal. Place enough metal in the cavity, and play a blowpipe flame on it until melted. The heat from the charcoal helps to melt the metal. H. W. S.

[75157.]—**Textbooks on Mechanics.**—I find one of the best things to do in going in for science and art examinations, is to read up the books of the examiners. I believe Goodeve and Twisden are respectively the examiners for applied and theoretical mechanics, so that you had better get Goodeve's "Principle of Mechanics," and "Elements of Mechanism"; Twisden's "Mechanics"; besides which you will find Todhunter's "Mechanics for Beginners," Magnus' "Hydrostatics and Pneumatics" very good books. E. A. A.

[75174.]—**Terebene Driers.**—"M. L" (p. 159) appears to be under a misapprehension. The siccative known as terebene (or terebine) driers, was in use long before the discovery of the body to which he refers. This use of old-established trade names to designate newly discovered bodies is much to be deprecated. Another instance is the appropriation of the well-known title "saccharine" (a malt substitute) to designate the new coal tar-sweetener. Recently, it is true, this mistake has been partially rectified by dropping the final "e" in the title of the newer body; but the bodies are still able to be confused in the popular mind.

P. W. Stanley, Analytical Chemist.
Billson-street, Poplar, London.

[75192.]—**Small Arc Lamp (U.Q.)**—You cannot get a true arc with 20 volts. But by using small carbons sharply pointed and regulated by light spring pressure, you can do what you require. The points should lightly bear on each other.

F. Askew.

[75223.]—**Sharpening Wire.**—Wire is pointed by machines, of which there are several in the market, including pin-making machines. The wire is pointed either by being turned against a stationary cutter, or rolled into shape, or, as in the case of wire nails, is simply nipped up to a point. The ends of wire nails are not remarkably nicely pointed, but some of them are done by a press which cuts the wire into lengths and forms the point at the same time that the other end is being upset or swaged to form the head. T. L.

[75226.]—**Browning Brass.**—To turn brass a "deep brown or copper colour," the staining known as "brown to red" should be used. To a pint of water add 16dr. of nitrate of iron and 16dr. of hyposulphite of soda. If merely a dark brown, use a solution of one pint of water to 4dr. of nitric acid. If dark browns, approaching to black, use a solution of one pint of water to 5dr. of nitrate of iron. There are, I think, a number of recipes given in the "Brassfounders' Manual," by Graham, published by Crosby Lockwood and Son.

Nun. Dor.

[75228.] — **Bending Gauge Tubes.** — Gauge tubes are bent either by filling with rosin or sand, as a rule, and the former method accounts for the subsequent heating. Lead would be out of place, because a temperature sufficient to melt that out would tend to soften the tube. T. M.

[75229.]—**Frosting.**—The plates can be passed through embossing rollers, annealed, straightened, and polished. Selim.

[75231.]—**Model Steam Port.**—The hole can be filled up by means of brass, and the port be re-bored; or it can be plugged, and the cylinder be re-turned. M. J.

[75232.]—**Hydraulic Press.**—The "greatest pressure" used in hydraulic presses I do not know, but it must be many tons on the square inch. The maximum pressure is limited by the "reasons" that the metal of the cylinder might give, as it will certainly weep, and that it is not easy to pump water in when a very high pressure is reached.

L. M.

[75236.]— **Electrical Lighting.** — The old reader should refer to his back numbers, or give some definite particulars as to the voltage of his lamp. W. B.

[75243.]—**Gas Cylinders.**—These gas cylinders are intended mainly for use with the optical lantern, and though they might be made to work a gas-engine, it would be going a long way round to do the work. Video.

[75248.]—**Outside Painting.**—There is nothing better than real white-lead paint for outdoor work, if durability is required. It can be toned to almost any tint by admixture with coloured pigments ground up in oil. R. L.

[75259.] — **Camera Obscura.** — An ordinary prism is used as the reflecting agent; but a piece of glass placed at an angle of 45° does. See the indices of back volumes. Ganot.

[75263.]—**Grape-Juice.**—The juice of grapes can be preserved by boiling it down with the addition of sugar until it forms what the cook calls jelly. Salicylic acid will preserve it, no doubt, and so will alcohol; but presumably those things would be objectionable to the querist, who apparently wants to make what some people will persist in calling unfermented wine. Why not let the grape juice do as it pleases? Twaddell.

[75265.]—**Piano Pedals.**—"Practical Organ Builder" is right in anticipating that other readers of "E.M." besides the original querist would like to know how to construct these. The writer has been watching the correspondence on piano pedals from the beginning, and hopes soon to find full particulars how to make a set to act on the piano-keys, to be easily detachable, and to do no injury to the action of the piano, however heavily the feet might play. Traed Cymro.

[75344.]—**Hydraulics.**—The head employed in measuring the miners' inch varies in different districts; hence the quantity of water passed per miners' inch is not a definite amount. Its average value is about 1½c.ft. per minute. At this rate 1,000 miners' inches will be equivalent to 1,500c.ft. per minute; this, with 415ft. fall, will give 880H.P. If the length of the pipe does not exceed 2,000ft., a 24in. pipe will convey the water.

Chas. Louis Hett.

[75273.]—**American Organ.**—I don't wish to waste the valuable space of "E.M." by arguing the point with "Organon" *re* reeds. I am pleased to see, however, that he at least admits that reeds do require filing. I have found from practical experience that the best results can be obtained by filing, viz., quickness of speech and better quality of tone. He himself proves that his information is rather old-fashioned, as he admits getting his knowledge from writers of many years back, and also mentions the reeds of his own instrument as a specimen of voicing, which he has had in his possession over fifteen years—the same instrument perhaps having been in stock a few years more. He says Munro can make a reed about as good as it can be made; but I am afraid Mr. Munro must have made a great mistake in introducing his reeds for harmoniums if they are so unsuitable as "Organon" tries to make out (query 75269). As "Organon" has challenged me to explain how to fit couplers to harmoniums, I will do so on condition that he signs his name and address to his letter instead of a nom-de-plume.

Stubbins, near Manchester. J. Schofield.

[75350.]—**Section of Iron.**—A series of papers were read before the British Iron and Steel Association by Dr. H. C. Sorby upon the subject of the microscopical examination of iron and steel, in which the method of preparing the specimens is given; the dates are 1885 and 1887 (possibly before and after), published in the *Journal* of B.I.S.I. Should like to have "Ferrum's" address.

J. H. Noblit.
1319, North Broad-street, Philadelphia, Pa.

[75354.]—**Venus on the Night of April 12, 1782.**—I have been unable to refer to the *Nautical Almanac* for 1782; but the *Berliner Jahrbuch*, which, I presume, is quite as trustworthy as the former, gives the following particulars:—The planet was due South at 10h. 3m. a.m., rose at 4h. 0m. a.m., setting at 4h. 6m. p.m. These times are in Martinique local time. It would be a great improvement if our *Nautical Almanac* gave the times of rising and setting of the planets, as other publications do; but this is too much to expect.

Bogie Man.

[75354.]—**Venus in 1782.**—In case Mr. Munroe (query 75354, p. 118) has not access to the *Nautical Almanac* for 1782, I send the following extracts from it:—Venus was in inferior conjunction on March 20th, at 13h., she was therefore a morning star on April 12. The place of the sun at noon on April 12, was 1h. 23m. 53s., N. 8° 50′. The place of Venus at the same time was 23h. 25m. 48s., N. 1° 0′; her heliocentric place was longitude 216° 45′, latitude N. 2° 6′. Andrew C. D. Crommelin.

Montpelier House, Blackheath.

[75371.]—**Gas-Furnace Casing.**—I am well aware that asbestos does not make a furnace-casing more refractory; but, for all ordinary purposes, a case made of fireclay, with a small quantity of asbestos fibre worked up with it, is all that could be desired, and if "999," or anyone else, will try it, they will find that the asbestos greatly helps to bind the whole together, preventing cracks, &c. I have used a furnace made by myself, as above, for melting copper, brass, &c., and find that it gives every satisfaction.

Brighton. T. C. Smith.

[75377.]—**Blower for Gas Generator.**—Many thanks to "999." I must make a second holder. I have heard of a gasoline gas producer worked by weights, but have not been able to see it. In answer to F. W. Briggs, my gasometer is 3ft. high and 30in. in diameter, and will last, with one burner, about 8 hours. I use Bray's market burners. M.R.C.S., &c.

[75402.]—**Harvest Moon.**—It may help some of your readers to a right understanding of this phenomenon, if I supplement my remarks in the last number of the English Mechanic by emphasizing the fact that the gist of the whole matter lies in the relative inclination of the plane of the moon's orbit (which does not differ greatly from that of the Ecliptic) and the plane of the horizon. But the position of this last plane depends upon the latitude of the observer's station. Consequently, the harvest moon, that is to say, the fact that at a certain period the moon rises on each of several successive days only a little later than on the preceding, and very shortly after sunset, is not valid all the world over, nor is it identically the same phenomenon wherever it is observed. There is no harvest moon at the Equator. At the period in question the retardation of the moon's successive risings diminishes as we advance northwards from the Equator, till it becomes so small as to attract notice, and get smaller and smaller till we come to the latitude at which the moon's orbit coincides with the horizon, and then she will rise for several evenings absolutely at the same time. After passing that limit, the intervals between successive risings begin to increase again. It may be necessary to remind some that the moon's longitude may be 0° without its orbit intersecting the Ecliptic at the First Point of Aries. Its latitude in such a case may be extremely small, and can never exceed 5° 8′ 48″. All this depends upon the longitude of the nodes.

C. P. M.

[75402.]—**Harvest Moon.**—My thanks are due to "C. P. M." for his correction of my reply to the above, in regard to the moon's ascending node. But he must excuse me: I did not write to instruct astronomers. It would be an easy matter to explain to such. Those who inquire about the harvest moon are usually but little acquainted with astronomy, and as I had no idea how much "A. P. C."

knew of that science, I aimed at writing an explanation that could be understood by all who tried. To do this I endeavoured to show a resemblance between the sun and the moon as regards their apparent and real motions, and only noticed those points that bore directly on the question, so as to avoid confusion, and get at the point as directly as possible. If the moon were full exactly at the time of the autumnal equinox, it would cross the Ecliptic and the Equator together; and it was this contingency, as representing a "perfect" harvest moon, that I had in my mind when writing. Hence my mistake. Perhaps it would have been better if I had said the moon's apparent yearly motion amongst the stars is, roughly speaking, along the Ecliptic; but as the plane of its orbit is *always* inclined *about* 5° 8' thereto, it is for half of its revolution in its orbit above, and for half below, being only actually on the Ecliptic at its nodes. Does "C. P. M." wish to assert that the angle never varies that the plane of the moon's orbit makes with the Ecliptic?

H. Wake.

[75411.]—**Weather Indicator.**—This is not a weather indicator, but an *hygrometer*. The colour depends upon the amount of moisture in the air. It is blue in summer, when there is a difference of 18° between the wet and dry-bulb thermometers, and in winter when the temperature is below freezing point. The chemical used is cobalt chloride.

Sm.

[75419 and 75455.]—**Asthma.**—The question "Is asthma curable?" cannot, I think, be answered by a simple "yes" or "no." In our climate asthma is usually more or less complicated with bronchitis, and very frequently with some affection of the heart, while the disease itself, after a time, frequently causes secondary morbific changes in the heart and lungs, and when thus advanced is probably (though susceptible of relief) incapable of complete eradication; but if properly met at the outset, and uncomplicated, I see no reason to question the possibility of a complete cure. Physiologists are still divided as to the real nature of the morbid process in the disease; but to my mind the most probable explanation is that which refers it to a spasm of the bronchial muscular fibres; as if this be so, one can easily understand why the nitrites (which cause dilatation of the vessels) afford such prompt relief. The nitrites may be inhaled (with instant but somewhat transient effects) or taken internally. Nitrite of sodium (in doses of two to five grains in a little water) gives prompt and enduring relief. Nitrate of amyl, though oftener used, is, so far as my experience extends, not nearly so efficacious as the corresponding sodium salt. Iodide of potassium is another remedy which has been highly extolled; but as I have no experience of its use in the disease, I cannot give it my personal endorsement. Valuable also as an auxiliary in palliating the severity of the paroxysm is fumal inhalation, either in the form of "asthma cigarettes" (composed of stramonium, lobelia, &c.), smoked in the usual way, or in the form of powder to be burnt, and the fume inhaled direct. Of the latter class probably the best known is "Himrod's Asthma Cure," which came into popular notice during the last illness of the late Lord Beaconsfield; but the powder prescribed by Sir Morell Mackenzie is, in my opinion, decidedly superior. I shall be happy to send a copy of this prescription (in English) free to any address for postage only.

P. W. Stanley, Analytical Chemist.
Billson-street, Poplar, London.

[75423.]—**Electric.**—The crystals are ammonio-chloride of zinc, and the cause is the too-concentrated solution. Add some water. Sm.

[75426.]—**Coal-dust Bricks.**—These are sometimes made by mixing, in a homogeneous mass, sawdust, chips, small or fine coal (the waste of coalyards), and tar in sufficient quantities to form a solid mass when dry. They are generally made into bricks, and retailed at 1d. each. Ernalf.

[75429.]—**Electric Lighting.**—The best battery you can use is eight cells of the chromic-acid type, charged with Mr. Bottone's new depolariser; but I think you will find that electric lighting, except as an experiment, is very troublesome and costly with any battery.

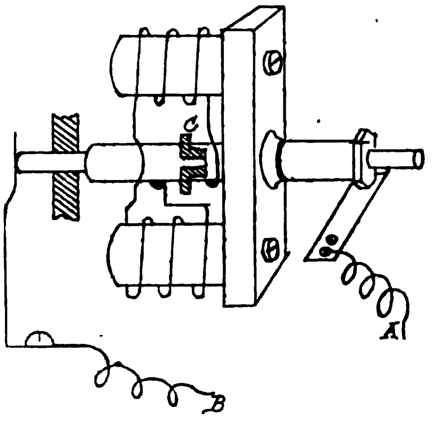
Brighton. T. C. Smith.

[75436.]—**Nasik Squares.**—Perhaps Mr. S. J. Burton would kindly explain how he manages to bring the notation of the Integral Calculus into play in his curious reply. Although I am tolerably good at the Calculus, I fail to make any sense of his symbols.

Bath. M.I.C.E.

[75436.]—**Nasik Squares.**—S. J. Burton, at p. 162, does not at all improve the attempt of a nasik square of 36 figures. It had formerly one of its 24 lines excessive and one deficient, but he now makes two of the 24 excessive—namely, the two diagonals that pass through the figures 21 and 25, and two deficient—namely, the two diagonals through 12 and 16. I fancy the "T. S. B." of p. 161 must be right, and should like to see how his square is composed. E. L. G.

[75433.]—**To Mr. Bottone or Others.**—Your machine is either connected up wrongly or short-circuits somewhere. I send sketch of correct connections. A and B are wires to the handles of machine; the shaded part C is an ebonite bush-piece to insulate the two halves of the spindle.



Brighton. T. C. Smith.

[75436.]—**Nasik Squares.**—The numbers 22 and 13 should be transposed, when it will be found that the six verticals, the six horizontals, and the two diagonals each sum 111.

15	8	19	24	35	10
34	21	23	7	12	14
2	13	27	29	22	18
31	11	9	4	20	36
3	25	32	30	16	5
26	33	1	17	6	28

J. S. N.

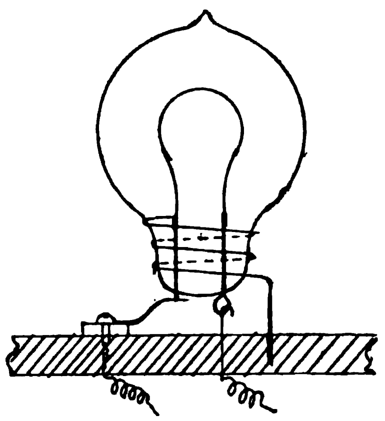
[75436.]—**Nasik Magic Squares.**—The specimen of a 6-square given by S. J. Burton is *not* a "nasik" one at all, two of the diagonals summing 120 and two only 102—exactly the same defect, as regards diagonals, as there was in the previous square as regards columns. Does S. J. Burton clearly understand what a "nasik" magic square is, as distinct from an ordinary or non-nasik magic square? A *nasik* 6-square must have all its 12 diagonals magic (6 in one direction and 6 in the other)—that is, each of the twelve diagonals must sum the same number as each of the rows and columns does. Lest any reader should not understand what the ex-centric diagonals are, the following will explain:—

1	2	3	4	5	6
	1	2	3		5
5		1	2	3	
	5		1	2	3
3		5		1	2
2	3		5		1

The central diagonals, as, for example, the path marked out by the figure 1, need no explaining; but the figure 2 also is said to be in a diagonal. It is a broken one, five of the figures running down adjacent to the central diagonal, the other in the corner. Similarly, the four 3's, together with the other two, constitute a diagonal. Also the six 5's, broken up into two groups, constitute a diagonal. And so on with the others, which I have not marked in, so as to make the others clearer. Six other diagonals go in the other direction, in the same way. T. S. B.

[75447.]—**London and North-Western New Compound Loco.**—I quite agree with "Chillington" as to this new engine being the largest in England, and it will surprise me if it does not make a name for itself. The boiler, which is nearly 20ft. in length, has two sets of tubes and four tube plates, access being gained between the inner tube plates by a manhole leading into the combustion chamber. Stephenson's link motion is used throughout, and the valves both for the high pressure cylinders and low pressure cylinders, are Brotherhood's equilibrium valves. The boiler pressure is 175lb. per square inch. This monster, whose name is going to be "Greater Brittan," is intended for the Scotch traffic. Compound.

[75449.]—**Incandescent Lamp.**—If the platinum loop is not broken below the surface of the glass, you might get a drop of soft solder on the end of a piece of thin wire to adhere to it, or you might fix in a holder with a piece of springy brass or copper to press on the broken wire, as sketch.



Brighton. T. C. Smith.

[75453.]—**Cost of Electric Lighting.**—A 16c.p. 100-volt lamp running for 1,800 hours will absorb about 90 units, which at 6d. amounts to 45s. A 16c.p. gas jet, consuming 5c.p. per hour, will, at 2s. 9d. per 1,000ft., cost 24s. 9d. Cost of matches extra. Sm.

[75459.]—**Nitrogen in Sulphuric Acid.**—Nitrous compounds may be removed by heating 7lb. of the acid with about ¼oz. of ammonium sulphate. J. T. M.

[75459.]—**Nitrogen in Sulphuric Acid.**—If the only compounds of nitrogen objected to be the oxides, they may be destroyed by adding to the sulphuric acid $\frac{1}{300}$th of its weight of ammonium sulphate, and heating for some time in an open dish. This method, of course, introduces nitrogen as ammonia; it might then be eliminated by the troublesome process of distillation if desired. Possibly urea might do better than the ammonium sulphate. Director R.R.L.

[75459.]—**Nitrogen in Sulphuric Acid.**—May be removed by distillation, rejecting the first eighth part that distils over, or by passing a current of sulphur dioxide (sulphurous acid gas) through the suspected acid, and then heating to about 212° Fahr., to expel excess of sulphurous acid gas. If nitrogen oxides are present, they part with their oxygen to the sulphur dioxide, which becomes converted into sulphuric acid, which on heating the nitrogen (or its lower oxides) is expelled.

S. Bottone.

[75463.]—**Brazing Copper.**—It is impossible to give complete instructions for brazing, otherwise than by doing the work in the presence of the learner. When a blowpipe fails to do the work specified, either the gas supply is deficient, the blast is insufficient or obstructed, or the correct proportions of air and gas are not supplied. A blowpipe is at its maximum power when the flame is making the greatest noise; the peculiar sound of a perfect blowpipe flame for brazing when once heard is easily recognised, and an expert can adjust a blowpipe to its highest power without seeing the flame. Thos. Fletcher.

[75464.]—**Making Charcoal Soluble.**—If you burn the charcoal and pass the gas into water you will obtain carbon in solution in the form of carbonic acid. That is the simplest method with which I am acquainted. Sm.

[75464.]—**Making Charcoal Soluble.**—Charcoal is, strictly speaking, not soluble in anything. Boiling oil of vitriol will oxidise it to CO_2, but this will, I fancy, not suit the querist.

Wm. John Grey, F.C.S.,
Analytical Chemist, Newcastle-on-Tyne.

[75464.]—**Making Charcoal Soluble.**—Both useless and impossible. The medicinal value of charcoal depends not on the nature of its substance, but on its physical state. This would, of course, be altered by solution, even were such possible.

Director R.R.L.

[75464.]—**Making Charcoal Soluble.**—It is impossible to make charcoal, as such, soluble in hot or cold water. But charcoal can be oxidised to form carbon dioxide, and this is freely soluble in cold water. Pure sugar also contains charcoal, united to one and a half times its weight of water; and this, as you know, is freely soluble in hot water.

S. Bottone.

[75465.]—**Tartaric Acid, &c.**—No; it will not.
Sm.

[75465.] — **Emulsifying Oils by Tartaric Acid or Cream of Tartar.**—Neither tartaric acid nor cream of tartar will produce assimilation of fatty matter with a syrupy liquid. Oils can be emulsified by the addition of alkalies, or carbonates of the alkalies. A mixture of starch, gum arabic, and sugar also emulsifies fatty matter well. Take 1oz. pure rice starch, mix it with 1oz. best gum arabic in powder, and 1oz. of finely-powdered white sugar (that sold as caster for icing cakes will do very well). Rub these up well together in a clean Wedgwood mortar. Add gradually, stirring constantly with the pestle, about 2oz. of the oil or fat you desire to emulsify. Work up into a smooth paste. Now add, little by little, working the pestle with a circular motion all the time, about one pint of water. This will give a beautiful milk-like emulsion.
S. Bottone.

[75466.]—**Oxidising Silver.**—By "oxidising" I presume you mean darkening, which is not oxidation, but caused by a film of sulphide. Dipping into *very weak* solution of ammonium sulphide will do this.
Sm.

[75466.]—**Oxidising Small Silver.**—Immerse the articles in a hot solution of ammonium sulphide, and, when dark enough, rinse them with water. The coloured film is sulphide—not oxide—of silver.
J. T. M.

[75469.] — **Mullein — Charcoal.** — Verbascum thapsus is the botanical name of mullein, a coarse, upright plant, growing wild in Europe, 3 or 4ft. in height, by roadsides and in waste places, but attaining 6 to 8ft. in the temperate parts of India; was used by the old herbalists as a narcotic, and its seeds for poisoning fish; has long ago been rejected by our Materia Medica as useless, though the French investigator, Feé, contributed an article on the Verbascums, an extensive genus. Charcoal is a vegetable carbon, its quality greatly dependent on the material from which it is prepared. Willow charcoal is preferred in the manufacture of gunpowder. As a forge fuel I have never been able to obtain it in England, but used to make my own in the forest-clad parts of India, where material could be got for the cutting. At Sheffield you could soon find out the right stuff. I discovered accidentally that cocoanut shell subjected to red-heat in a covered iron receptacle and allowed to cool down makes a very hard silicious carbon for polishing purposes. The favourite fuel of Indian artisans is charcoal of the hard-wooded Acacia Arabica; but I found a number of other trees quite as good—perhaps elm or alder would suit you.
Eos.

[75469.]—**Mullein—Charcoal.**—This handsome wild flower, 2ft. to 4ft. in height, grows profusely in the Forest of Dean, wherever the limestone formation crops up, or wherever a calcareous débris occurs. The great Mullein blossom is similar in colour and size to a primrose. As to charcoal, the oak loppings, &c., throughout the Forest of Dean and Monmouthshire are carbonised in iron boxes or ovens, the gases or aqueous products resulting from the destructive distillation process being condensed and utilised as by-products. Amongst them acetate of lime happens to figure highly as one of the curative agents in homœopathy, while charcoal itself, an impure (chemically speaking, that is) form of carbon, *rendered dynamic* (of force or power) by trituration with a non-medicinal medium, has, during the 50 years which have elapsed since the great therapeutic philosopher's death—i.e., Hahnemann, of all other drugs sustained the truth of his immortal writing, notably his "Chronic Diseases: their Specific Nature and Homœopathic Treatment" (Balliere, King William-street, Charing Cross), a five-volume work translated from the German by the late Dr. Hempel, of New York, in 1846. (For an explanation of the phrase in italics above see No. 22 of the League of Homœopathy pamphlets, "How can such Small Doses have any Curative Power?")
The Lydney Dispenser.

[75471.]—**Roller.**—Yes; beech-wood will do. Have the first-quality, and well seasoned. J. C.

[75470.]—**Polarisation of Light.**—The rhomb of iceland spar splits up the beam of ordinary light into two rays of plane polarised light, whose planes of polarisation are at right angles to each other. For the sake of clearness let us suppose that in a given case the vibrations of one ray are north and south (A), and those of the other ray east and west (B). A Nicol prism will only transmit rays vibrating in a single plane. If the prism be held so that this plane lies east and west, then the ray B will pass, and A will be stopped. If the prism be turned through a right angle so that the plane lie north and south, then the ray A will pass, and B will be arrested. Suppose now the prism to be midway between its two positions above mentioned, then each ray of polarised light will penetrate with diminished intensity. Each ray will, in fact, be resolved into rectangular components, one of which will get through the Nicol, and both dots will be visible at once. The fact that with a beam of ordinary light the Nicol gets rid of what is called the ordinary ray, has nothing to do with the observation.
Wm. John Grey, F.C.S.
Analytical Chemist, Newcastle-on-Tyne.

[75473.]—**Salt Bath.**—A compound called sea-salt is sold by grocers and chemists. The chief ingredient of sea-water is sodium chloride, or common salt. In preparing a bath use rock salt. This is the analysis of sea-water given by Roscoe and Schorlemmer of water from the Irish Sea, summer of 1870 (see *Challenger* reports). A thousand parts by weight of sea-water contain:

Sodium chloride	26·43918
Potassium chloride	0·74619
Magnesium chloride	3·15083
Magnesium bromide	0·07052
Magnesium sulphate	2·06608
Magnesium nitrate	0·00207
Calcium sulphate	1·33158
Calcium carbonate	0·04754
Ammonium chloride	0·00044
Ferrous carbonate	0·00503
	33·85946

Traces of magnesium carbonate, lithium chloride, and silicic acid. The total quantity of salt varies, the maximum being: North Atlantic Ocean, 37·37.
No Sig.

[75474.] — **Clock-Making.** — I have seen an arrangement for turning between centres in a watchmaker's mandrel which answered fairly well. A circular brass plate, having a tapped hole in centre, into which various chucks were screwed and provided with a carrier, was centred by means of a pump centre, and firmly fixed in the dogs. This formed a kind of temporary lathe head, and, provided no great pressure was put upon it, remained quite true. This would answer for small clockwork if used very carefully. Another, and better, way would be to use a large pair of turns for pinions, &c., similar to watch turns.
F. J. G.

[75476.]—**Dubbin.**—I have frequently made and used a mixture of equal parts of beeswax and linseed oil boiled together and applied to the boots, which have been previously warmed. I have found this to answer exceedingly well. S. G. B.

[75476.]—**Dubbin.**—1. A dubbin may be made of cod-oil and tallow melted together in equal proportions. 2. Old boots that have become hard may be softened by applying castor oil.—Spon's "Workshop Receipts." 3. Linseed oil, 1 pint; mutton fat and beeswax, ½lb. each; boil in a pipkin, apply twice with a brush at milk-warm heat; will make boots waterproof.—Spon's "Workshop Receipts." 4. Fill the boots with oats to absorb moisture, and anoint with deer suet; where this cannot be got cobbler's-wax (probably small quantity meant?), melted with Russian tallow.—Keene's "Practical Fisherman." The sort of oil, &c., used is of less importance than that the boots should never be dried by a fire, never put away wet, and never left for a long time together without attention.
H. S.

[75476.]—**Dubbin.**—Get well-made, hand-sewn boots; wear occasionally in dry weather till they become shaped to the feet; then give the boots a good dressing with the following:—Take 5lb. best tallow, 1lb. best beeswax; cut up into small pieces and melt together slowly; then add a tablespoonful of Norway tar, and allow to cool. When required, cut a small piece and melt, and give the boots a good dressing, rubbing well into the leather by the aid of a short, stiff brush. I have been a keen grouse-shooter for 35 years in all weather, and do not know the discomfort of wet feet. Do not use the boots for three months after the first dressing—it will pay, in the long run, not to do so.
T. R. Clapham.

[75477.]—**Electric Light: Cost of Installation.**—The cost of a complete installation for eight lamps of 50c.p., each taking 1·6 ampères at 105 volts, will be roughly as follows:—

	£	s.	d.
Engine (Otto gas) 2H.P.	£123	0	0
Dynamo, 13 ampères, 110 volts	36	0	0
8 lamps, 50c.p., 105v., 1·6a., at 5s.	2	0	0
8 holders at 1s.	0	8	0
8 brackets, or pendants, at 5s.	2	0	0
Cable, leads, and branch wires (say)	3	0	0
Main switch	1	0	0
8 small switches at 2s. 6d.	1	0	0
Safety fuses (two) at 4s. 6d.	0	9	0
Ammeter and voltmeter at £3 each	6	0	0
	£144	17	0

S. Bottone.

[75479.]—**Slide-valve Setting.**—If "Engine-Driver" has eccentrics fixed right for lead on crank-shaft, then to set valve put valve in spindle, and after placing in steam-chest, couple up to quadrant, and both rods are ready for working. Now with reversing lever put in forward notch, i.e., that one mostly used in expansive working, turn crank-shaft until valve is at one end of stroke. Note the amount of port opening, then turn until valve is at opposite end, and compare that port opening with the former. If both are equal, valve is set right; but if, say, front port opens ¼in. and back port ⅜in., then halve the difference and place a liner $\frac{1}{16}$in. between the butt end of forward eccentric-rod and strap; or if valve-spindle is adjustable, you must lengthen it by that amount, and vice versâ if front port opens ⅜in. and back ¼in., rod requires shortening or spindle adjusting the same $\frac{1}{16}$in. This will equalise ports in forward motion. Now reverse lever to proper back notch and work as before, with this exception that any required alteration must be made through backward eccentric rod alone, the valve-spindle not being altered, of course. As regards more opening on one side of valve than other, some locomotives are set with valves opening $\frac{1}{32}$ less on back ports to allow for engine sinking down after being at work some time, when position of valve, &c., is moved nearer the front end: but this does not apply to your case.
New Cross, S.E. A. Marriott.

[75482.]—**Best Arrangement of Zincs and Carbons.**—Your best plan will be so to cut your plates as to enable you to make up a number of cells equal to half the voltage of the lamp you intend to use. Say your lamp is one marked 24 volts, make up 12 cells.
S. Bottone.

[75484.]—**Milking Machines.**—Yes. A good illustration of the folly of *a priori* conclusions, and like M.D.s' writings in making a disease, and its nature and (of course) cure to fit their ideas of what it should (and therefore must) be. I remember a milking machine, a simple silver tube inserted up the cow's teat, through which the milk flowed out freely, having caused quite a *furore* amongst the dairy farmers; but the consequent inflammation of the cow's teat soon rendered that invention obsolete. Then again came the pneumatic suction machine, to be followed (so I hear) by numerous calamitous consequences—amongs others, of drying the cows in some instances, of causing an excess of watery per-centage in the milk in others, and a consequent occupation for some vampire of a city, &c., and one of the great unpaid magistrates (those ardent lovers of power over their less honoured (?) fellow creatures, and for some city analyst to whom a wholesome (as to his pocket) lesson would result if he were to become, *pro temp.* a dairy farmer; then he would find that the analysis would show that the milk from one and the same cow varies during the current year as much as the genus *homo* male and especially female vary in common sense.
The Lydney Dispenser.

[75488.]—**Screw Cutting.**—Wheels to cut $\frac{19}{32}$in. pitch, with ½in. leading-screw, are spindle 95, screw 80. If you cannot by an means get 95 on, you might use $\frac{47}{80}$in. or $\frac{19}{32}$in. if it is worth while providing special wheels for the job. The square threads found to be thin at bottom may have been made so by thinning with a tool that has too much clearance backwards.
British Bulldog.

[75491.]—**Speed Indicator.**—A few years ago I was troubled with variable speeds caused by throwing off and on heavy machinery. The dynamo in use was, and is now, a Weston, with automatic cut-off; at times the speed would be so low that current was entirely cut off from plating vats; at other times machine went ahead much too fast. There was fixed in the shop extra shafting with cones for altering speeds, but this did not give entire satisfaction, for at times the alteration in speed would be so gradual that I should not notice it; this caused me to contrive an indicator of some sort. I made a small pair of governors, into which a movable jointed lever was fastened, carrying a comb; this geared into a broad toothed wheel fixed to a long shaft, which had fixed at the end a clock-wheel 1½in. diameter, gearing into ½in.; on the spindle of this ½in. wheel a hand or pointer was placed, the whole inclosed in a box 6in. by 9in. A dial marked in degrees on the outside of box, always by the aid of pointer, gave correct reading of speed. This was driven from the shaft of dynamo; but now having other dynamos, it is driven from the shaft that drives dynamos, and still works well.
S. Robert Bonney, Electroplater, &c.

[75492.]—**Cement.**—For cementing fine building stones which have become broken in working, masons use a solution of shellac in naphtha, which is very strong, and might suit "C." N. S.

[75496.]—**Coil.**—Yes, you can use d.c.c. wire, but silk-covered is preferable. Two layers of 16 d.c.c. wire (about 1lb.) will be required. Tube, 7in. by 1in. diam. Sections unnecessary. You must fit a 50-sheet condenser. Probable spark ½in. Large coils are fitted with two primaries to suit the battery power in hand.
F. Askew.

[75496.]—**Coil Dimensions, &c.**—To Mr. Bottone or F. Askew.—Cotton-covered wire not so good as silk for two reasons:—1st, insulation not so good; 2nd, covering much coarser, so that coils lie further from each other, and from iron core. 1lb. No 24 B.W.G. will do for the secondary of a coil giving ½in. spark. The tube should be 1½in. outside diameter, 8in. long clear between the heads; diameter of heads, 4½in.; primary, No. 16, two layers, about 1lb. The insulation will be better if you use a vertical division of ebonite between the two sections, and if you go to this expense, it would certainly be worth while to use 1lb. No. 38 or 40 silk-covered wire, which can be procured at 12s. 6d. per lb., and will give a 1in. spark, while the No. 34 cotton will cost 4½d. per lb. (so that you will only save 8s. 6d. on the entire coil), and give only ½in. spark. I have never known two primaries to be used in any induction coil, so am unable to answer the question. S. Bottone.

[75493.]—**Resistance of Iron Wire.**—The following is a table of the reistance of soft iron wires of different B.W.G. from 8 to 30. Any other gauges can be calculated by multiplying the resistance of the corresponding gauge of copper wire by 5·3149.

B.W.G.	Ohms per lb.	Yards per lb.	Gauge carrying capacity.
No. 8	·0265	4·332	7·5 ampere.
„ 10	·0658	6·84	5·0 „
„ 12	·1510	10·26	3·0 „
„ 14	·4311	17·10	1·6 „
„ 16	1·062	27·36	1·0 „
„ 18	3·349	51·30	0·5 „
„ 20	10·629	91·20	0·3 „
„ 22	29·231	136 80	0·2 „
„ 24	79·723	233·70	0·15 „
„ 26	164·761	348·84	0·07 „
„ 28	374·0	513·35	0·02 „
„ 30	756·0	735·30	0·01 „

S. Bottone.

[75497.]—**Magnetic Oxide.**—You can make it by burning iron in an atmosphere of oxygen; but it will be cheaper to buy the native ore. Sk.

[75497.]—**Magnetic Oxide.**—Make a solution by dissolving 2oz. of iron sulphate in 2 pints of distilled water, and mix it with 5½oz. of solution of persulphate of iron. To this mixture add 4 pints of solution of soda, and stir. Boil; allow to stand two hours, stirring occasionally; collect on calico, drain, wash until free from unconverted sulphates, and dry at a temperature not exceeding 46·8° C.
H. Ebbage.

[75497.]—**Magnetic Oxide.**—Dissolve 9oz. of ferrous sulphate in water, and divide the solution into three equal portions. To two of these in a basin add 1oz. (by weight) of conc. sulphuric acid, and heat; add nitric acid, drop by drop, until it causes no further dark coloration. Heat for some time to drive off nitrous fumes, and then mix with the third portion. Dissolve 3oz. of caustic soda in water, and pour it into the mixed iron solution heated. The black precipitate is ferroso-ferric hydrate. Filter and dry. Director R.R.L.

[75497.]—**Magnetic Oxide of Iron.**—There are three modes of preparing this. 1. By heating iron to whiteness and hammering. The scales which come off are the substance in question. 2 By passing a current of steam over iron borings or turnings heated to redness. 3. By precipitating a mixture of ferric and ferrous sulphates dissolved in water by means of liquor ammoniæ. The solution of sulphates must be hot. A green precipitate falls, which, when washed and dried, is the magnetic oxide. S. Bottone.

[75497.]—**Magnetic Oxide.**—Put into a 10oz. evaporating dish 2oz. of sulphate of iron, 3oz. of water, and 1½oz. fluid drachm of sulphuric acid, and apply heat until the salt is dissolved, then add 1½ fluid drachm of nitric acid, and boil gently until sudden effervescence occurs, and the black liquor turns red. Dissolve in another dish 1oz. of sulphate of iron in 1½oz. of water. Mix the hot liquors and pour them into an excess of solution of ammonia; boil a few minutes and set aside for an hour; collect the precipitate on a filter, wash with water, and dry it at a heat not exceeding 150° Fahr.
J. T. M.

[75498.]—**Electric Lighting.**—Suppose you had three arc lights on wharf, each taking 8 ampères at 30 volts pressure, and 8 incandescent lamps in house, each taking 1 ampère at 50 volts. These would require a compound-wound dynamo capable of supplying 32 ampères at 50 volts. Cost of dynamo, say £36; vertical engine and boiler, 3 H.P., £67; three arc lamps at £8 each, £24; eight incandescent lamps at 5s. each, £2; brackets, or pendants, for lamps at 6s. each, £2 8s.; one mile go-and-return cable, seven strands No. 20, vulcanised-rubber and lead-covered, £120; branch wires and fixing, £5; ammeter and voltmeter, £6; switches, £3; total, £273 8s. Putting the price of steam coal at 16s. 6d. per ton, and reckoning 8lb. of coal per horse-power per hour, we may call the expense for fuel 1d. an hour. This, at six hours per day, makes nearly £9 per annum. Add to this £52 for stoker's wages and £27 for interest on capital and depreciation; we get £88 per annum as the cost of three lights of 1,000c.p. on wharf, and eight lamps of 30c.p. in house (see also reply 75477). S. Bottone.

[75502.] — **Charging Constant - Current Battery.** — These are simply sealed Leclanché cells. Melt off the pitch to get at the elements. Then take out the zincs and carbons, also the broken carbon and dioxide of manganese. Wash out the cells thoroughly, and let them dry. Wash the zincs, and replace any that are badly corroded. Wash the carbons for several hours in many changes of water; dry. Wash the broken carbon and manganese, add fresh manganese. Replace the elements (with porous cells or canvas, whichever may have been used), and fill the cells three-quarters full of salammoniac solution, 1½oz. to the pint. Seal the cells with pitch, leaving the vent-holes as before.
S. Bottone.

[75503.]—**Extracting Zinc from Lead.**—If the lead is kept at a red heat for a short time, all the zinc that may be in it will pass away in vapour, burning with a bluish-white flame on the surface of the lead. S. G. B.

[75506.]—**Phonograph Motor.**—The slight difference in size is not enough to seriously affect the working of the motor. Get all you can on the armature. In the replies to queries 75417 and 75435, $\frac{3}{10}$in. should read $\frac{3}{16}$in., and $\frac{1}{10}$in. $\frac{1}{16}$in. respectively. W. Gillett.

[75508.]—**Medical Coil.**—Have you wound the wire in one direction? Does current leak to core? I cannot say further what is wrong without examining; but if you send it to me, carriage paid, I will correct it for you.
14, St. Paul's-road, Southsea. F. Askew.

[75510.]—**Model Electro-Motor.**—The cause of the bumping sound that you hear when the rotary poles pass before the fixed poles is that your frame has not sufficient rigidity, so that the magnetism actually causes them to touch. This should not be. You will gain nothing by making the rotary magnet four-poled instead of two, if you couple up as at present. But if you wind all four poles in exactly the same direction, and having prepared a four-part commutator, you connect the end of the one coil to the beginning of the next, and solder each of these four pairs to the four separate sections of the commutator, taking care to place the brushes at right angles to the positions they occupy in your present motor, you will gain the advantage of the machine being self-starting. A flywheel will not improve matters. S. Bottone.

[75513.]—**Casting in Lead.**—Having made a variety of small castings in this and other easily-fusible metals, I know of no better plan than the following:—Obtain a piece of flat wood, at least 1in. thick, and large enough to admit of a hole 3in. diam. being made through it; (2) provide another piece of the same size, only it need not be more than ½in. thick, to serve as lid; (3) a piece of flat glass, the thicker the better; (4) a straight pen-holder—take off the steel pipe, and knock a pin in the end as nearly in the centre of circumference as possible, afterwards cutting off the pin's head; (5) provide a few paper tubes, 4in. long, and large enough to admit of the holder being moved freely through it; lastly, a pennyworth of best whiting—a sufficient quantity of this (about three table-spoonfuls) must first be scraped into a clean saucer, and put into the oven to get thoroughly dry; well knead afterwards, and use cold. You then proceed to mould and cast as follows:—Place the piece of glass on a firm table; then lay your pattern wheel, *flange edge downward*, upon it; next get the piece of wood with hole in it, and place it on the glass and over the pattern—the latter should be in the middle of the hole; then proceed to gradually fill up hole with the whiting, well ramming down after each addition. When the hole is half-full, take one of your paper tubes and stand it on the whiting, and as near the centre as possible; then fill up hole, pressing well down with your fingers to keep the tube firm; now take the pen-holder and gently slide it down the pipe (pin end first, of course); then press it carefully until you feel the pin grating upon the pattern; now pull it out, lift up the mould, and give it a slight tapping, in order to make the pattern drop out; then turn it over and give another tap, to clear the tube of any loose whiting which may be in it, and give a good blow with your mouth over the small hole made by the pin, in order to clear that also; lastly, place the mould down upon the other piece of wood, the surface of which must first be well rubbed with whiting. It is also advisable to place a few weights upon the mould to keep it down while pouring in the molten metal, which it is now ready to receive, and which should be poured in quickly without a break, until the tube is quite full. If you should require further details, write again.
Practical Caster.

[75516.]—**Chromic Acid.**—Mix 50 parts of distilled water with 42 parts of sulphuric acid, and in this mixture dissolve 30 parts of potassium dichromate. Set aside, and, after twelve hours, decant from crystals (acid sulphate of potassium). Heat to 85° C., and add sulphuric acid 15 parts, and sufficient water to just redissolve any crystals of chromic acid that may have formed. Allow to cool, collect crystals, drain, and dry on porous tiles, in hot air at 57·8° C. H. Ebbage.

[75517.]—**Scrap Copper.**—Boil the copper scrap in a mixture of equal parts of sulphuric acid and water, when the copper will be seen to dissolve. This, when evaporated, forms the crystals of sulphate of copper. S. G. B.

[75517.]—**Scrap Copper.**—Sulphate of copper is made by dissolving copper oxide in sulphuric acid. This copper oxide is the scaly copper. You may dissolve the copper scraps by heating to a black colour, and plunging into the sulphuric acid from time to time. This is rather tedious work; but you will soon find the acid become green. If you do this, keep a distance off while plunging the hot copper into the acid. I should rather prefer selling the copper and buying copper sulphate than troubling to prepare it myself.
S. Robert Bonney, Electroplater, &c.

[75517.]—**Scrap Copper.**—Put into an earthenware jar 1lb. of scrap, seven pints of water, and 24oz., by weight, of sulphuric acid. Set the jar in a warm place under a chimney, and add from time to time ½oz. of nitric acid, until the metal is nearly dissolved. Then without removing the undissolved copper, evaporate the solution to about half and set aside to crystallise. For tinker's work I should think crystallisation might be omitted. J. T. M.

[75518.]—**Collecting Leaves.** — An "herbarium," or collection of dried leaves, is a most perishable and bulky affair, as I know from experience. "Nature printing" is far more portable and convenient. In India I once saw two large books of printing-paper, filled by a lady. I, too, covered the pages of a broad album with these pleasing and lasting specimens of foliage, most useful to the flower painter and designer of patterns in embroidery, carved works, and modelling. The art is soon acquired, and the materials cost but little. After a short practice, the leaf-prints will be very distinct and durable. I recommend the vine and oak for first trials. "Skeleton leaves" are very troublesome subjects for manipulation. In China they are prepared, with butterflies painted on their surface, the Ficus religiosa being the favourite. Eos.

[75522.]—**Power and Heat Calculation.**—Isothermal expansion is hyperbolic. The work done in compressing 10,000c.ft. of air, if performed in one minute upon air at 14·7lb. pressure (P_o), will be—

$\frac{P}{P_o}$	Ratio expn. r	$\frac{\log_e r}{r-1}$	P_m lb.	Space ft.	Ind. H.P.
$\frac{21·7}{14·7}$	1·4762	·8176	3·042	3226	42·82
$\frac{24·7}{14·7}$	1·6803	·7626	4·136	4049	73·08
$\frac{27·7}{14·7}$	1·8844	·7162	5·139	4693	105·24

And the rise in temperature in Centigrade units, in compressing 1,000c.ft. of air at 50° Fahr. (T_o = 510°) adiabatically, where T = $T_o \times r$, will be—

$\left(\frac{V_o}{V}\right)^{·408}$	Ratio r.	T.	$T-T_o$.	$F° \times \frac{5}{9} = C°$.
$\frac{1000}{·125}$	39·12	19,954°	19,444° =	10,802° C.
$\frac{1000}{·25}$	29·49	15,048°	14,538° =	8,076° C.
$\frac{1000}{·5}$	22·22	11,334°	10,824° =	6,013° C.
$\frac{1000}{1}$	16·75	8,542°	8,032° =	4,462° C.

Liverpool. W. S.

[75519.]—**Mnemonics.**—Before paying heavy fees I should advise "J. S." to purchase Bacon's "Guide to the Improvement of the Memory," price 1s., published at Pitman's, Amen-corner, E.C. This work did me more good than any of the gentlemen named did. J. W.

[75519.] — **Mnemonics.** — I know nothing of Loisette's method, but I learnt Stokes's system under Mr. Stokes, some years ago. It is not much use for learning things permanently, but as an aid to remembering things temporarily it is first-rate. I used it once at an examination in military drill: I did not know much about drill, and took very little interest in it, but I did want to pass, and to pass well. So I memorised all sorts of rubbish out of the drill-book artificially, and passed first, although, as far as real knowledge was concerned, I was the worst candidate in the room. Of course, I forgot it all again directly, and at the end of a week I could not have drilled a squad to save my life. Wm. John Grey, F.C.S.
Staff. Sergt. 5th V.B. Durham Light Infantry.

[75519.]—**Mnemonics.**—If "T. S." has a bad memory, no system of mnemonics will be of much use to him. There are many systems, but all are based on the same principle, and practically only enable a person to remember dates, lengths of rivers, heights of mountains, and numbers generally. As long as the jargon of some, the outlandish sentences and disjointed words of others, run correctly in his head, he will be able to recall the dates and other particulars they express. Any one plan may doubtless be useful in passing an examination, but if not kept up, soon fades from the mind, and is forgotten. Before expending any money in lessons, I strongly advise "T. S." to read "All about Mnemonics," by Middleton (Simpkin and Marshall), price 1s.; Loisette's "Art of Never Forgetting, compared with Mnemonics," by F. Appleby (Pitman, 20, Paternoster-row), price 6d. There are many works on the subject; but these two will give him a clear, broad, and general idea of the differences between the rival systems, and enable him to judge which is the most suitable to his wants. G. G. B.

[75524.]—**American Organ.**—See No. 1186, Dec. 16, 1887, p. 372. J. C.

[75524.]—**American Organ.**—This is rather a large order for an amateur to attempt. I am afraid he will not be able to get all the information he will require from any work on the subject. He will find that materials alone for such an instrument will cost many pounds, and perhaps the organ would not give him satisfaction when finished. Far better to begin with a small organ first, as it requires a great experience to make a two-manual and pedal-organ satisfactory. J. Schofield.

292, Stubbins, near Manchester.

[75524.]—**American Organ.**—You can have soundboards made to any desired specification. I know of no work on the subject of American organ-making, but instructions appeared in Vol. XXVI. of the English Mechanic for making an organ with 2½ rows of reeds, if I remember rightly. These instructions will give "Four Years' Subscriber" a good insight into the ordinary construction of American organs; but, of course, since these instructions were written many great and important improvements have been made, and, needless to say, most (if not all) of these improvements have been patented—and right that they should be, for if any man goes to the expense and trouble of effecting any improvement, that person alone deserves to have the full benefit, for the trouble he may have taken. I am willing to answer any question in relation to the subject, providing it will benefit the readers who are interested in the matter. Specifications are numerous, and may be decided on according to taste. What one person would consider a good specification another would not. If "Four Years' Subscriber" knows so little of organ construction as he acknowledges, I think it hardly safe to venture such a large undertaking, unless he can secure the assistance of an experienced man. Such assistance would necessarily incur some expense. Practical Organ Builder.

[75527.]—**Charging Accumulators.**—Impossible. What you propose is impracticable. F. Askew.

[75527.]—**Charging Accumulators.**—You cannot charge an accumulator by an alternating current. A lamp in circuit does not reduce the alternations; it reduces the current proportionately to its resistance. S. Bottone.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75082. Turning Eccentrics, p. 534.
75049. Dynamo, 534.

75222. Leyden Jars, p. 46.
75233. Folding Mètre Rules, 46.
75237. Photographic—Blue Prints, 46.
75238. Testing Rape-seed Oil, 46.
75244. Catenary Curve, 46.
75249. Japanning Round Wire, 46.
75250. Japanning, 46.

Cutlery Exports to the United States.—The quarterly return of Sheffield cutlery export to the United States was issued recently, and again a large falling off is reported, owing to the injurious effects of the M'Kinley tariff. The value during the last three months was only £29,364, as compared with £74,970 in the corresponding period of 1890. This, however, is hardly a fair comparison, as the exports a year ago were above the average, owing to the despatch of a heavy amount of goods to anticipate the imposition of the heavier dues. A fairer comparison is with the third quarter of 1889, when the value was £59,207. The decline in Sheffield cutlery business with the States is, therefore, fully 50 per cent.

QUERIES.

[75529.]—**Artificial Foot.**—I should be obliged if any fellow reader would tell me which is the best make and probable cost of above? The person requiring it has had his foot amputated about 2in. above ankle.—E.A.A.

[75530.]—**Mould.**—Having found some hairy-looking substance growing on a lime-washed wall, I am curious to know what it is. In appearance it is much like a tuft of glossy black hair. The hairs are about 5in. long, the ends of which are covered with little black projections, which look to me like seed-pods. If anyone can give name, &c., it will oblige.—E. A. A.

[75531.]—**Electric Light.**—Having a gig in which I have to drive every night to inspect a mill of which I have charge, I am greatly plagued by the candles, which, though of the best quality sold for the purpose, owing to the jolting of the trap on the bad roads, often go out, and leave me in considerable danger of collision with men returning asleep from an adjacent market. I would be glad to know if I could light my gig lamps by electricity generated by a battery of dry cells carried in the gig? Is this practicable? and about what would battery, wire, one switch, and two lamps cost? Would like two 10-candle lamps, but would be satisfied with less if this is too much to expect—say even 2 × 1 candle. The light would only be required one and a half hour each night.—Lux in Tenebris.

[75532.]—**Hydrometer.**—Could some reader of "E.M." give me a reliable method of grading specific gravity hydrometers? I have made the glass part, but do not know how to grade them to indicate the specific gravity of liquids.—Ohm.

[75533.]—**Alcohol-Proof Cement.**—What cement may be used to fasten the metal top of a dram-flask to the glass which will securely hold the same, and resist the action of brandy and similar liquors?—H.

[75534.]—**Printers' Roller Composition.**—Being largely employed in the erecting, repairing, and running of large and swift printing machines, and occasionally finding a difficulty in getting the rollers to stand the high speed in very hot rooms, I shall be glad if any of your readers, having overcome a like difficulty, would give a recipe for a good and tough compo. I prefer to make in preference to the patent articles.—Rotary.

[75535.]—**Detached Retina.**—Is there any treatment, operation, or cure for a "detached retina"? Mine is in the right eye. The light is not entirely obscured, but cannot distinguish objects plainly. I have had the trouble for the last 12 months. I am informed that it is caused by a clot of blood getting between the retina.—John Sohl, Pharmacist and Chemist, N.W. Cor. Fayette and Stricker streets, Baltimore, U.S.A.

[75536.]—**Condensing Steam-Engine.**—Will one of "ours" kindly give me a sketch of an atmospheric engine of 1½H.P., and a few words of explanation?—Vulcan.

[75537.]—**Wool-Winder.**—Will some kind reader of the "E. M." please give me a design and the construction of a wool-winder, one to stand on the, table and wind the wool into balls?—Mad Cap.

[75538.]—**Fire-Lighters.**—I beg to ask for information respecting fire-lights made from sawdust or wood shavings and rosin. I wish to know of any solid or liquid to improve the quality of rosin now used. Oil will not do. I want some very cheap material to mix with the rosin used; oil lubricates the rosin, and will not allow it to set.—One in a Fix.

[75539.]—**Switch-Board.**—Should I feel greatly obliged by sketch of connections and hints for making switch-board, with ringing key, so that weight of receiver will alter circuit from ringing (separate bell) to speaking.—Arrow.

[75540.]—**Osbo-Premier Battery.**—I am at present lighting an incandescent lamp by means of a bichromate battery; but I find it is expensive to work, needs recharging at short intervals, and will not give a constant current. In the description of the Osbo-Premier battery which appeared in the English Mechanic of July 31, this was claimed to be cheap, to run for a long time without recharging, and to give a constant current. Will any reader who has tried both batteries kindly say how they compare on the points named?—W. S.

[75541.]—**Piano Sound Subduer.**—I should be glad if any reader can tell me how to make a simple contrivance to deaden the sound of my piano while I am hum-drumming away at exercises, to the evident discomfort of the inmates and the annoyance of my neighbours? Some simple means that can be removed and replaced easily is most desired.—Chwareuwr.

[75542.]—**Silica.**—Wanted, a simple test for presence of silica in lime?—A. Ireland.

[75543.]—**Division by Seven.**—My text-book gives methods of finding whether numbers are divisible by 2, 3, &c., but makes no mention of divisibility by 7. Why is this omission? Is there no method? Can any reader of "E.M." enlighten?—Scholasticus.

[75544.]—**Thickness of Metal Pipes and Cylinders to stand Steam-Pressure.**—Will some practical man kindly give a reliable rule for finding thickness of metal in cast-iron pipes and engine cylinders, to withstand steam of 200 to 400lb. pressure. Molesworth's rule seems to bring the thickness out too light.—Pat.

[75545.]—**Tea Drinking.**—What can be taken before, with, or after tea-drinking, to neutralise the tannin and other injurious qualities of tea? Will someone please reply?—Istriel.

[75546.]—**Body Vermin.**—What lotion or ointment will rid the human body of vermin? It is an unsavoury question, but I ask it on behalf of an institution situated abroad, which is much troubled by receiving children in a shocking state of dirt from neglect. Washing is futile. Any reply welcomed.—Istriel.

[75547.]—**Theopathy.**—For what study or science does this word stand? and is such study or science comprehended by any other term?—Istriel.

[75548.]—**Best Incandescent Lamps.**—Cannot I get some incandescent lamps that will last as long, give as good light, and also act in other ways as well as Edison and Swan's, cheaper than theirs (5s.), as they are rather expensive, especially quantities?—Ernalf.

[75549.]—**Accumulators.**—Why is it necessary to use a glass cell for accumulators? Why would not a watertight wood box or iron tank filled with acidulated water and plates, as used for ordinary ones, do? An explanation of this from our electrical readers will much oblige an amateur.—Ernalf.

[75550.]—**Planing up Thin Stuff.**—What kind of stop do cabinet-makers use in planing up thin mahogany, say 1-16in. thick?—Cabinet.

[75551.]—**Moulds for Metal Casting.**—To Mr. Thomas Fletcher.—You will, I am sure, be conferring a favour on many readers of this paper if you will kindly give us some information respecting a method of making the above, which you described in the *Journal* of the Society of Arts a few years ago, and in which "fine loam" is mixed with petroleum oil and asbestos. It struck me as being just what amateur moulders and casters would be glad to know, and would appreciate, being so easily done. I have not myself been able to practically use the process in consequence of being unable to obtain any "loam" that would mix with petroleum oil, and I think what you intend by "loam" is not the material understood and used by moulders and founders under that name. If you would kindly make it clear what the material is which mixes with petroleum oil, all difficulty would cease, and the information would be a valuable acquisition to the "E. M." store of knowledge.—Brightonian.

[75552.]—**Phonograph.**—I have constructed a phonograph like the old form, inasmuch as the cylinder is turned by hand; but as in the "latest" the record is taken on wax, there is only one diaphragm, which is ferrotype, and instead of the needles being fixed on springs, they are screwed in a socket, which is soldered to the centre of the diaphragm. The recorder is made of steel, with a blunt point, while the repeater is glass, with a ball point. The diaphragm is 2¼in. in diameter; the needles are 1-16in. in diameter and ½in. long; the cylinder is 2½in. in diameter and 3½in. long; there are 19 threads to the inch on the axle. By revolving the cylinder at the rate of from 90 to 100 revs. per minute I get what appears to me to be a good record; but when I try to reproduce it, awful shrieks, accompanied by scratchy noises, issue from the funnel, and the needle seems to flatten the record down again. The wax I use is the ordinary paraffin, and it runs perfectly true when turned down by the cutting tool. I tried to get a reproduction from tinfoil wrapped round the wax cylinder; now, I certainly got a faint attempt at words from the wax about twice, but the tinfoil was entirely "off." I should feel it a great favour if any of your readers would help me out of my difficulty?—Robert Grocott.

[75553.]—**Waterproofs and Sea Water.**—I have a black Inverness waterproof which has once or twice lately been drenched with sea water, and now, when the coat is dry, it is covered with a mass of white patches—salt, probably. I have tried sponging with warm water, and also with a weak solution of ammonia, but without effect. Perhaps some reader may have had the same experience, and possibly have found a remedy. If so, I shall be much obliged if he will communicate with me through these columns?—R.T.R.

[75554.]—**Saturation.**—Will some practical reader kindly explain to an amateur what is meant by the point of saturation? Also how to tell a shunt from a series or compound-wound dynamo?—H. A. R.

[75555.]—**Ring Micrometer.**—Will anyone who has experience of it kindly state whether in actual use this form of micrometer gives a disproportionate amount of labour and trouble, and whether the calculations are practically very tedious? Chambers, in Vol. II. of his "Astronomy," p. 48, rather sneers at it (*more suo*) as only suited to the "German temperament." Has the double ring distinct advantages over the single-ring form?—Phi.

[75556.]—**Astronomical Watch.**—Are watches made showing sidereal time? If so, will anyone kindly say where I can hear of them? Is what is called a "deck watch" sufficiently accurate to be used with an equatorial? I am told a watch with "centre seconds" is usually not so good a timekeeper as the ordinary form. Is this so, and why?—Georgos.

[75557.]—**To "Sm."**—In question 75289, if the word "conductor" was changed into "non-conductor," what would be the effect?—Frictional.

[75558.]—**First Aid.**—There are many men who have not time or opportunity to attend ambulance classes who would, I am sure, be glad to know how to act in a case of emergency. Is there any book published on the subject? If not, a few illustrated lessons on binding up broken limbs, tying up wounds, staunching blood, &c., could be followed by anyone that has a rough idea of anatomy, and I think would be appreciated by a good many. Accidents will happen in the best-conducted homes, and if a doctor is not at hand it often ends seriously. We read very often about people getting poisoned by mistake or otherwise. If the symptoms of the more common kinds of poisons, with their antidotes, were known, it would at least be possible in many cases to give relief while someone went for the doctor. If the subject is suitable for the "Mechanic" I am sure there are many correspondents able and willing to give the advice asked.—G. Hargett.

[75559.]—**The Stars.**—Elsewhere Mr. A. C. Ranyard speaks of "the twelve brightest stars in the heavens." Will any reader acquainted with astronomy kindly give me the names of these twelve stars?—Thomay.

[75560.]—**Pin-Hole Camera.**—I saw a camera which had no lens, merely a minute hole, which acted as a lens on to sensitive paper. (1) What size should I make it? (2) What paper to use? (3) What length of time for exposure? (4) What distance away from object, and also whether the negative requires any fixing?—One in a Mud-Puddle.

[75561.]—**Telescopic Field.**—To "F.R.A.S." or Others.—If I get a field of 2° with power of 40 on a 2½in. telescope, 36in. focus, how much larger will the field be in a 4in. telescope, 60in. focus, with another eyepiece, giving also a power of 40 ?—J. W.

[75562.]—**Sounds at Sea.**—During the prevalence of the hot weather a few weeks ago, I was walking along the sea-front at Ostend, when my attention was attracted by a loud, resonant sound out at sea, resembling the discharge of very heavy artillery or thunder. As the atmosphere was clear, and there was a total absence of clouds, the sky being a bright blue, I deemed it impossible to be thunder, and inquired of a crowd of boatmen, who united in saying that it was caused by fogs out at sea. I afterwards spoke to a professional gentleman, a resident in the town, who informed me that the noise was not of infrequent occurrence in hot weather, and sometimes even in winter. The inhabitants term the phenomena "coups de brouillard." Can any of your readers explain ? The reports, I may say, occurred at pretty regular intervals nearly all the afternoon.—Ignoramus.

[75563.]—**Rain Gauges Recording.**—Will someone please give me full particulars of the interior arrangement of Crosley's recording rain-gauge, with a sketch of the actual working parts ? Also details of Yeates's electrical recording instrument ? I am told it is an improvement on Crosley's. Kindly mention, if possible, the names of several books containing the particulars asked for. What is the simplest, yet quite reliable, recording rain-gauge besides the side tube arrangement, which is apt to burst in frosty weather ? Any suggestions will greatly oblige.—An Old Mem. Soc. Engs.

[75564.]—**Safety Bicycles.**—Can anyone tell me of a safety fitted with apparatus for holding it upright, instead of being propped up against some wall ? I fancy I saw one some time ago in City ; but forget name and whose patent, if any. Should be obliged for a sketch.—Cyclist.

[75565.]—**Resounding Room.**—A village schoolroom 36ft. long, and 18ft. wide, and about 14ft. high to top of wall-plate, with ornamental queen-post roof, ceiled to rafters, resounds or echoes so as to have a very disagreeable effect. Will someone kindly suggest a remedy ? Could anything be affixed to beams to help it ?—E.R.S.

[75566.]—**Armature Winding.**—To Mr. Bottone.—Will you please say how I can best attach the insulating paper to the iron core of a large drum armature ? Should the shellac varnish be applied to the iron or the paper first, in order that it should adhere firmly ? Also how can I best secure the starting end of the binding wire when armature has been wound, as I have found that it has a tendency to slip over the mica on attempting to draw it tight ? I usually bend the end at an angle, and then wind the successive turns over it, bending the finishing end round a narrow strip of tin previously placed under the whole and bent over so as to lie flat on the outside of the binding wire. Is there a better way than this, as I cannot get it so tight as I could wish for ?—J. Edwards.

[75567.]—**American Organ.**—I have bought a new one with two sets of reeds (8ft. and 4ft). I find the tone rather coarse and reedy in the treble. Is there any easy way by which I could make the tone a little softer ?—M.

[75568.]—**Estimation of Lead as Sulphate.**—To "Sm." and Others.—In estimating the lead in brass, fusible metal, Britannia metal, &c., which of the following methods yield the best results. Method No. 1.—To the nitrate acid filtrate remaining after the separation of the tin oxide, add sulphuric acid, evaporate until the acid begins to volatilise, dilute with water, heat, and filter off the lead sulphate. Method 2.—Remove the excess of acid from the nitric acid filtrate remaining after the separation of the tin oxide, add excess of sulphuric acid, and twice the volume of alcohol. Allow to stand in a warm place, and subsequently collect the precipitated $PbSO_4$ on a filter.—Jayem.

[75569.]—**Medical Coil.**—I have a medical coil of seven strengths (supposed to be), which I got through the Exchange column of your paper. Since I have had it I cannot get a shock from it. In my opinion, it was only made as a three-strength one coil, or four at the most—which I intend to rewind. It has been wound with about No. 34 c.c. wire, which is a 3-in coil ; core, ½in. ; head of coil, 3in. If any of your readers will help—that is, to say what kind of wire and how much I am to put on, and what distance apart I am to put each strength (seven in number), that is to say, from commencement of winding to finish, and where I am to connect end of wire—to switch or terminal—you will oblige ?—One in a Fix.

[75570.]—**Enamelled Iron Plates.**—I have a large quantity of sheet-iron plates, or sheet-strips, enamelled on both sides. They have been used for outdoor advertisements. As they are of no use to me, is there any process known by which I can get rid of the enamel, so that I can use them for some other purpose ?—Adolphus.

[75571.]—**Dry Cell.**—I have several dry cells stamped as follows :—"Moorthamro Graef, Pile Seche, Brevetée, S.G.D.G., No. 82878." Will someone kindly tell me the voltage and life of this cell, and when run down, can they be recharged from dynamo ? I want to use them for lighting.—J. F.

[75572.]—**Limits.**—What is the value of $\frac{x}{a}(\sqrt[ax]{x}-1)$ when $x=\infty$, a being a constant ? $\frac{a}{x}$ becomes ∞, and $\sqrt[ax]{x}-1$ becomes 0 ; so that we get the singular form of $\infty \times 0$. Am I right in thinking that the value is ∞ ; or, in other words, that as x increases without limit, so the whole expression also increases without limit ?—B.

[75573.]—**Stable Fittings.**—I should be greatly obliged if any of your numerous readers could tell me of any particular stables where the floor of boxes and stalls has been laid level and paved with self-faced paving without drainage ? If so, is the result satisfactory, and is the consumption of straw greater ?—H.

[75574.]—**Astro. Eyepiece.**—Would "F.R.A.S." or some other reader tell me how to ascertain the focus of a Huyghenian eyepiece ? How am I to find the focus of each lens ?—Tyro.

[75575.]—**Model Screw Propellers.**—Would any reader please tell me what diameter of twin screw propellers will be suitable for a model 8ft. long by about 8in. beam ?—Ship.

[75576.]—**Camber.**—Will any of your many readers that have experience in the construction of iron girders girders kindly give me, fully, the usual process of setting out flange and web plates so as to get the required camber at centre—say for a girder 60ft. span, with a camber of 6in.—G. W.

[75577.]—**Small Furnace.**—Will any reader be kind enough to inform me if it is possible to safely construct a small furnace of bricks in the space occupied by an ordinary open grate ? And if so, would it be troubling him too much to ask him to sketch me one suitable for small metallurgical work. The space measures 3ft. high high (from the top of which leads the chimney), 2ft. wide, and depth about 1ft. 6in. or 2ft.—T. A. E.

[75578.]—**Paint for Iron.**—I am desirous of protecting some sheet-iron from acid fumes, &c., by some sort of paint that will stand a temperature not exceeding 250° C. (480° F.). Will some reader inform me of such, or put me in the way of obtaining the information ?—Director R.R.L.

[75579.]—**Buzzing Water Tap.**—Can any reader tell me cause of, and how to prevent, my water tap from making a harsh buzzing noise when turned half on ? It is the same with all pressures, and the sound travelling along the pipes annoys the neighbours. The water works inspector has examined it, but says the tap is all right—½in. service. There is no noise when full on.—Filius.

[75580.]—**Electric-Motor.**—To Mr. Bottone.—I want to make an electric-motor of fully 1 man-power. Will you kindly give me a sketch of best kind of field-magnet carcase, also particulars of dimensions in every way ? It is to be made entirely of wrought iron, and with a drum armature.—Amateur.

[75581.]—**Electric Light.**—To Mr. Bottone.—Will you kindly inform me what would be the cost of a water-motor, dynamo, and accumulator of sufficient power to work about four 10c.p. lamps, and, supposing I required twice the amount of power, would the outlay be just as much again, and would it be possible to work from house supply tap direct from the main ? Any information on the above will oblige.—J. E. B.

[75582.]—**Electrical Cylinder Machine.**—I have a cylinder machine with speed wheels in a massive brass frame, beautifully finished, but had no conductor to it. I have made one as directed in the "E. M.," with a 2½in. brass pipe with two 4in. diameter spherical brass balls insulated with a 1in. diameter glass rod on a mahogany stand, and can get no spark from it, although there is a plentiful supply seems to go on to it from the cylinder, as there is one sheet of blue flame leaves the cylinder and flies on to the conductor ; but yet if I put my finger near it I can get no spark, but if I hang a Leyden jar on to it, it will readily charge it ; but if I hold it ½in. away from it I get no effect. Could I get a better effect if I insulated the cushion or rubber, which at present is not insulated, but is worked in a slide on frame, if I were to connect a brass chain to it to lead on to the floor ? Also, should the cylinder be insulated from the frame, as there are two brass caps on end of cylinder and a steel rod goes right through the centre of it ?—A Puzzled One.

[75583.]—**Softening Rubber Washers.**—We have a quantity of rubber washers as used for steam-gauge glasses, which have become quite hard (we suppose through exposure to the air), the insides are slightly elastic, but outsides crack when bent. Can we soften these to render them fit for use ? If so, by what process ? M. and F.

[75584.]—**How to Calculate H.P. of a Cylinder.**—Would some engineer please say how I can get nominal H.P. of a cylinder, and much oblige.—Engineer.

[75585.]—**The Zodiacal Light.**—Would any of your correspondents kindly give me some information upon the autumn apparition of the Zodiacal Light ? If the Editor would kindly allow it, a rough outline of its shape would be very helpful. The particulars are :— 1. Over what constellations does it pass ? 2. What altitude does it attain from the horizon, and what is its width and shape ? 3. Is it as conspicuous in the autumn as in the spring ? How long before and after Sept. 23 may it be seen ? Will Nov. 1 be too late ? 5. Is two hours before sunrise too early for its appearance ? Is one hour before sunrise too late ?—H. Dowsett.

[75586.]—**Simplex Dynamo.**—I have a dynamo of the above type with ring armature wound with 8lb. No. 18 d.c.c. wire, and field is wound with 14lb. of No. 20 d.c.c wire, connected up as shunt. I want to light six 16c.p. lamps ; they are the Swan lamp, and marked 16c.p. 40 volts, and I find when I have them all in circuit they only come to a bright red ; but with only two on, it lights them to perfection. I should be glad to know the reason of that ?—F. A. G.

[75587.]—**To Mr. Gillett.**—Will you please describe in detail how to make the governor to work with motor of phonograph ? Would there be any advantage in making the armature much larger ? I think Mr. Edison's is about 5in. diameter, and I know it is worked by two single-fluid bichromates, each zinc exposing about 18sq.in.—i.e., 9in. each side. Will you also say how to attach a quick return motion ?—F. S. Sc., London.

[75588.]—**Heating by Steam.**—Will some one give reason for hammering noise in 1¼in. pipe round large room ? Also, is it absolutely necessary that water-level of boiler be under lowest part of return-pipe, as water does not circulate into boiler, though I have a reduced nipple to ¾in. bore, 2ft. from boiler and back-pressure valve ?—High Peak.

[75589.]—**Engine.**—I have small dynamo, will light two 16c p. lamps at 2,000 revs., am about to make horizontal engine to work same. Being in a fix as to proper dimensions, would one of "ours" be kind enough to give me length and breadth of cylinder, connecting-rods, &c., also diam. and weight of flywheel, or anything to same would oblige ?—B. W. B.

[75590.]—**Electrical.**—What c.p. incandescent lamp could be lighted from two zinc plates 10in. by 6in. by ½in. thick, carbon ditto ½in. thick, placing carbon in centre and using single-fluid battery ?—B.W.B.

[75591.]—**Organ Pipes.**—Will any one kindly give me scale to make two sets of pipes of 54 each, for a small organ ? I want them to give the sweet and soft tone, and be as small as they can be made to give a sweetness and that of flutes. This would be played separate or together. A few hints about the soundboard will oblige ; it will be put under the keyboard. It is for a room 12ft. by 12ft. If any one should say have a reed organ or harmonium, I have both.—J. C.

[75592.]—**Condenser.**—I should be glad if someone will give me the number of sheets of tinfoil and size for a condenser for a coil wound with two layers of No. 20 B.W.G. for primary and ½lb. 36 for secondary ?—C.

[75593.]—**Microphone.**—To Mr. Allsop.—Can the transmitter described last—page 143—be used minus the resistance-coil on a line already laid three-quarters of a mile long, battery power at each end, seven quart Leclanchés ? and would it have any advantage over the watch and Bell instruments now used ? I understand the Hunnings can be so used, and answer well—but for the patent.—N.N.

[75594.]—**To Mr. Bottone.**—I am much obliged to Mr. Bottone for his answer to my query, No. 75421. I evidently made a mistake, and said series, when I meant parallel, in reference to lamps. I can wind the armature, either ring or a drum, as it is hollow. Does not the drum give the best results ? If you will kindly tell me the gauge of wire and number of layers on armature and magnets to run the lamps in parallel, I shall be grateful ? I have room for four layers of wire on armature.—Fredk. Buxton, 14, Butterworth-street, Radcliffe.

[75595.]—**Precession.**—I should be greatly obliged to "F.R.A.S." if he would inform me whether the statement put forward by General Drayson with reference to the rate of precession is accepted by astronomers ? General Drayson states that the pole of the earth is capable of making a path—increasing or decreasing—round a point which is 6° from the Pole of the Ecliptic, so that, although the distance is 23° 27′ at present, it might become 17½° (about), and also 29½° (about). If this is not accepted, is it because of some error in calculation, or because of want of proof ?—J. D. H.

[75596.]—**Masons' Stamps.**—Will some kind reader tell me how masons' stamps are made, such as they stamp their tools with ? Are they stamped into another stamp, or are they cut with tools ? Any information how to make them will oblige.—Masons' Tool-smith.

[75597.]—**Iron Chuck for Brushmaker's Lathe.**—Will any reader kindly say if I can get, or make, an iron to receive and fix true any size brush-bit for boring purposes ?—Desideratum.

[75598.]—**Fan for Forge.**—Having a fan with an outlet opening to ½in. by 2in., I want to connect it to a portable forge which has a rose 2in. diam. full of holes ⅛in. diam., air to come up underneath. Would it do to make piping same size as fan opening—reduced to suit the rose—or shall I have to get a larger rose ? If so, would some reader say what size I shall want ? It is for small forgings.—W. C.

[75599.]—**Enamelling Bricks.**—Will someone oblige by giving recipes for enamelling or glazing—in white colour—a highly silicious brick—silica 70 to 85 per cent. ? Also by mentioning any good treatise on enamelling and glazing fireclay goods, and on stoneware, pottery, porcelain, and other kindred manufactures ?—Coal.

[75600.]—**Astro. Eyepiece.**—I have seen it stated somewhere that Herschel always used an eyepiece with a double convex lens for his highest power. Would "F.R.A.S." or some other reader state the advantages and drawbacks with such an eyepiece over the ordinary Huyghenian eyepiece for astronomical work ?—Orion.

[75601.]—**Furness Railway Co.'s Engines.**—Can any of your readers give sketch of the single-wheel tanks—5ft. 6in.—built in 1866 ? Also of their usual pattern with the boiler low down and high funnel ? If so they will oblige many "Southerners."—Sekon.

[75602.]—**Speed of Milling Cutters.**—I shall be obliged if someone will give a list of speeds for running these useful tools suitable for different metals and materials. A table showing the speed at periphery should be the simplest form, and useful to many readers of the English Mechanic.—Acier.

[75603.]—**Dynamo.**—To Mr. Bottone.—I have the carcase of a dynamo, Simplex type, made of cast iron, with armature 1¾ diameter, 3in. long, of drum type. Kindly tell me the number and size of wire to put on F.M.'s and armature, to get best possible result. —Anxious.

Coal-Gas as a Fuel.—Mr. Thomas Fletcher has issued a third edition of his "Coal-gas as a Fuel : a concise Guide to Fitters and Users." It contains much trustworthy information, derived from a lengthened experience.

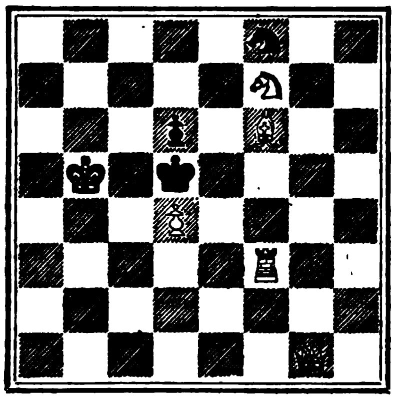
New Automatic Rifle.—A Chicago paper says :—The officers and soldiers at the Fort Sheridan range witnessed the testing of an automatic repeating rifle on September 10th. It becomes automatic by the utilisation of the gas produced by the combustion of the first cartridge fired. The gas escapes into a chamber, and acts on a piston that is set against a spiral spring, the recoil of which propels the piston back against a rod that sets the mechanism of the gun in motion, the empty cartridge being removed and replaced by a loaded one, also cocking the gun. This is done with so much rapidity that by pressing against the trigger the gun will discharge the nine cartriges that are required to fill its magazine in two seconds. The best record was eight shots in five seconds. Lieutenant Ingersoll is, however, enthusiastic in his commendation of the mechanism of the gun, and is satisfied that it will do all that is claimed for it. It is intended to apply the principle to heavy guns, for use in naval warfare, in propelling torpedoes and as a machine gun. The army board will investigate the merits of the gun at their meeting at New York.

CHESS.

All communications for this department must be addressed to "J. Pierce, Knollside, Yawl, Lyme Regis, Dorset."

PROBLEM MCCLXXVI.—By Philip H. Williams.

Black.



White. [6 + 8

White to play and mate in two moves.

Solution to 1274.

White.	*Black.*
1. Kt takes K P.	1. K-B 5 (*a*)
2. Kt-Q 6 (ch)	2. K-B 4
3. Kt mates.	
	(*a*) 1. R takes B (*b*)
2. Kt takes B P &c.	
	(*b*) 1. P takes B (*c*)
2. Kt takes P (ch).	
	(*c*) 1. Kt-R 4 or R moves (*d*)
2. Kt takes P (B 7), (ch), &c.	
	(*d*) 1. Kt or B takes P (*e*)
2. Kt takes Kt or B (ch), &c.	
	(*e*) 1. Kt-B 8 (*f*)
2. Kt-Q 6 (ch), &c.	
	(*f*) 1. Q P takes Kt (*g*)
2. Q-Q 6 (ch), &c.	
	(*g*) 1. B P takes Kt (*h*)
2. Q takes P (B 8) (ch), &c.	
	(*h*) 1. P-Kt 5 (*i*)
2. Q-K 8 (ch), &c.	
	(*i*) 1. Kt-B 4
2. B takes P (ch), &c.	

NOTICES TO CORRESPONDENTS.

Correct solutions to 1274 by W. T. Hurley (dual), Biène (dual, but no triple, as if 1..B takes P, black's second move is K-B4, unless white play 2, Q Kt takes B), and J. Johnston (2 duals); to 1273 by W. Jay (2 duals), W. L. Martin (ditto), R. W. Houghton (ditto), Biène (1 dual), and J. Johnston (3 duals); to 1272 by R. W. Houghton.

T. H. Billington and J. Nield.—Thanks for amended problems.

A. Fellows and R. Houghton.—Problems received with thanks.

E. Schwann.—We trust you will find the correct version.

W. T. Hurley.—Have you not sent the same problem before? We seem to recognise it.

C. S. Bright.—You have not hit 1272. If 1. R-K B 7, Kt-B 6, then how do you proceed?

The October number of the *British Chess Magazine* is unusually good. The verses by A. L. Stevenson and T. Winter Wood are above the average. "Delta's" reminiscences are extremely interesting, and there is an elaborate analysis of the Ruy Lopez Fianchetto defence by L. P. Rees, the vice-president of the Surrey County Chess Association. The following end game, given on p. 450, will repay study:—White: K-K Kt 4, Ps Q R 2, Q Kt 3, and K B 2. Black: K-K 4, Ps Q R 4, Q Kt 4, and K 5. Black played 40. P Kt 5. The play then proceeded, 41. K-Kt 3 (if K-Kt 5, black wins by P-K 6), K-Q 4 (if K-Q 5, 42. K-B 4 draws), 42. K-Kt 4 (if K-B 4, K-Q 5 wins), P-K 6 (the only move to win), and White resigned.

Liverpool Weekly Mercury.

CHESS COLUMN.

The second Problem and Solution Tourney will be commenced in November. It will be divided into two sections for two and three-move direct mates respectively. All classes of competitors are invited. The prizes will be of a substantial character in cash or chess works at the option of the winners. For rules see the October issues of the *Weekly Mercury*.

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ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

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1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, October 14, and unacknowledged elsewhere:—

A. Purgia.—C. J. Barbosa.—King, Mendham, and Co.—G. B. and Co.—C. J. Hunt.—Beginner.—S. D.—Geo. E. Clark.—Fraser.—Miroir.—B. Noble.—A. K.—F.R.A.S.—C. G.—Fibre.—J. A., Bellringer.—Litharge.—Bisschof.—G. A. Morgan.—Richard Plant, jun.—F. J. G.—John Mills.—A Beginner.—W. Hosken.—British Bulldog.—C. G. M. Bennett.—J. McC.—Lonely Workman.—T. C. Smith.—A. T. Wheeley.

C. M. (We think you can employ a mechanic to make parts of a machine that is the subject of a patent, but dealers must not sell the parts so that the machine could be completed. That was decided in the case of the telephone. Practically, anyone is at liberty to make a patented article for experimental purposes, and he may employ others to make parts which he has not tools to make; but there must not be any beneficial user—for instance, exhibiting or lecturing for profit on the machine you mention. The machine may be described in a lecture, but it can only be experimented with at an entertainment by permission of the owners of the patent.)—Lightning. (You send a mere examination question, which is answered in all the books on the subject, and in many of our back volumes.)—Alpha. (The secretary of any institution or society will send full particulars required as to the qualifications of candidates for admission. As you are practically engaged in the profession, we should think it would be necessary only to get the required number of proposers.)—A Young Engineer. (Apply to Crosby Lockwood and Son, Stationers' Hall-court, E.C., for one of their lists of books. You will probably find something to suit in that. The best way is to go to a public library—at the Patent Office for instance—and look at the various works on the subject. The Patent Office library is open until 10 p.m.)—A New Subscriber. (It is not safe to show any really good invention until a patent has been applied for.)—G. Flower. (The light-coloured portions of pure rubber are sliced finely and dissolved in bisulphide of carbon or in mineral naphtha. You can buy it cheaper than you can make it, in bottles price 2d., at almost any shop that keeps shoemaker's materials. The process has been described many times.)—J. H., Bournemouth. (It depends on the cause. Ointment of nutgall is sometimes used; but put the question to Dr. Allinson in the *Weekly Times and Echo.*)—C. K. (Have they not been answered many times in previous numbers? Look through the indices under head Dynamo for many references. Probably the very question will be answered in the Replies this week.)—Narom. (We do not know of a work devoted to the subject; but there are chapters on it in various works—for instance, Gee's "Goldsmith's Handbook," Crosby Lockwood and Son, Stationers' Hall-court, E.C.; but you do not state the nature of the metal. There are several articles on the subject in back volumes.)—B. R. M. G. (We cannot say, because we do not know; but any of the patent agents advertising in our columns will give an estimate of the cost when they are informed of what amount of work has to be done in searching, drawing, &c. It is not necessary to go to America.)—A. W. G. (Please see the correspondence lately inserted about space, and refer to the textbooks.)—Noswad. (If you soften the ends in steam, or in boiling water, and squeeze them in a vice, they can be slipped through, and will afterwards regain their shape.)—W. P. (The lamp you mention would surely give light enough. Go to any of the large pianoforte dealers, or music warehouses, or lampmakers, and ask to see what they supply. There is one form, we think, which is placed directly over the music.)—J. C. S. (We do not know how its performance compares with the phonograph, or why it has not come into more general use. It is certainly much less costly to make; but we do not know the price of the phonograph.)—B. A. Darby. (Get a patent agent to protect it, and then send full description to the Admiralty. Have you tried it full size?)—Light. (Please see many answers to your query in back numbers, or put the query direct to some of our advertisers. Do you want a dynamo, or to work by battery? Either way, we do not think you will get the apparatus for the higher sum named.)—Upton. (Charles's "The Practical Cabinet-Maker," E. and F. N. Spon, Strand, W.C., 10s. 6d., may perhaps suit.)—Fitter, Jersey. (You can buy one cheaper than you can make a single specimen. Several have been illustrated in back volumes. They require very careful making.)—Alltfat. (A good concordance might help you, or a Life of Christ; but to answer the questions would need much searching. They seem to have been put to test a student's amount of knowledge).—R. A. Baxter. (Bois-durci was made from sawdust subjected to a high temperature and an enormous pressure. The process was invented as a substitute for carving, the material being pressed into moulds. There is a method of treating sawdust with acid and pressing it into moulds. Any sort of cellulose will do.)—Thomas Casson. (The Wimshurst is the best. Various sizes and forms have been described in back volumes—the latest so recently as May 1 last. The inventor's instructions for making a modern form were given by himself in number for Oct. 29, 1886.)—A. M. (The best information could be obtained, we should think, by sending a note to Secretary of the R.G.S.)—S. Tolver Preston. (Will look them up and let you know; but we are afraid they are out of print.)—E. J. Burrell. (Last week's paper was actually at press at the time you must have written the letter. Correspondents should remember that we have to go to press many hours before the time of publication, which is Thursday, 2 p.m.)—A. T. M. (There were articles on the practical construction of the harmonium as far back as Vol. IX., and there have been many special articles since. We do not think there is any book which gives all the details of the work; but there are many descriptions of parts scattered through back volumes.)—W. Pezzack. (Always glad to hear from kindly friends like yourselves. Your reply shall appear next week.)—Lt.-Col. Simpson. (We shall be pleased to publish another series on Clockmaking as soon as the author is ready. We wish the subject elicited more correspondence than it seems to.)—J. R. (We use nothing but the asbestos lubricants in our machine room. We find them cheaper and cleaner than lard oil, or anything else. We get ours from the United Asbestos Co., Dock House, Billiter-street, E.C. They are cheaper, and, we think, quite as good as the firm we used to recommend.)—J. C. (None whatever. You must have a dark room of some sort.)—O. (We expect not.)—A. H. Brake. (In type.)

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Bench Lathe, 3in. centre, 2½ft. bed, back-gearing, three-groove pulleys and few tools, value £4; also 3in. Leg Vice. Offers. J. Beddard, Cleveland-road, Wolverhampton.

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The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, OCTOBER 23, 1891.

LATHEWORK FOR AMATEURS.* —VIII.

(*Continued from page* 102.)

Boring-Collars or Cone-Plates.

THE boring-collar poppet has been spoken of (see p. 418, Vol. LIII.). Now, the shapes of the cone-plates and the methods of making them have to be explained.

Fig. 89 represents a brass plate ¼in. thick, and having ten conical holes of various sizes arranged in a circle around the centre. This plate is marked out by the proportions afterwards indicated by means of strong compasses. First, the central hole is marked by a circle about ⅛in. diameter. Then, opening the points of the compasses, mark a second circle at such a distance that, on the plate being mounted on its own poppet, this second circle corresponds exactly with the cone-points of the lathe. On this second circle, considering the whole circumferential line as the central point, mark other circles—⅛, ⅜, ½, ¾, ⅞, 1, 1⅛, 1¼, 1½, and 1⅝ inches in diameter, and spaced with equal distance between their circumferences, as shown in Fig. 89. Next mark a circle concentric with, and of about 1⅛in. larger radius than, the second. This last circle gives the external diameter of the plate.

This plate is now carefully made round, the central hole and the ten others are drilled right through and broached out smooth, these latter being made tapering, as shown by the double lines on the illustration. The poppet for the cone-plate, which is described on p. 418, is placed on the lathe-bed, and the plate is laid against its straight face, and its position is adjusted so that the circle of conical holes is in a line with the lathe centres, and also so that the central hole is in the middle of the poppet. This is easy to see if care has been taken to draw on the straight face of the poppet a vertical line showing the middle. Through the central hole in the plate mark the face of the poppet and then bore a hole through it the same size as the one in the plate.

The cone-plate is fixed on its poppet by means of a bolt long enough to pass through both the plate and the poppet, and then to project sufficiently to take a nut. This bolt (Fig. 90) has a strong rounded head of at least 1in. in diameter, undercut sufficiently to touch all round, and on it is placed a strong washer slightly larger in diameter than the head. The bolt, fitted with its washer, is passed first through the central hole in the cone-plate, and next into the hole in the poppet. Another washer similar to the first is then put on, and finally a winged nut secures the whole firmly. When it is wished to use either of the conical holes bored in the plate, it is only requisite to loosen the nut, turn the plate so that the hole wanted is uppermost, and refix by means of the nut.

Wooden Cone-Plates.

There is a more simple and more economical method of making cone-plates. They are made of wood, like Fig. 91, by putting on the running mandrel lathe small parallelogrammical planks, well smoothed with the trying plane, of a somewhat hard and compact wood, such as service-tree or sycamore. These planks, of ⅜in. to ¾in. in thickness by 4in. wide, rest on the shoulder formed by thinning the upper part of the poppet, and rise vertically to such a height that after having marked the central point of the conical hole, by impressing the two cone points of the other poppets, and boring the conical hole there still remains on top ¼in. to ⅜in. of solid wood. The plank is slotted at the lower end in the middle to allow it to be placed across the bolt (Fig. 90) of the poppet, and to be fixed by the winged nut.

It is important for a turner to have a certain number of these planks or cone plates, of different diameters, and bored through parallel; but it is also necessary for him to have some that are bored through conically for two-thirds of their thickness, and the remainder with a hole large enough to allow the introduction of the bit or drill which it is wished to use to bore a hole in a piece of cylindrical wood. To prevent the tool from deforming or enlarging the small side of the cone-plate, a small round plate of brass is let into this side, bored centrally, and fixed by four pins or wood screws, but care will be taken to insert them in such a direction that the points cannot come out in the conical part of the cone-plate. When turning with a cone-plate, it must be rubbed with soap to diminish the friction of the work, but never with oil, which, penetrating the pores of the wood, from the effect of the friction and the heat which it communicates, causes it to swell, and renders the rotation hard and difficult.

Split Boring-Collars.

Boring collars are made with dies which are useful in numberless cases. Similar in their lower part to that which has just been described, they differ from it essentially in their upper part. They have two grooved uprights, with a cross-piece fixed by two screws, and tapped in the middle so as to receive a pressure-screw, acting upon a jaw of iron or of brass, which rises and falls in the grooves, and meets a lower jaw, which is also caused to rise and fall at will by a pressure-screw, placed in the lower part of the poppet. It will be well to cut the circular parts of the jaws in the form of a very open arch, and even to have several interchangeable jaws, some semicircular, others angular, and in this way all sizes of work can be held.

This kind of boring collar, extremely simple and handy, is shown by Fig. 92, the poppet complete with jaws. Fig. 93 shows one of the interchangeable dies with an angular notch. Fig. 94 shows the cross-piece forming the nut for the lower pressure screw marked A in Fig. 92. Fig. 95 shows the top of the poppet, with the grooves for the dies to slide in, as seen from above. The two holes serve to take the screws which fix the cap.

Adjustable Support.

A contrivance recently invented is much better; it is rather complicated, but it is easy for amateurs to simplify it. A plate of iron or of brass is turned ⅛in. thick, and of a diameter proportionate to the height of the lathe centres, ordinarily 7in. in diameter. When turned true, mark on it at ¾in. from the circumference a first circle, a second at ⅛in. inside the first, and one at $\frac{5}{16}$in. inside of this second circle. This third circle is cut entirely through the plate. Next, either with a chisel or a file cut away the material contained between the first and the second circles, as if it were intended to cut the large ring into two; but to guard against this separation occurring, three equidistant points of union will be reserved. Fig. 96 shows this arrangement; the three holes in the lower part of the ring are intended to receive three screws, which fix the ring to the poppet (Fig. 97).

Next are prepared three small strips of iron (Fig. 98), each fully $\frac{1}{16}$in. thick and ⅜in. wide, split down their centres by a groove ⅛in. wide and running the whole length of each strip to within ¾in. from each end, so that this groove will be 5½in. long.

Next will be made six little bolts with square heads (Fig. 99). These heads slide in rabbets made along the grooves in strips. These bolts receive winged nuts, which will bind the strips to the circular plate. In this manner, by separating or by closing the strips, a triangle will be formed in the centre of the large circle, as shown in Fig. 96. This triangle can be made larger or smaller according to the diameter of the piece it is intended to support, which it touches only at three points of its circumference, and will not oppose any material resistance or disagreeable friction. As the strips are superposed, care should be taken to make each lie level with the plate by adding small washers of the right thickness. A half-round hollow can be made in the inner edge of each strip near the middle, which touches the work so as to give a greater bearing.

In this method the three strips should form an infinity of equilateral triangles, the bases of which are horizontal. Two of the three strips can be joined like the joints of compasses, and the third, which makes the base of the triangle, left free. In this case the base of the triangle, instead of being, as in the other case, downwards nearest the poppet, is placed in the contrary position—that is to say upwards. In this manner a crossing of the strips is avoided, and the two small bolts at the top are the only ones which project, and these do so both alike. If these three strips are required to touch at the shoulder of the work, this may be accomplished by adding a small projection to the first and second strips at those parts where a slight curvature was made. The projection will be ⅛in. on the first strip and $\frac{1}{16}$in. on the second.

Figs. 96, 97, 98, and 99 show this adjustable support and the parts which compose it. As has already been said, this appliance is susceptible of simplification; but it is described so as to leave nothing unknown to the amateur. It is possible that by splitting two of the three strips in their thickness, and making them cross one within the others instead of one upon the others, greater facilities may be obtained; but this is only a suggestion. It has also been observed that the projecting bolts are inconvenient; it would be better to countersink them flush. In this case pressure would be obtained by means of a screw with a slitted head instead of a nut.

Tools for Boring Wood.

There are many cases in which holes have to be made for joining pieces of work together, either before turning them or after. For this purpose a brace, Fig. 100, is indispensable. This tool need not be described, as it is well known; it holds bits of all sizes suited to the uses to which they are to be put, and which are easily found at the tool-shops. Holes may be made, especially when the wood is not very thick, and holes of small diameter only are required, with gimlets, an assortment of which can be seen at the tool-shops. These tools are also sufficiently well-known not to need description here; it will be sufficient to say that all sizes, from the largest to the smallest, should be had.

Nothing further will be said about tools suited for boring wood, because those which are not spoken of here are, properly speaking, tools for the running mandrel lathe, and the names and descriptions of these will be given later on. It should, however, be observed, that it is well to restrict as much as possible the use of gimlets, as they are very liable to split the wood. When it is desired to bore into a plank, the centre-bit, Fig. 101, should be used in preference. With this holes are made perfectly round and flat at the bottom. If boring into end wood it is better to put a spoon-bit, Fig. 102, into the brace. The drill-stock, shown by Fig. 103, is a very convenient tool for boring perpendicular holes into hard substances. This

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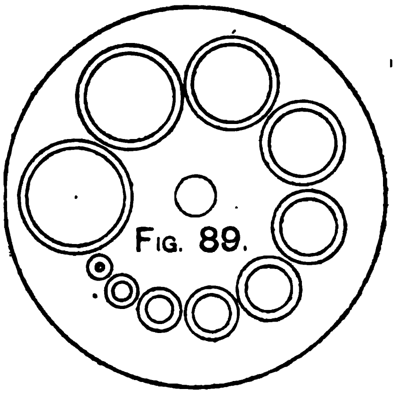
* "Lathework for Amateurs" is mainly adapted from "L'Art du Tourneur," by Desormeaux; but deletions and additions are numerous and extensive. The illustrations are new, and the treatise entirely remodelled.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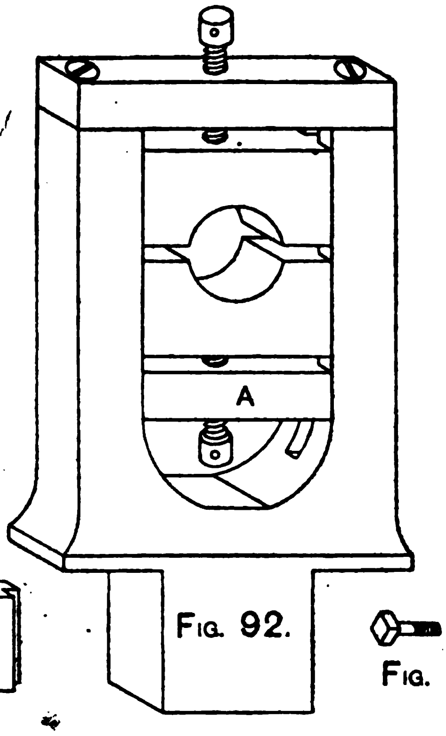

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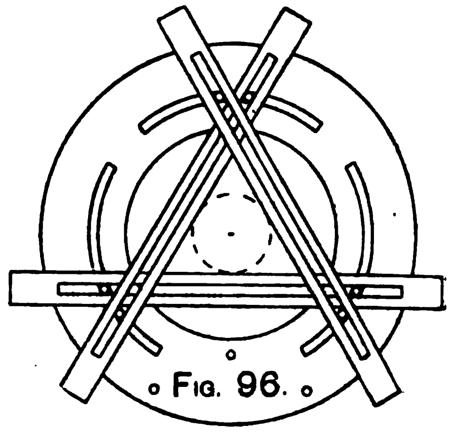
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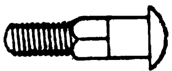
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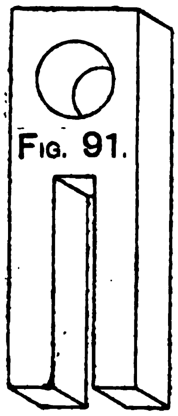
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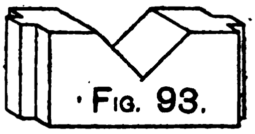
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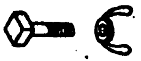
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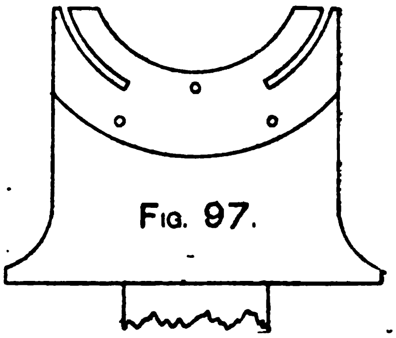
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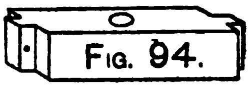
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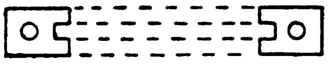
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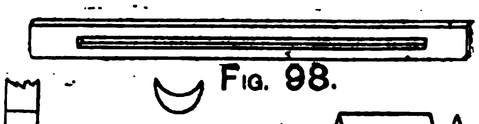
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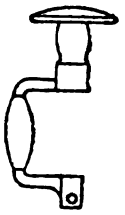
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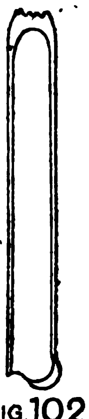
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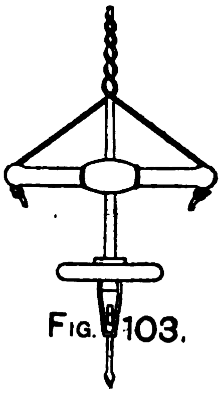
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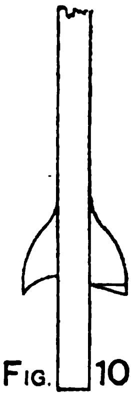
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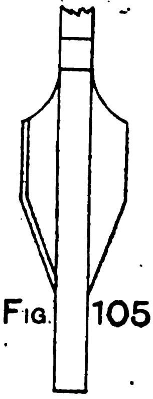
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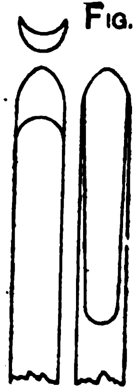
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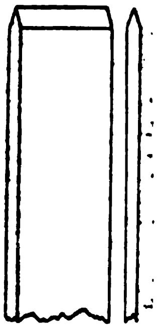
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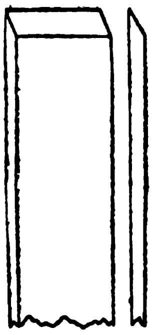
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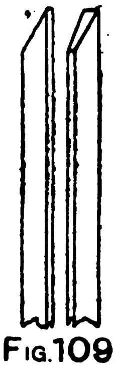
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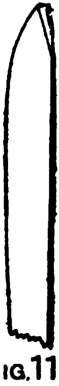
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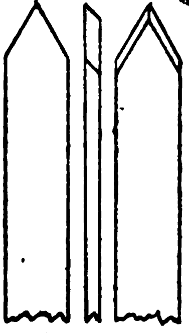
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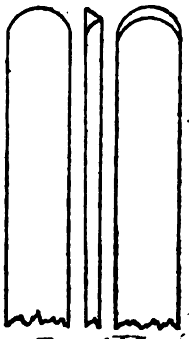
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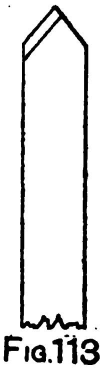
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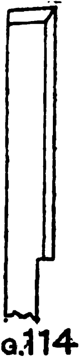
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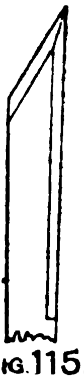
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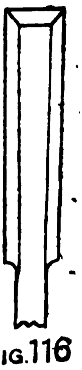
FIG. 116

will be further noticed when speaking of boring iron, and of chucks for holding drills.

If it is wished to make a large tube, the hole is first bored very small, and enlarged afterwards with pin centre-bits like Fig. 104. The largest of these are made of wood, with two lateral steel blades, each sharpened to a cutting edge (see Fig. 105). It should be stated that a piece of round boxwood furnished with these two lateral blades makes an excellent bit having a central guiding pin for boring large tubes, fishing rods, &c.

Tools for Turning on the Dead-centre Lathe.

The gouge, Fig. 106, is beyond a doubt the foremost amongst the tools used by the turner for all kinds of woods, because it is with the gouge that they are roughed out. Its perfection consists in the correctly hollowing out the channel, regularly and smoothly, so that the bevel, which is underneath, and which abuts against the channel, makes the cutting edge of a regular half-circular form. There should be in the workshop not only gouges of different sizes, from ¾in. wide to the smallest, which are less than ⅛in. wide, but even gouges of the same size having cutting edges more or less acute, as the wood to be operated upon is softer or harder.

The double-bevelled chisel, Fig. 107, serves to obliterate the hollows left by the gouge, and to smooth the work. Its cutting edge is obtained by the meeting of two long bevels. It is necessary to have a certain quantity of these of different widths, from 1½in. to ⅛in. The illustration sufficiently shows the shape they should be.

NOTE.—It should be here observed that modern practice makes the double-bevelled chisel for wood-turning with its edge obliquely across the blade forming angles of about 70° and 110° with the parallel sides. It is ground with a bevel on both faces to form the cutting edge in the centre of its thickness, and it is for the sake of greater convenience in holding the tool to the work that the cutting-edge stands obliquely. The edge is occasionally ground square across, as shown in Fig. 107; but the oblique edge is far more general and convenient.

The gouge and the double-bevelled chisel are the only tools to be regarded as indispensable for turning, if this is considered as the art of cutting wood circularly. After these tools come others which do not cut, but only scrape, viz.:—

The single-bevelled chisel, Fig. 108, is a tool used for turning hard woods. Its bevel, which forms an angle of 30° with the side, should be ground very straight. They are made of widths from ¼in. to 1in.; but the small ones to be stronger should be ground edgeways of the tool, because they are used chiefly to make little square grooves in straight parts.

The parting tool, Figs. 109 and 110, can be used in the same cases as the preceding. Its principal object is to make deep grooves in the wood, so as to cut it apart, and from this it should withstand even greater resistance, and it should always be ground narroways of the tool. The thickness should always diminish toward the handle, so that the tool should not wedge in the work. Notwithstanding its slimness, its strength is preserved if care is taken to leave it sufficiently wide on the edge.

The point tool, Fig. 111, serves chiefly for smoothing hardwoods, for cutting by an acute groove two pieces which are to be separated, or for hollowing between the members of a moulding. The point tool is ground to a very acute point formed by the meeting of two bevels commencing at the breadth of the tool, and both terminating at the end in such a way that it cuts not only with the point, but with the side of each bevel also. This is convenient when it is wished to round off a moulding which has been first traced with the point. There should be a certain quantity of point tools of various widths, and with the points more or less elongated. Care must be taken to preserve sufficient strength in the small ones that they are shaped and ground edgeways of the blade, as has been stated in speaking of the parting tool.

The Round-nose Tool (Fig. 112). It is often wanted to cut out hollows of all curvatures in woods that offer too great a resistance to the gouge, and in this case there should be provided several round-nose tools, of different curvatures and lengths, for all the places where they may be necessary. This tool should have a cutting edge ground to a rather blunt bevel. It is apparent that some very narrow ones are wanted to cut out narrow grooves. These should be made on edge so as to give them by a great thickness what they need in breadth. In regard to these the method of narrowing should be observed, which has been indicated in speaking of parting tools and of point tools.

The boring tool, Fig. 113, is principally intended for use with the boring collar; it has two bevels inclined one to the other: one has the cutting edge on top at its front part where the tool is placed upon the rest, and the other is below, so that the top edge cuts when the work descends, and the bottom edge performs the same function when the work ascends. In this way one is assured of boring straight. This boring tool is very good for hard woods, and for ivory: for woods it is dipped into grease, and for ivory it is dipped into water.

The side tool, Fig. 114, has its principal cutting edge on the side of the tool. The side bevel must be made to the left with the greatest care, and above all quite straight. The edge at the end should make a slightly acute angle with that of the side, so that when hollowing work which should be square at the bottom, a right angle may be insured. They are of all widths, from about ¼in. up to ⅝in. The side bevel is from 2in. to 6in. long on the cutting edge, care being taken to make this edge project slightly from the body of the tool.

The side-tool is also made in the way shown by Fig. 115, which is useful in certain circumstances when the one just spoken of is inadequate.

The double side tool or flat tool (Fig. 116) is a very handy tool in numberless cases—it cuts on both sides and at the ends. It is very difficult to grind, particularly on the grindstone, because its perfection consists in that the side bevels shall be very straight, without the least inequality, for its principal use is to bore things which have a cover, such as needle cases. If after turning the neck with the end bevel the side bevels are used to bore the needle case, the least inequality will render the work imperfect. As to width and length, the double side tool is the same as the side tool. It should be observed, however, with regard to the former that as its shape tends to weaken it, it is well not to make the smallest, except on edge. This tool is not absolutely necessary—it is described in deference to custom; but it may be observed that the side tool absolutely fulfils the same purpose.

All these tools are shown in the figures reduced somewhat from their natural size. The bevels are shown, and independently of having shown the tools in each case as seen from the top and the bottom, their thickness has also been illustrated when this has been useful to make them understood.

All these tools are those which should be specially used for turning on the dead-centre lathe and with the boring collar; but there are still many others, the use of which is indispensable for turning on the running mandrel lathe. Descriptions of these will be given when speaking of the running mandrel lathe. Old catalogues include many other tools, but it has not been thought necessary to speak of them. Most of them are but show furniture, rendering no service, and causing trouble to keep clean. The tool dealers have had their reasons for augmenting the number, but notwithstanding all the wish I have to be agreeable to them, I cannot allow myself to draw my readers into useless expense. If they find cases where the tools indicated are insufficient, they will know how to make for themselves those which they need.

(*To be continued.*)

HOW TO MAKE A VIOLIN.—V.*

By W. Pickering.

On Tone Production.

I WILL now assume that the instrument, though unvarnished, or, as it is technically termed, "in the white," is ready to be strung up to pitch. As I have already remarked, I believe that the "old masters" had a very simple mode of arriving at the "proper balance of equilibrium," as it has been called—by Fetis, I think—and that there was not quite that amount of scientific measuring and calipering which most writers on the subject would have us believe. That it is absolutely necessary to have a "balance of equilibrium," or, in other words, that the back and belly shall have an appropriate relation of substance, there cannot be a question; but no two pieces of belly-wood, even from the same tree, were ever known to produce exactly the same tone, however accurate the gauging, and I therefore offer the theory that what was considered the finest tone was arrived at by *trying the instruments before they were varnished.*

The makers probably left the back, as I have directed you to do in the case of your experimental fiddle, very thick in the centre, and then, after stringing up, reduced the thickness with the scraper, testing the tone frequently as they proceeded. In the case of the instrument you have so far completed, you will observe on trying it that the tone will be dull, or "sleepy"; but if you operate slightly on the back with a sharp scraper you will find the tone improve in a remarkable manner. When you have worked a short time at the middle of the back, alternately with scraper and glass-paper, so as to maintain a smooth and regular contour, and having carefully observed the alteration in the character of the tone, you may operate cautiously all round the flanks, more particularly the waist-curves and across the corners. Take, however, very little from the part immediately below the neck-block, as if you get the wood too thin there the whole thing will be spoilt, and you will have to make a new back. It is just possible that the belly may be slightly too thick, as the necessary gauge depends, as before mentioned, so much on the nature of the belly-wood used. In this case you may glass-paper very slightly round the flanks from the purfling inwards for a breadth of, say, ⅛in. to ¼in. keeping the surface quite smooth, so as not to leave the semblance of a ridge. The more pains you take in the matter of alternate scraping and trial of the tone, the more satisfactory will be the result, and you will find that you can get almost any kind of tone you choose. Do not, however, attempt too much with your first experiment. When you have arrived at a round, free, and at the time *solid* tone, stop instantly. Another touch of the scraper might go too far, and although there is such a thing as "thickening up" the wood, it is most objectionable, and decidedly unscientific.

I have long been under the impression that it was by some such simple means as this that the "old masters" reached that excellence of tone which distinguishes most of their instruments, and that the "profound knowledge" credited to them with such a halo of mystery was so much moonshine. Stradivarius, for instance, could hardly have foreseen that his violins would in a couple of centuries fetch £1,000 or more a-piece, and certainly could not know that some more skilful maker would not soon succeed him. Guarnerius del Jesu, too, was, judging by some of his productions, apparently not working solely for fame or posterity; but mainly for the bread, cheese, and macaroni of the period. And as we learn that Stradivarius got only about £4 for a violin, supernatural gifts were hardly to be expected, or were very badly paid for. His excellence was, it is more reasonable to surmise, the outcome of especially fine wood and very careful workmanship, coupled with some easy and simple way of adjusting the thicknesses of back and belly, such as I now suggest. Doubtless the fact that his productions now command larger sums than those of any other maker is owing to the accident that a still better operator did not follow him; but this is a matter of which he could not have had cognisance.

The foregoing theory is to a certain extent confirmed by facts I have observed in old violins in a state of purity—that is, instruments which have palpably not been tampered with. Many of them have evidently been varnished *after the fingerboard has been put on*; others are found to have been worked remarkably thin in the waist curves of the back—so much so as to be partly transparent when held before a strong light, and a close examination leads one to the conclusion that such thinness has been produced from the outside—*ergo*, before the fiddle was varnished.

Having, some years ago, come to this conclusion, I set to work to test it, and have made fiddles of various shapes—one, for example, in which the belly was perfectly flat, and another in which the *inside* of the back was left absolutely level as it came from the saw, without even having been scraped. The contour was given to the outside only, the reduction for "equilibrium" being attained by the scraper after the fiddle was strung up. Each experiment resulted in the production of what is recognised as a "matured" tone, and the evidence is apparently conclusive that such result is attributable to the "proper balance of equilibrium" having been obtained in the manner indicated.

The more this point is studied, the more it will, I think, be seen to be feasible, and I shall be exceedingly glad to hear of any experiments which may be made by amateurs who try this mode of procedure. The result need not detract one whit from the esteem with which the "old masters" are regarded, because there will always remain their glorious and unapproachable varnish to keep them at the top of the tree—unless, by the way, "some other fellow" should settle that point in an equally summary and cold-blooded manner.

An interesting fact recently related to me by Mr. Laurie, the well-known connoisseur of Glasgow, goes to prove more conclusiv anything I had previously heard, that really nothing uncanny about the two or three chief makers of Cremona, but that they obtained their eminently satisfactory results by some such process as the one I am promulgating. When in Paris on one occasion Mr. Laurie had in his possession four "Strads," two of which had never been "opened." He took them to the celebrated Mr. Gand to be opened, with the particular view of ascertaining whether there was any truth in the stories constantly reproduced in fiddle literature, as to the extreme accuracy of gauging on the part of the Italian makers. The instruments were calipered with great care, and it was found that there was not, by any means, such accuracy in the workmanship as had always been supposed. Indeed, in the back of one of the previously unopened instruments, and in the belly of the other, were several gouge-marks, which had not even been scraped down! This was a revelation to the examiners, who were probably thereby left in greater doubt than ever as to the means to an end by which the old makers operated. But it was just the result which it delighted me to learn, as it further confirmed the opinion I had long before formed, and which I have now offered in these columns. There are many excellent amateur violin makers in this country, and I would suggest that they may carry out some interesting experiments, and attain some good effects, by giving this plan a trial. If, after having done so, they will communicate the results to the English Mechanic, I venture to think that a certain amount of instructive matter may be evolved, which will tend to improvement in the art of violin construction, and which even the professional maker may deem not unworthy of attention. The more free and unfettered the experimentalist may be from all preconception as to what must be done, or what left undone, the more valuable will be the issue of his research.

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* All rights reserved.

It is, of course, not to be denied that the varnish of a violin has a certain amount of influence on the tone, and it is therefore all the more desirable that the instrument should be brought up to the best possible condition of resonance before the varnish is applied. The tone of a new fiddle is invariably very "free" before it is varnished, and care should therefore be taken to select a covering which will interfere with that freedom in the least possible degree. The hard, flinty spirit varnish of the modern cheap violin is usually accompanied by a hard, flinty tone, whereas those covered with an oil varnish, in which soft and elastic gums have been dissolved, will have a different voice entirely. It may be taken for granted, however, that, though the flinty varnish will spoil a good violin, the finest varnish procurable, even were it possible to reproduce that of Stradivarius, would not transmute a bad instrument into a good one. Wherefore it is eminently desirable that the amateur should spare no pains to bring his work up to the highest pitch of perfection before he applies the varnish.

I purpose saying something about varnishes in the next chapter.

CHEMISTRY FOR STUDENTS.—II.

By John Mills.

Author of "Alternative Elementary Chemistry," &c.

THE reader, on referring back to our first article (Sept. 11, 1891, No. 1381, page 54, of the "E.M."), will find that at the finish we were discussing the indestructibility of matter. We proved conclusively that an actual increase in weight takes place when a candle burns in air. The popular belief, therefore, which obtains among the masses as to the possible annihilation or destruction of tangible bodies is fallacious and delusive.

By arranging our burning candle as shown in Fig. 11, we may collect the products of combustion separately. For this purpose, from a glass rod held by a clamp on the retort-stand, is suspended a V-tube containing calcium chloride, to absorb the water; a large test-tube holding lime-water to imbibe the carbon dioxide; and a wide tube is fitted, as indicated, with a short tube passing through a cork, to admit air, while another tube, also passing through the cork, and drawn out to a fine jet, is connected to an ordinary gas-jet by an indiarubber tube. The gas is first lit, and then the cork adjusted, while the products of combustion are aspirated forward by running water from a tubulated bottle into a basin, as shown. In this way, as before, an augmentation in the weight takes place, and a visible change is also effected, as evidenced by the lime-water turning milky or turbid.

Combustibles and Supporters of Combustion are Relative Terms Only.

The student will now understand that combustion is caused by the union of so-called combustible bodies with the oxygen of the air. We must not suppose, however, that when a body burns, flame is always the result. For example, when iron is exposed to moist air or earth, it rusts, or, in chemical language, oxidises—that is to say, a compound is formed consisting of iron chemically united with oxygen. This union of iron and oxygen is just as much a process of combustion as was the case with the burning candle. It is possible to modify the state of affairs so as to make even iron burn with brilliance; thus, heat a piece of iron wire in the blowpipe-candle flame, as indicated in Fig. 12. The highly-increased temperature thus obtained enables the metal to combine readily with oxygen, and beautiful scintillations, or sparks, are thrown off plentifully.

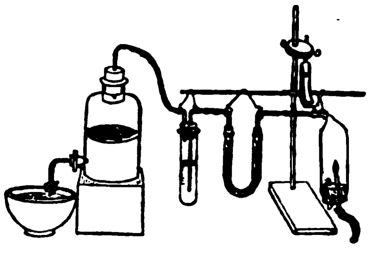


Fig 11

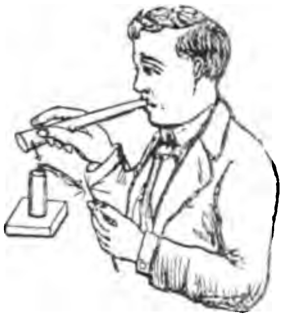


Fig. 12.

Fortunately, it is within our power to reverse the usual state of things; in other words, we may cause air to burn in coal-gas. To do this an ordinary glass chimney is provided at its lower end with a cork and two glass tubes (Fig. 13), while over its upper end a piece of wire gauze is fitted. Coal-gas is passed from an ordinary gas-jet through an indiarubber tube into the glass chimney till all, or nearly all, the air is expelled. A light is then applied over the wire gauze to ignite the escaping gas, and then, on introducing a burning taper into the tube A, the air takes fire, and burns in the coal-gas just as readily as the latter burnt in air. We thus learn that the terms "*combustible*" and "*supporter of combustion*" are interchangeable.

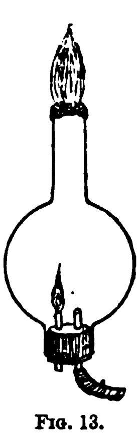


Fig. 13.

Heat is Evolved when Chemical Combustion Takes Place.

Among the many peculiarities attendant upon chemical change, one of the most characteristic and interesting is the remarkable development of heat which often takes place. It is altogether contrary to the popularly-received opinions, but nevertheless true, that by the bringing intimately together of certain cold bodies a temperature equal to, or above, that of boiling water may be attained. In lighting a match, for example, it is necessary to bring it to the igniting point by means of friction: no such apparent expenditure of energy for the development of heat, however, is required when chemical action takes place.

Put some pieces of quicklime in a basin and pour cold water upon them. Soon the lime begins to crack and crumble, and the heat evolved is evidenced by the abundant formation of steam (Fig. 14), as well as from the fact that the lime feels hot. Whence comes this heat? We may answer the question, in part at least, by saying that it is mainly due to the great energy of chemical combination between the two bodies, water and lime; and that it may also be partly owing to the water, on entering into combination, having given out heat in passing from the *fluid* to the *solid state*.

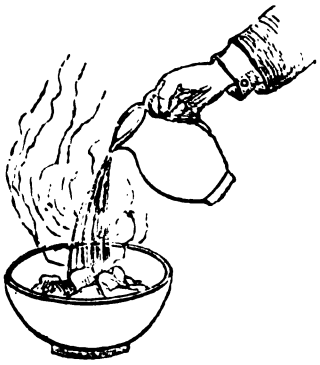


Fig. 14.

A still more striking case, perhaps, bearing on this point is observable when strong sulphuric acid and water are carefully mixed in the cold. When about equal quantities have been thus brought together, it will be found that the temperature of the mixture is so high that the containing vessel can scarcely be held in the hand. Put a small quantity of ether in a test-tube, provided with a cork and delivery tube drawn out to a fine jet. The sulphuric acid should be slowly poured down a glass rod into the water, care being taken to stir well from time to time. We would urge the reader to bear this caution in mind, as serious accidents sometimes occur by the incautious mixing of the two liquids. When about equal Fig. 15, and then place the tubes in the mixed liquids. By this means the ether is rapidly boiled, and the issuing vapour may be ignited, the luminous flame being augmented the deeper the tube is placed in the liquid. This great evolution of heat is commonly expressed by saying that sulphuric acid has a powerful *affinity* for water. Yet such an explanation, although true

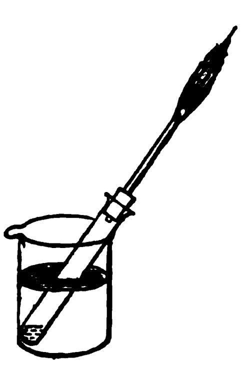


Fig. 15.

as far as it goes, is only a bald statement, and gives us but a faint idea of the real state of affairs. The innate nature of chemical affinity is one of the mysteries of the science of chemistry.

Chemical Action requires Intimate Contact of Bodies.

Each portion of matter in the boundless universe, according to the law of *gravitation*, exerts an influence over every other portion, that is to say, all the separate particles attract and are attracted, no matter however far they may be from each other. We may raise a stone from the ground, but immediately the stone is released from the hand the earth draws it to itself. We know that the sun is a tremendous distance away from us, yet his light and heat remind us every day of his existence. A magnet, when brought within a short distance of a piece of soft iron, will lift or draw the latter to itself. In like manner, if a stick of sealing-wax, or a strip of vulcanite, be rubbed with dry flannel, and then presented to a wooden lath suspended by a silk thread from some convenient support, Fig. 16, the lath will be attracted towards the electrified body.

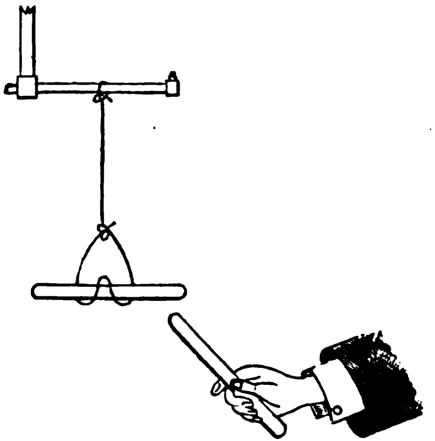


Fig. 16.

Gravitation, heat, and electricity, then, do not require bodies to be in close proximity in order that their effects may be rendered visible. Not so in the case of chemical action. Tartaric acid and sodium carbonate may be ground to fine powder, and mixed intimately; but even after the lapse of many years it will be found that no chemical change has been effected. The contact is not close enough. Dissolve some tartaric acid in water, and pour the solution thus obtained upon some sodium carbonate. A vigorous effervescence at once takes place, due to the escape of *carbonic acid*, which shows conclusively that a radical change has taken place.

Another remarkable illustration of this peculiar feature of chemical action may be carried out as follows: Mix together equal weights of potassium chlorate and sugar; after each of these substances has been previously ground to powder in a mortar, place the mixture on a tile, then moisten a glass rod with strong sulphuric acid, and place it as near to the mixture as possible without actual contact. No change occurs. Now touch the powders with the moistened rod. This time a brilliant and rapid combustion of the mixed powders will take place. These and similar experiments naturally lead us to the conclusion that the necessary close contact of bodies required to bring about chemical change is, in a general way, obtained only by rendering one or more of the bodies liquid or gaseous.

Change of Form and Colour.

It is often said that "fact is stranger than fiction." Yes; we are prepared to solemnly affirm that our favourite science affords ample proof of this statement, and that the invisible powers of nature find a medium or agent in chemical change for producing the most enchanting and, apparently, supernatural effects. No wonder, then, that the *magicians* of the olden times, and the votaries of the "*Black Art*" should have had such a power over the minds of their untaught brethren.

Dissolve a few grains of *potassium iodide* in water contained in a test-tube; in another portion of water dissolve a pinch of *mercuric chloride* —using a separate test-tube—a clear, colourless solution is formed in each case. Now pour a little of either solution into a third test-tube, and then add about an equal quantity of the other solution—a finely-divided solid (*precipitate*) of a bright scarlet colour separates. Add a further quantity (*excess*) of either of the solutions—say mercuric chloride; the red precipitate disappears, but may be brought back again by pouring in more of the potassium iodide solution.

The intelligent reader of the English Mechanic will probably ask himself questions similar to the following:—What is the red substance? Why does it thus become visible at one moment, and disappear or slip away from us the next? Whence comes the scarlet hue, seeing that the liquids employed are devoid of colour? We answer: (1) The bright-coloured precipitate is a new chemical compound, which has been formed by an interchange of the constituents of the original substances—mercuric chloride and potassium iodide. (2) This new substance dissolves in either a solution of mercuric chloride, or a solution of potassium iodide. (3) The new compound possesses the property of reflecting only red rays of light. The reader will be better able to appreciate these explanations later on, when we have entered into a more detailed account of the nature of chemical change.

The student will, perhaps, be still more impressed with the peculiar qualities of chemical change by the following experiment:—Nearly fill two tumblers with distilled water, and put into one of the tumblers a pinch of salt, not so much as would impart a saline taste to the liquid. Now add a drop or two of *silver nitrate* (*lunar caustic*) solution No change will take place in the case of the distilled water; but in that holding salt in solution a characteristic white curdy precipitate forms consisting of silver chloride.

Put a small quantity of ammonia solution into a gas-jar, cover with a glass plate, and shake up vigorously; now pour the solution out, and cover again. Take another gas-jar, put into it some hydrochloric acid, and proceed as before. Bring the two jars mouth to mouth, remove the glass covers, and observe what takes place. The white cloud formed is a new solid substance in a very finely divided state, and is termed ammonium chloride, popularly known as *sal ammoniac*.

We will give one more experiment to elucidate this part of our subject still further, because it, as well as those which have gone before, may be readily performed by the reader, and because it is our settled opinion that there is nothing like successful manipulation for inspiring a real love of, and interest in, chemical science. Place a few lumps of sugar in an ordinary tumbler, and pour in sufficient strong sulphuric acid to cover the sugar. The latter will soon begin to blacken and froth up, until finally a loose mass of carbonaceous matter nearly, or entirely, fills the vessel. Sugar contains carbon and the elements of water, and the latter are extracted by means of the acid, thus leaving a porous mass of carbon behind.

A careful performance of the experiments we have described in this article will be the best means of fixing the fundamental truths of the science in the minds of those who seek after real knowledge, and we can promise each reader of the English Mechanic, who chooses to follow the advice we gave in our first article, that every successful attempt to practically establish some truth, and so increase his knowledge by the exercise of his own skill and observation, will act as a powerful stimulus, and so create an eager desire to launch out into deeper waters.

(*To be continued.*)

PRACTICAL MICROSCOPY FOR STUDENTS.—IV.

By Frederick Davis, B.Sc.

We will now review the changes which the ovule undergoes after fecundation, noticing more particularly the microscopical appearances. The ovule contained within the carpel presents, if cross-cut, an outer coat, termed the primine, and an inner called the secundine, situated in the centre of which we have the nucleus, the pollen tube entering by way of the micropyle, which is an opening in the primine, sheds the fovilla upon the embryo *sac* within, the germinal cell absorbs this fovilla, and immediately a convulsive movement may be observed, and a division of the germinal cells into a number of little granular bodies takes place, the plumule and radical being formed, joined by one or several cells, called the tigellus or neck, and the ovule is thus converted into the seed. The student will observe the embryo is entirely surrounded by the endosperm.

The point of attachment of the seed to the carpel is termed the placenta; the little scar upon the seed is called the hilum. If the seed is attached directly to the placenta, it is said to be sessile; but if attached by a stalk, called the funiculus, it is termed appendicular, or stalked. If we take a transverse section of the capsule of the poppy, we shall find the seeds are attached to the sides of the ovary—this form of placentation is said to be parietal; but if we examine the fruit of the cyclamen, we shall find the seeds are unattached and near the centre, merely lying in the pulpy mass—this is named free central placentation; whilst in some fruits we have the seeds attached to the central portion—it is then termed axile placentation, as in the lily and campanula. The student should cut and mount specimens of each variety, and preserve them by mounting in Canada balsam in place of water, then applying to the edges of the juncture of the cover-glass and the slide a solution of asphalte, which will dry and retain the cover-glass in position.

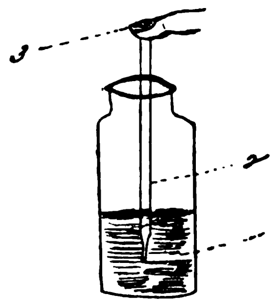
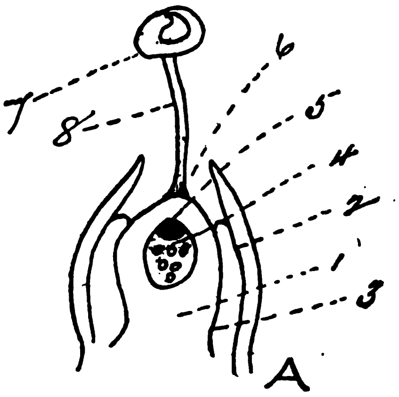
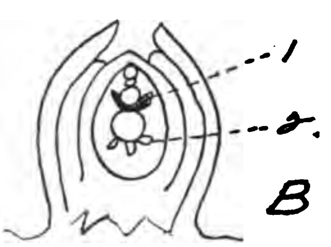


Figure showing Method of taking Canada Balsam from Bottle by means of Pipette.

1, Canada Balsam in Benzole; 2, Pipette; 3, Finger regulating pressure.



A.—Figure showing Impregnation of Ovule. 1, Nucleus; 2, Secundine; 3, Primine; 4, Embryo Sac; 5, Germinal Cell; 6, Foramen; 7, Pollen Grain; 8, Pollen Tube.



B.—Figure showing Development of Germinal Cell after Impregnation. 1, Radicle; 2, Plumule.

Air-bubbles must be rigorously excluded. In preparing the Canada balsam a little care is necessary. Obtain about an ounce in the semi-fluid condition from a chemist, and having evaporated it down to total dryness by the aid of a water-bath, dissolve the solid products thus obtained in benzole just sufficient to cover it. When in use the benzole being volatile, evaporates, the Canada balsam acting as a preservative to the specimen.

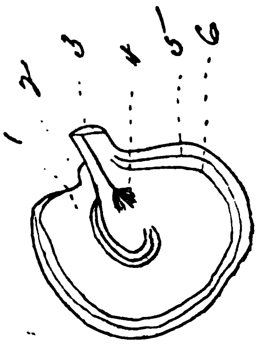
As a rule it is well to mount botanical specimens dry, more especially pollen grains; but if to be preserved, this is not always possible. In practice it will be found the mouth of the balsam bottle will, after a time, become a mass of solid balsam around the lip. This may be obviated by bending a piece of wire triangularly for the purpose of supporting the pipette which is employed for dropping the balsam upon the slide when not in use. Of course to mount a section of a moist specimen, special treatment is necessary. In the case of the transverse section of the poppy capsule, we must remove the contained water by soaking the section in absolute alcohol: this absorbs the water; and after removing the section from the alcohol, and exposing to the air that the spirit may evaporate; we simply place the section upon the slide; add, by means of the pipette, a drop of the prepared balsam; cover the specimen with an ordinary cover-glass; press firmly down until no more balsam exudes from beneath; permit it to remain a few minutes, and then cement the margin as before described.

A good varnish can be made by dissolving true Trinidad asphalte in benzole, carefully straining to remove any insoluble particles.

The cement when finished should be thick; in fact, rather more so than ordinary paint, and can be applied to the slide with a camel-hair pencil kept for the purpose.

Five drops of an expressed oil added to an ounce of the varnish is an improvement.

Absolute alcohol may be obtained from any chemist, or may be prepared from rectified spirit of wine by treatment with caustic and recently-dried chloride of lime, or with carbonate of potash and chloride of calcium. A method recently suggested is to remove the water by treatment with anhydrous sulphate of copper, which, of course, is nearly colourless; but as it absorbs the water from the spirit, it becomes blue. I would suggest that all alcohol employed for floating sections, &c., should be preserved in a special bottle, and used upon a future occasion for hardening animal tissues, &c.

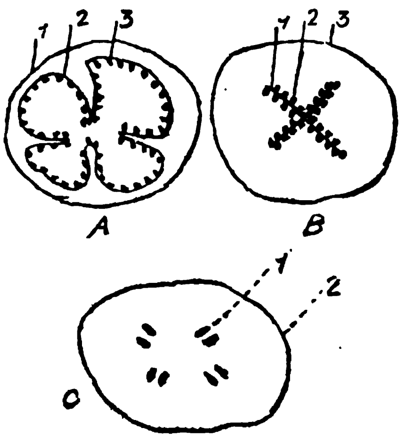


Vertical Section of a Campylotropous Ovule.

1, Nucleus; 2, Micropyle; 3, Funiculus; 4, Chalaza; 5, Primine; 6, Secundine.

I may here mention the necessity of keeping the scalpels with which the sections are cut perfectly clean; this may be accomplished by inserting the blades, when not in use, in a flannel sheath, upon which a little soft paraffin or vaseline is smeared. The student must be careful that the blades are perfectly free from all moisture before inserting in the flannel. In teasing out various specimens, it will be found necessary to employ needles. These may be made by inserting in elder-wood an ordinary needle, the eye penetrating the wood; the handle may then be bound with thin waxed twine, the wood will contract, and the needle be firmly fixed in position. A very useful form is that called the glover's needles; these are angular, and in practice will serve many useful purposes. If the student does not care to fix his own needles, they may be purchased ready-made at any optician's.

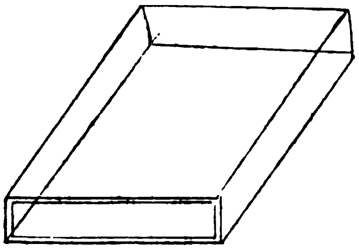
It is essential also that a finely-pointed pair of scissors be always at hand, and a small pair of brass forceps; if delicate dissecting is needful, it must be conducted under water in a shallow trough, with a lamp and condenser, the latter for the purpose of throwing the light in the required plane. If possible, however, daylight should always be employed, as the shadows in artificial light frequently retard correct manipulation. The object for dissection must be fixed by means of pins, preferably to a piece of cork, because pins hold firmly to cork and are not likely to break away. Some microscopists prefer mixture of spirit and water, or pure spirit, for dissecting purposes. It is not desirable to have the trough too large, as more spirit would be required, and consequent greater waste occur. These technicalities being understood, we proceed to the seed—the characters and forms of which are innumerable. In many respects the ovule resembles the seed. It will be observed, however, the apex of the ovule is termed the micropyle, whilst in the seed it is called the chalaza. The seed as such consists of two parts—the outer portion, called the integuments, and the kernel, nucleus, or cotyledons. The parts may be well observed in the almond, which is really the seed of the rosaceous tree bearing the name Amygdalus communis. Generally speaking, the integuments or outer portion consists of two layers or seed coats: the outer, termed the testa or episperm; and the inner, called the endopleura or tegmen.



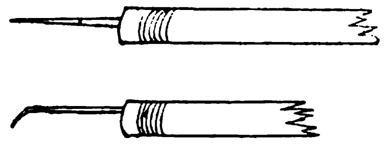
A.—Parietal Placentation. 1, External covering of Ovary; 2, Placenta; 3, Seeds.

B.—Axile Placentation. 1, Placenta; 2, Seeds; 3, External Covering of Ovary.

C. — Free Central Placentation. 1, Seeds; 2, External covering of Ovary.



Shallow Trough for Dissections.



Various forms of Needles for Teasing-out, &c.

By careful manipulation and examination under the one-eighth objective, we shall find the testa consists almost entirely of parenchymatous cells surrounded in some cases by hair-like processes possessed of spiral fibres. The seeds obtained from the order of plants known as Polemoniaceæ or Phlox order, are lovely objects for microscopical examination. In the course of our perigrinations we shall come across a few seeds having an extra layer in addition to the two integuments; a good example is the nutmeg, the seed of a plant bearing the name of Myristica fragrans: in this we have a third coating of a partial character, termed the aril or arillus, and from observation it appears the ovule does not develop this formation until after fecundation.

A NEW MECHANICAL PROCESS FOR RESETTING BLUNT FILES.

THE costly method of sharpening worn files by means of the sand-blast is likely to find another rival in a new process, which has recently been developed by a Bavarian file-merchant.

In the English Mechanic for July 11th, we gave a somewhat detailed account of a process for renovating old files by means of electricity.

The new process which we are about to describe involves the use of no acids or liquids. It depends on purely mechanical principles, and is very easy both to understand and to practise. It consists in operating upon the teeth of a file with a rapidly-rotating cylindrical brush, armed with wire "bristles." These "bristles" are arranged obliquely, making a certain angle with the axis of the cylinder.

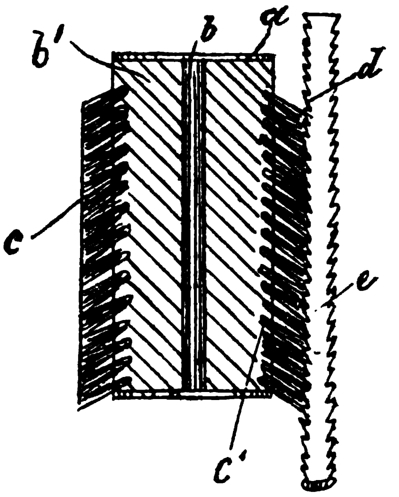


Fig. 1.

The brush is mounted in a frame, and can be driven by any sort of driving gear. While it is at work, emery powder or similar matter is fed in upon the bristles, and assists in the process of abrasion or rubbing down. Meanwhile the file is held or clamped sufficiently close to the rotating brush to obtain the maximum effect.

In Fig. 1 a file is shown in the process of being sharpened; *a* is the brush frame, turning upon the axis *b*. The cylindrical body *b'* of the brush is furnished with oblique perforations *c'*, in which are inserted the steel "bristles," but iron or brass wires may also be used for some kinds of work. These "bristles" are so arranged as to have a direction corresponding to the angle of the teeth *d* of the file *e*, which is held or fixed parallel to the axis of the brush.

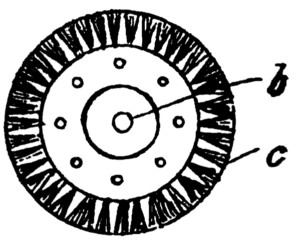


Fig. 2.

In Fig. 2 the brush is shown in section, and the same lettering holds as before.

It is easy to see that during this process each tooth of the file is separately sharpened in a manner similar to that in which a knife, axe, or chisel may be sharpened by means of a steel or stone. At the same time as the files are thus renovated they are polished almost equal to new, and the inventor claims that the surface which his process gives to the individual serrations of the file are much superior to the effect produced by sand-blast sharpening. The advantages of resharpening or resetting old files by this process may be gathered by reference to Figs. 3 and 4.

Fig. 3 is an enlarged drawing of some of the teeth of a file that has been set by the usual process.

Fig. 4 is an enlarged drawing of some of the teeth of a file that has been treated by this new process.

It will be observed that in Fig. 3 the sharpened teeth carry at their upper edge a bent-back burr, *f*, which deviates considerably from the form of cutting-edge suitable for working on metal. This burr cannot, we believe, be prevented when resetting a file by the old method, for it is a consequence of a lateral over-pressure in the material through the various cuts which are set close to one another. In Fig. 4 the burr has disappeared, and each tooth has a clean-cutting edge.

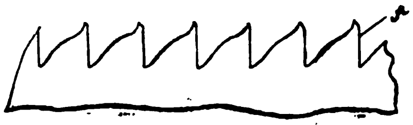


Fig. 3.

Practical men will at once see another advantage besides the best cutting effect, for files sharpened by the new process are not likely to get so readily clogged, and hence their working efficiency is greater. And, again, wherever there is machinery in motion and driving-power available, as is the case in most workshops of any consequence, it will be possible to have one of these machines, so that whenever a file becomes blunt it can be immediately reset. J. T. N.

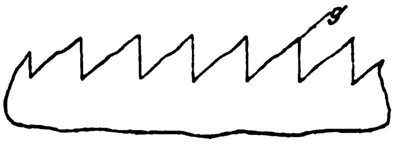
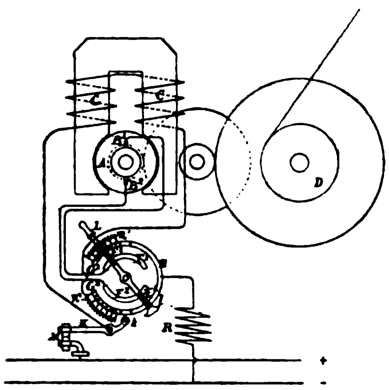
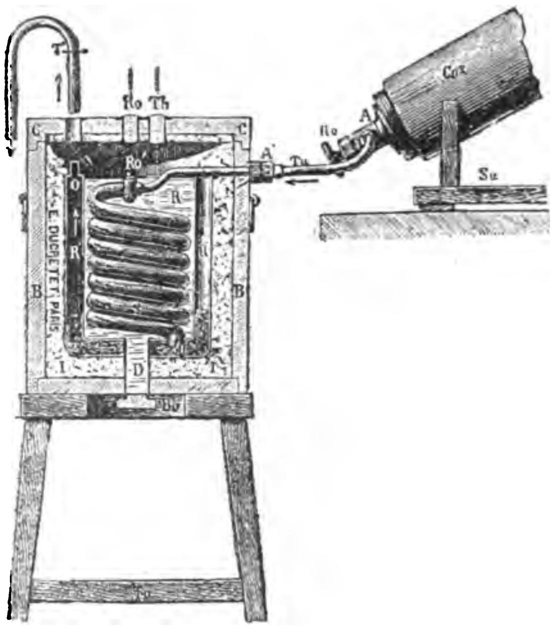


Fig. 4.

SIEMENS'S IMPROVED ELECTRO-MOTOR.

THE electro-motor shown in the engravings annexed is one of those which can work in either direction as well at variable speeds. It forms the subject of a patent obtained by Mr. Alexander Siemens, of Queen Anne's-gate, Westminster. The motor is arranged with its armature shaft either in a vertical or a horizontal position, and is connected to the working machine either directly or by toothed or other gearing. The connection may be made through an intermediate shaft coupled thereto, in such a manner as to allow of a slight amount of end and side play, in order to obviate the necessity of accurate adjustment relatively to the working machine. The commutator brushes may consist of a number of metallic fingers arranged side by side, which are pivoted at one end to a fixed pivot, while the other ends are pressed upon the commutator by helical springs connecting the two opposite sets of fingers together at an intermediate point of their length, but so that they are insulated therefrom. The windings of the field magnets and of the armature are connected to the main circuit through switches and resistances, by means of which the speed, power, and direction of rotation of the motor can be controlled, as illustrated by the accompanying diagram. A indicates the armature, B^1 B^2 the commutator brushes, and C the coils of the field-magnets of an electro-motor geared to the barrel D of a winch. L is the handle of a lever which has on it two conducting plates E^1 E^2, insulated from one another, arranged to slide over and make contact with two inner segments F^1 F^2, and two outer segments G^1 G^2, each of which is divided into a number of insulated parts connected to a series of resistances, R^1 R_2. There is also an extended outer segment, H, with which either E^1 or E^2 makes contact when the other is over the divided segments G^2 or G^1. The lever K of a carbon break switch carries a roller *k*, on which the cam-shaped end *l* of the lever L comes to bear when the lever is in middle position, thus separating the carbons M, and throwing the motor out of circuit When the lever L is in the position shown, the course of the current is + M, K, C part of the resistance R^1, G^1, E^1, F^1, B^1, A, B^2, F^2, E^2, H, through a permanent resistance R to −, the motor being thus caused to turn in the one direction with more or less power according as the lever L is moved more or less over, cutting out more or fewer of the resistances R^1. When the lever is moved over beyond its middle position the direction of the current through the armature A is reversed, causing the motor to turn in the opposite direction. In order to prevent the motor being injured by an excess of current in the event of its movement being arrested by overloading it with work, a permanent resistance may be provided in the main or armature circuit.





CAILLETET'S CRYOGEN.

THE "cryogen," a new apparatus constructed by M. E. Ducretet, from instructions given by Mr. Cailletet, is designed for effecting a fall of temperature of from 70° to 80° C. below zero, through the expansion of liquid carbonic acid. The apparatus consists of two concentric vessels having an annular space between them of a few centimètres. A worm, S, is placed in the internal vessel R. All this is of nickel-plated copper. The worm S carries, at R*o*', an expansion cock and ends at O in the annular space R'. A very strong tube is fixed to the cock R*o*', and to the ajutage A'. It receives the tube T*u* which, at the time of an experiment, is coupled with the cylinder of carbonic acid, CO^2. A tubulure, D, usually closed by a plug, B*o*, communicates with the inner receptacle R. This is capable of serving in certain experiments in condensation. The table T*a* of the tripod receives the various vessels or bottles for the condensed products. The entire apparatus is placed in a box, B, lined with silk waste and provided with a cover, C, of the same structure. Apertures, T*h*, R*o*, and T', allow of the passage of a key for acting upon the cock R*o*', as well as of thermometers and stirrers if they are necessary.

When it is desired to operate the internal vessel R is filled with alcohol (three quarts for the ordinary model). This serves as a refrigerant bath for the experiments to be made. The worm S having been put in communication with the carbonic acid cylinder CO^2, the cock R*o* of the latter is turned full on. The cock of the worm, which is closed, is opened slightly. The vaporisation and expansion of the liquid carbonic acid cause it to congeal in the form of snow, which distributes itself and circulates in worm S, and then in R. The flakes thus coming in contact with the metallic sides of S rapidly return to the gaseous state and produce an energetic refrigeration. At the lower part of the annular space R' are placed fragments of sponge impregnated with alcohol. The snow that has traversed the worm without vaporising reaches R' and dissolves in this alcohol, and the refrigeration that results therefrom completes the lowering of the temperature. The gas finally escapes at O, and then through the bent tube T'.

The apparatus may be constructed with an inverse circulation, the carbonic acid then entering the annular vessel, R, directly, and afterward the worm, S, whence it escapes to the exterior of the apparatus. The expansion cock sometimes becomes obstructed by the solidification of the snow. It will then suffice to wait until the circulation becomes re-established of itself. It may be brought about by giving the cock, R*o*', a few turns with the wooden-handled key that serves to manœuvre the latter. It is not necessary to have a large discharge of carbonic acid, and consequently the expansion cock needs to be opened but a little bit. A few minutes suffice to reduce the temperature of the alcohol bath to 70°, with an output of about from 4½lb. to 5½lb. of liquid carbonic acid. When the circulation is arrested, the apparatus thus surrounded by its isolating protective jackets becomes heated again with extreme slowness. In one experiment, it was observed that at the end of nine hours the temperature of the alcohol had risen but from 10° to 22°. On injecting a very small quantity of liquid carbonic acid from time to time, a sensibly constant and extremely low temperature may be maintained indefinitely.—*Le Genie Civil.*

PARALLEL MOTIONS.*

The Use and Abuse of the Name.

POINT paths in mechanisms, or, as they may be more shortly termed, *mechanical loci*, form an interesting and useful branch of study that has not as yet received very much attention from writers of books on drawing. It is a study that may be made to give an excellent training in accurate drawing, and at the same time to impart some knowledge of the practical application of geometrical principles. There are three well-known classes of mechanism from which examples may be taken: (1) panto-

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* By Prof. A. MacLay, in *American Machinist.*

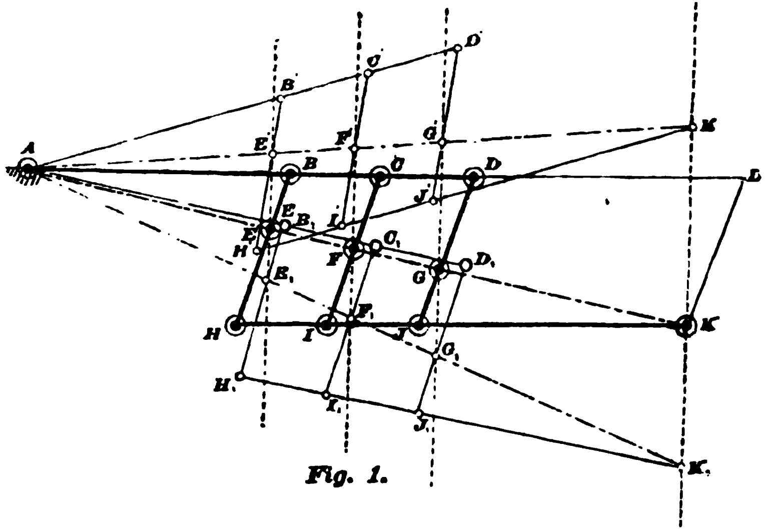

Fig. 1.

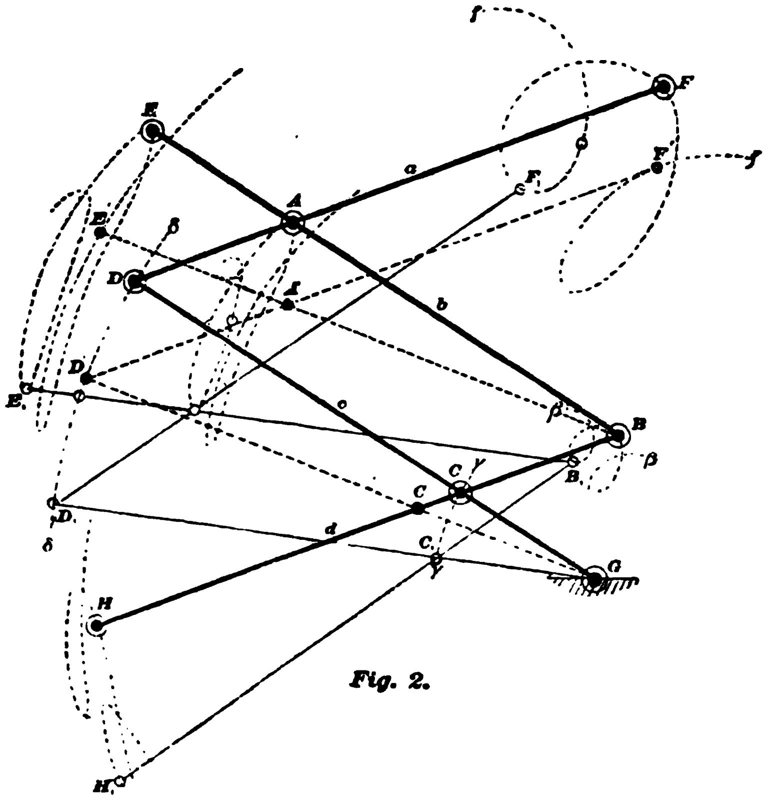

Fig. 2.

graphs, (2) straight line motions, and (3) valve gears.

(1) The first includes those mechanisms in which two or more points move in similar paths; (2) the second class includes those in which one point is made to move either exactly or very approximately in a straight line, without the direct use of straight guides; and (3) the third class refers to arrangements in which the motion of slide-valves depends upon the variable relative paths which can be given to one or more points in each gear. In the present papers it is proposed to give some examples of the first two classes combined, under the head of parallel motions, and the younger readers of this journal may find it worth their while to draw them out. First, a word or two as to the name. Rankine defines parallel motions as "jointed combinations of link work, designed to guide the motion of the piston-rod either exactly or approximately in a straight line, in order to avoid the friction which attends the use of straight guides."

This appears to be the ancient and honourable use of the term, as we find it so used by Watt himself in his letter to his son, in November, 1808, in which he explains how the idea of "the construction, afterwards called the parallel motion" originated (1784) in his mind, winding up with the famous declaration: "Though I am not over anxious after fame, yet I am more proud of the parallel motion than of any other invention I have ever made." But as thus applied the name cannot be said to be in any way appropriate, since no two points in any of these so-called parallel motions move in parallel paths. If, however, we call them what they really are—viz., straight line motions, approximate or exact, then the term parallel motions may be very consistently applied to combinations in which two or more points are made to move in parallel straight lines—viz., to pantographic applications of straight line motions, and it is in this sense the above heading is used.

(2) The Pantograph.

There are two varieties of this mechanism: (1) the ordinary pantograph, and (2) the skew pantograph, or plagiograph. The geometrical principle upon which the ordinary pantograph is based is very simple. It depends upon the well-known properties of similar triangles.

Let B D J H, Fig. 1, be any parallelogram, and let A K be any transversal* intersecting the sides B H, D J, and the sides D B, H J, produced at the four points A, E, G, and K. Further, let the figure be supposed to represent links pin-jointed together at B, D, J, and H. Then if one of these transversal points be made a fixed fulcrum or pivot, and the linkage be turned about that point, it will be found that the other three points on the transversal (1) always lie on a straight line passing through the fulcrum; (2) always move in similar paths in the proportion of their distances from the fulcrum. Thus, for example, suppose that we fix point A, and cause the point K to move in the straight line K' K, then it will be found that the intermediate points E and G on the straight line A K will in like manner move in the straight lines E' E and G' G parallel to K' K. Also if any other parallel link be added, such as C I, the same will be true of the the point F in which it is intersected by the transversal. F will move in the straight line F' F parallel to K' K. Further, it will be found that the range of motion in each case is proportional to the radii A E, A F, A G, and A K respectively.

For since by the nature of the construction supposed, opposite links must always remain parallel, then, by the principle of similar triangles, A E, A F, and A G must continue in the same ratio as A B, A C, and A D. But the three latter lengths are fixed—i.e., their ratio is constant. Therefore, the ratio of the three former lengths is also invariable. And if K L be drawn parallel to J D, and A D be produced to meet it, the same thing must hold good for A L and A K. Thus, A E : A F : A G : A K :: A B : A C : A D : A L (1). Therefore, the distance of any one of the four points E, F, G, and K from the fulcrum A is always in the same ratio to that of any other point, in whatever position the linkage may be turned. Again, by exactly the same reasoning it can be shown that B E : C F : D G : L K :: A B : A C : A D : A L (2)—i.e., that the ratio of the lengths B E, C F, &c., is also constant in all positions of the linkage. Therefore, if the points A, E, F, G, and K are on a straight line to begin with, they will remain on a straight line in all positions of the mechanism, and it has been shown that in all positions they preserve the same ratio of distance from the fulcrum. Therefore, the paths described by them must be similar, and proportienal to those distances.

This principle has had two important applications: (1) to the reduction or enlargement of drawings, and (2) to the duplication of straight-line paths in mechanisms.

Fig. 2 shows a line diagram of the drawing instrument known as the pantograph. It consists of four links connected together so as to form a parallelogram. One intersection of a transversal is made a fixed point, and the relative motions of the other two are employed to enlarge or reduce drawings. The four links are permanently connected at two opposite joints of the parallelogram; but the other two joints are made easily disconnectable for varying the scale of the reproduction.

There are two ways of using the instrument. In the one, the two describing points are on opposite sides of the fixed point or fulcrum joint, and in the other they are both on the same side. By the former arrangement the fulcrum may be fixed to the board between the drawing and the copy, but the copy is upside down relatively to the original. The other arrangement is as shown in Fig. 2, in which *a*, *b*, *c*, and *d* are the four links jointed together at A, B, C, and D. A line drawn through the hinge-joint B, for example, intersects link *a* at F, and link *c* at G. Then if G be made a fixed point, the distances G B and G F will preserve a constant ratio throughout the entire range of movement of the instrument. If, therefore, pencils or tracing points be placed at B and F, and one of them be guided to follow the outline of any figure within the range of motion of the instrument, the other will copy or reproduce it in the proportion of their respective distances from the fulcrum point G. Thus if B be the guided point, F will enlarge the representation in the proportion $\frac{F\,G}{B\,G}$; on the other hand, if F be guided, B will reduce the representation in the proportion $\frac{B\,G}{F\,G}$.

To alter the scale of the representation, it is only necessary to disconnect joints A and C, and fix them anew in some different position, taking care that the distances B C and D F are in the proportion required, and that the parallelism of the links is strictly preserved. Thus, for example, suppose that in F's reproduction of B's movements the scale of the representation is to be altered from $\frac{F\,G}{B\,G}$ to $\frac{F'\,G}{B\,G}$, the change can be made by disconnecting joints A and C, and altering the position of pencil F, making D' F' : B C' : F' G : B G or $\frac{D'\,F'}{B\,C'} = \frac{F\,G}{G\,B}$. The new setting of the instrument would now be as shown in heavy dotted lines, and F would follow B in the required proportion; but the same alteration can be made without the inconvenience of having to change the position of the pencil F on the link *a*. Thus let F D be a fixed length, and let the alteration of scale be as before $\frac{F\,G}{B\,G}$ to $\frac{F'\,G}{B\,G}$. Firstly, then, for joint C on link *d* we must have F' G : B G :: D F : B C' or B C'

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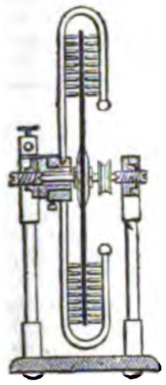
* Any line, straight or curved, which cuts a system of other lines.

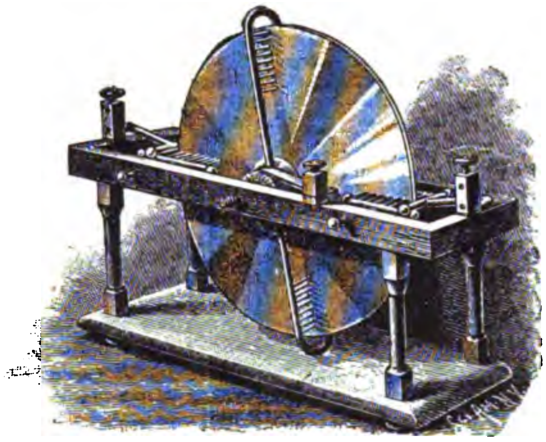
$= \frac{BG \times DF}{F'G}$. Secondly, for joint A on link *a*, we have D A′ = B C′. Again, since D G is a fixed length, we must alter joint A on link *b* and joint C on link *c*. For the former we have F′ G : B G : : D G : B A′ or $BA' = \frac{BG \times DG}{F'G}$. For the latter, viz., C on *c*, we have D C′ = A′ B.

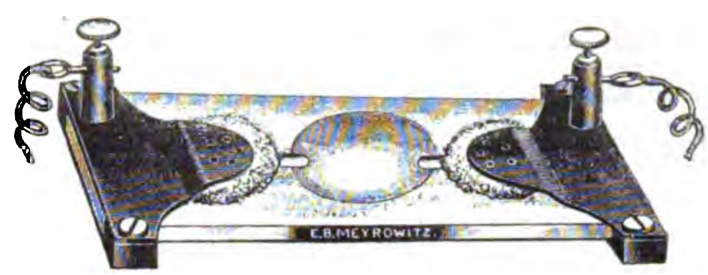
To enable such changes to be ready and accurately made, each link is graduated like a scale, and relative positions marked by the same number on all four links. To keep the links parallel to the surface of the paper and facilitate their movements on it, a roller is provided at D.

A SIMPLE FORM OF ELECTRIC MOTOR.

THIS motor, adapted for the use of students and for experimental purposes, especially intended to be operated by static charges, may be used with a different number of combs, or have the electricity thrown upon one side of the main disc only, is shown in perspective and vertical cross section in the accompanying illustration. It has been patented by Messrs. John W. Davis and John B. Farrington, of No. 32, East Forty-fifth-street, New York City. A dielectric disc is mounted to revolve centrally in the frame, the shaft on which it is secured having tapering ends pivoted in the inner socketed ends of screws, the screws being held in nuts sunk into the frame, and the bearings being insulated so that the electricity on the disc cannot be grounded. The disc shaft has a pulley on which a belt may be placed to run any light mechanism. At one side of the frame is a strip carrying a sleeve encircling one end of the shaft, both strip and sleeve being of rubber or other insulating material, and on the sleeve is mounted a hub having arms extending from opposite sides and bent over the edges of the disc, the arms carrying metallic teeth forming combs, the ends of the teeth nearly touching the disc and serving to conduct the electricity to it. The hub is held in fixed position by a set-screw, and has gauge marks by which the arms may be brought into a desired position. Electricity is supplied to the combs, the arms, and the hub by a contact strip resting on the hub and secured to a suitably connected binding post. Arranged on opposite edges of the disc, nearly at right angles to the combs on the arms, are other combs made in two parts, each part having an insulated shank mounted in the frame, these combs receiving the discharges from the disc, and their shanks being connected by a conducting-bar on the side of the machine opposite that shown. The combs on the arms and those held by the frame are arranged in slightly different planes, to prevent the electricity in one comb neutralising that in the opposite comb, and thus holding the disc at a standstill. Contact is made with the horizontal combs by T-shaped conductors, the ends of the shanks of which are bent at right angles and pivoted in binding posts, so they may be readily swung out of contact with the combs. With the binding posts on the ends of the frame connected with the positive pole of a source of electric supply, and the post near the hub connected with the negative pole, the electricity will pass from the horizontal combs upon the disc, which will then be repelled and attracted by the combs on the arms, thus causing the rotation of the shaft, the current keeping it in motion. The arrangement and connection of the combs is such that a greater or less number of them may be thrown into a circuit, according to the experiment to be made. The electricity is preferably supplied by an electric machine, Leyden jar, or some similar source.—*Scientific American.*






E.B.MEYROWITZ.

ELECTRO-MICROSCOPIC SLIDE FOR TESTING THE ANTISEPTIC POWER OF ELECTRICITY.*

THE accompanying cut represents an instrument that I have devised for the purpose of ascertaining whether or not electricity will destroy the life of germs. It is the result of a number of experiments to confirm the belief I have long held, that electricity is an antiseptic and disinfectant. I also learned while experimenting that Apostrali had made the same claim. The instrument consists of a glass slide, in the centre of which is a sunk cell. Two grooves, each ¾in. long, run from this cell outwards. Two brass pieces are fitted over the extremities of the slide in such a manner that the rounded points, the under surfaces of which are lined with platinum, will cover a portion of the grooves. These rounded points do not touch the glass, but are raised above the grooves about ⅛in. Binding posts are riveted to the brass for connection with a battery.

In order to apply this instrument, a sufficient quantity of the fluid containing the bacteria should be used to fill the cell and grooves. A cover-glass is placed over the cell and its contents. Two small clean sponges, saturated with either the fluid or distilled water, are then placed underneath the platinum points, and in contact with the fluid in the grooves. The bacteria are now ready for observation, the electricity is turned on and the quantity noted by the milli-ampère meter to stop all signs of germ life. They can now be cultivated on gelatine in the ordinary way should it be desired to determine whether or not their vitality has been entirely destroyed.

Other uses for this slide will readily occur to one working in this field; for example, the effect of electricity on the blood and different tissues. I have found this instrument very satisfactory, not only as an easy, but as a quick way of finding out the amount of electricity required to destroy micro-organisms.

HEATH'S CHANGEABLE SPEED GEARING.

THIS is the invention of Lawrence Heath, of Macedon, N.Y., and relates to that class of changeable speed gearing in which a centre pinion driven at a constant rate of speed drives directly and at different rates of speed a series of pinions mounted in a surrounding revolable case or shell, so that by turning the shell one or another of the secondary pinions may be brought into operative relation to the parts to be driven therefrom.

The aim of my invention is to so modify this system of gearing that the secondary pinions may receive a very slow motion in relation to that of the primary driving shaft, whereby the gearing is the better adapted for the driving of the fertiliser-distributers of grain drills from the main axle, and for other special uses.

Fig. 1 is a side elevation; Fig. 2 a vertical cross section. A represents the main driving shaft or axle, driven constantly and at a uniform speed, and B is the pinion-supporting case or shell, mounted loosely on and revoluble around the axle, but held normally at rest by means of a locking bolt, C, or other suitable locking device adapted to enter notches, *c*, in the shell. D is the primary driving pinion, fixed firmly to the axle and constantly engaging the pinion E, mounted on a stud in the shell. The pinion E is formed integral with or firmly secured to the smaller secondary pinion F, which in turn constantly engages and drives the centre pinion G, mounted to turn loosely on the axle within the shell, so that it is turned in the same direction as the axle, but at a slower speed. F′, F_2, F_3, F_4, &c., represent additional secondary pinions grouped around the centre pinion, mounted on studs in the shell, and made of different diameters, so that they are driven by the centre pinion at different speeds. Each of the secondary pinions is formed with a neck or journal, *f*, projected out through the side of the shell, so that the external pinion H may be applied to any one of the necks at will in order to communicate motion thence to the gear I, which occupies a fixed position from which the fertiliser or other mechanism is driven. In order to drive the gear I at one speed or another, as may be demanded, it is only necessary to apply the pinion H to the neck of that secondary pinion which is turning at the appropriate speed and then turn the shell bodily round the axle until the external pinion is carried into engagement with gear I, when the shell is again locked fast. The axle communicates motion through D, E, and F to the centre pinion, which in turn drives all the secondary pinions except F. If the external pinion is applied to F, it will receive motion directly therefrom; but if applied to either of the secondary pinions, it will receive motion through or by way of the centre pinion. It will be seen that all the pinions are sustained and protected within the shell.

The essence of the invention lies in the introduction of the pinions D and E between the axle and the series of secondary pinions to reduce the speed.

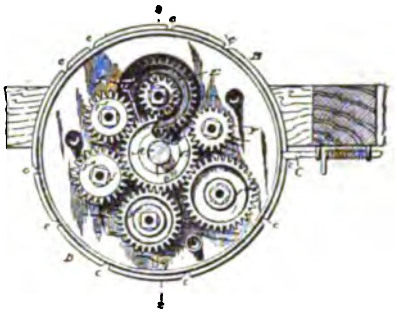


Fig. 1.

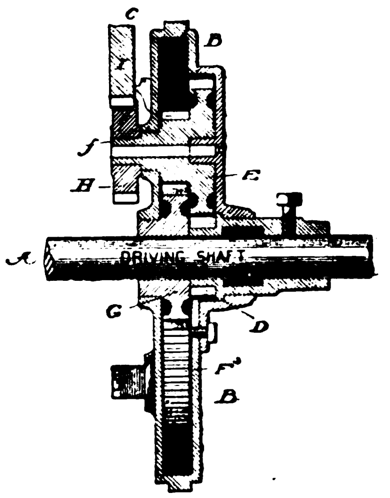


Fig. 2

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* By Robert L. Watkins, M.D., New York, in the *American Monthly Microscopical Journal*.

SCIENTIFIC SOCIETIES.

QUEKETT MICROSCOPICAL CLUB.

THE 296th ordinary meeting of this club was held on Friday, October 16th, at 20, Hanover-square, W., Dr. W. H. Dallinger, F.R.S., president, in the chair.

The minutes of the preceding meeting were read and confirmed. New members were balloted for and additions to the library since the last meeting announced.

A paper on "A New Cysticercus with Ten Hooks and Armed Suckers, and its Corresponding Tapeworm," by Mr. T. B. Rosseter, of Canterbury, was read by the secretary.

A vote of thanks to Mr. Rosseter for his valuable and interesting communication was proposed from the chair, and carried unanimously.

Two papers by Mr. Rousselet "On Two New Rotifers, Conochilus unicornis, and Euchlanis parva," and "On the Sense of Vision in rotifers" were read in the author's absence by Mr. Parsons. In his second paper Mr. Rousselet adduced evidence from his own experiments to show that rotifers possessed a real visual sense, and not simply a mere perception of light. It was pointed out, however, by Mr. Karop, Mr. Michael, and the President that these experiments were quite inconclusive, and while not wishing in the least to deny that rotifers did possess a visual sense, it was shown that the motions by which Mr. Rousselet mainly sought to prove his case—viz., avoiding each other and obstacles, pipettes, needles, &c., purposely introduced among them, were shared by organisms which had no visual organs whatever, and, as was stated by Dr. Dallinger, the lowest monads never came into collision with one another in all their varied and rapid evolutions, and however thickly they might be assembled.

Mr. Western gave an account of two male rotifers hitherto undescribed. 1. Notops clavulatus ♂, more transparent than ♀, having neither digestive organs nor foot, muscular system prominent, eye spot and large sperm sac, no vascular canals or vibratile tags, about one-third the size of ♀. 2. Triphylus lacustris ♂, no digestive organs, sperm sac, lateral canals, &c., as in ♀.

Votes of thanks were passed to Messrs. Rousselet and Western for their interesting communications, and the proceedings terminated. The next ordinary meeting will be held on Friday, November 20.

It is reported that a valuable deposit of coal has been discovered at Rangiriri, New Zealand. The first seam has been bored through, and has proved to be 6ft. thick. Below it were found 17ft. of very hard sandstone, then 4ft. of chocolate-coloured clay, and then a second seam of coal, very hard, and 12ft. thick. Below that again is fireclay. The depth so far reached is 233ft. to 234ft.

Damage from Lightning in Germany.—Lightning casualty returns have been made in conformity with a German Ministerial Order, showing the extent to which the buildings belonging to or under subsidy from the State have, within the period from 1877 to 1886, been damaged by lightning. The number of buildings with regard to which returns were collected was 53,502, of which 22,682 were actual State property, and 30,820 were entitled to State subsidy for rebuilding or repair. Buildings were struck in 264 cases, or about five for every 1,000 buildings in ten years. Of the various classes of buildings, the number struck per 1,000 for the period are as follows:—Elementary schools, 0·8; parochial houses, 1·4; revenue buildings, 1·7; prisons and penitentiaries, 3·4; forest-rangers' houses, 7·2; churches, 8·2: court-houses, 11·9; seminaries, 14·6; gymnasia, 15·4; university buildings, 24·1; domain buildings, 44·9; and horse-breeding establishments, 312·5. Those which are the property of the State are less subject to injury by lightning than those only under subsidy. Out of the 264 cases in which the lightning struck, 81, or not even one-third, resulted in a fire. The amount of injury wrought by lightning on the 53,502 houses coming within the scope of these statistics was £56,834, or £215 for each casualty, or 21s. per building in ten years—about 2s. per building per annum. The amount of injury done to domain and horse-breeding establishments was considerable, amounting to £42,000, or more than two-thirds of the total injury caused by lightning. It has been calculated, from the returns of 60 fire insurance companies of Germany, Austria, and Switzerland, embracing the period from 1855 to 1877, that the danger from lightning has increased two-and-a-half fold in those countries during the period named. The danger is said to have increased three-fold in Germany within the last thirty years. The average loss sustained annually by Germany from this cause is computed at from six to eight millions of marks. Casualties have thus increased in the period of lightning conductor extension.

SCIENTIFIC NEWS.

THE position of Wolf's comet on Nov. 3 will be at Berlin midnight R.A. 4h. 40m. 19s. S. Dec. 3° 36·6'; brightness, 11·44 as compared with unity at time of rediscovery.

The position of Tempel-Swift's comet for Oct. 30, as calculated by M. Bossert, for Paris midnight will be R.A. 21h. 33m. 30s. N. Dec. 11° 12·8'; brightness, 12·83 as compared with unity at time of rediscovery.

The minor planet discovered by M. Charlois at Nice on Sept. 24 will be numbered as 318. Dr. J. Palisa, of Vienna, has discovered two more—one on Oct. 12 and another on Oct. 15; but a revision of the list must be made before assigning numbers to them, though they are nominally 320 and 321.

The Rev. T. E. Espin, of Wolsingham, has found two new variables in Cygnus—namely, D.M. + 36°·3852 and D.M. + 49°·3239. Both are of a strong red colour, the first having a Type III. (Group II.) spectrum, and the other a Type IV. (Group VI.)

As president of the Birmingham and Midland Institute, Sir R. Stawell Ball, F.R.S., after distributing the prizes to the students, opened the session with an address, the main subject of which was the important part played by the spectroscope in modern astronomy. He said that "it seemed as if the prism, forsaking its chemical work on the heavenly bodies as having been practically achieved, was now about to constitute itself a revealer of movements of a kind utterly inappreciable to any other instrumental appliances." Our telescopes and other accessories of the observatory enable us to find the place of a star, but the spectroscope is enabling us to do much more. This subject is, as is well known, attracting much attention, and spectroscopy is now an important branch of work at all the suitable observatories.

M. E. L. Trouvelot has presented to the Paris Academy of Sciences a memoir entitled "Observations of the Fall of a Solar Prominence into a Spot," relating to some remarkable luminous filaments occurring in a group of spots, Aug. 6-10.

It is proposed that the great 40in. telescope which is being constructed for the observatory to be erected on Wilson's Peak, California, shall be exhibited at the Columbian Exposition (or World's Fair), Chicago, in 1893. The objective, which is being worked by Alvan Clark, is 40in. in diameter, or more than 4in. larger than the great Lick lens, and will cost about £12,000. The telescope complete, with mounting, will probably cost £24,000, and the observatory and dome about £6,000.

The appointment of Prof. J. E. Keeler to Allegheny Observatory has been signalised by one of those acts for which Americans are so famous. Mrs. Wm. Thaw, of Pittsburgh, has provided him with the requisite funds to purchase a spectroscope of the most efficient kind, and Mr. J. A. Brashear has, we understand, commenced its construction.

The Chamberlin Observatory near Denver, Colorado, is described by Prof. Howe, its director, in this month's *Sidereal Messenger*. The building, which has cost about £5,000, is the gift of the Hon. H. B. Chamberlin, of Denver, and is situated in the University Park, about five miles from the city, but close to the buildings of the University of which it will form a department. The observatory is to have a 20in. Clark equatoreal, which with the other instruments will be provided by Mr. Chamberlin, who, in addition, has also built the students' observatory, which now shelters the 6in. Saegmuller-Brashear equatoreal and the 2in. Saegmuller transit.

In the same issue of the *Sidereal Messenger*, Mr. W. H. Knight gives a rather long list of what he calls "some telescopes in the United States," part of the materials he has been collecting with a view to publishing a catalogue of the observatories of the world, with an account of their equipment and *personnel*.

The death is announced of Prof. Edouard Lucas, who recently presided at the meeting of the French Association for the Advancement of Science, at Marseilles, over the Section devoted to Mathematics and Astronomy. M. Lucas was injured whilst at Marseilles by a fragment from a pile of falling dinner plates, and on his return to Paris erysipelas set in, from which he died at the early age of forty-nine.

Mr. W. B. Watson, of Bolton, died recently in his eightieth year. He was one of Dalton's pupils, and assisted him in many of his researches. His name is often mentioned by Dr. Dalton as that "ingenious pupil of mine, Mr. William Barnett Watson."

Prof. Josef Petzval, who died last month, was born in Hungary in 1805, and for some years filled the chair of mathematics in the University of Vienna. In 1839, he turned his attention to the optical side of photography, and, in conjunction with Voightländer, produced the portrait combination. The orthoscopic lens was also worked from his directions, and he was also the inventor of the "opera glass" as now made by the leading opticians.

The death is announced of that promising young astronomer, Dr. J. C. Lamp, in his thirty-fourth year. He had been astronomer at Von Bulow's private observatory in Bothkamp, in Holstein, but when his health failed in 1888, he returned to Berlin, and assisted Prof. Auwers in his important investigations.

The next general meeting of the Institution of Mechanical Engineers will be held on Wednesday, the 28th inst., and Thursday, the 29th, at 25, Great George-street, at half-past seven each evening. The following papers will be read and discussed, as far as time permits: "On some Details in the Construction of Modern Lancashire Boilers," by Mr. Samuel Boswell (Wednesday); First Report to the Alloys Research Committee," by Prof. W. C. Roberts-Austen (Thursday).

There are two free admissions to the evening lectures and the laboratory in the Metallurgical Department of King's College, Strand, W.C., and those who cannot spare the ordinary fees should apply to Prof. A. K. Huntington, at the College.

The lecture next Sunday at St. George's Hall, Langham-place, will be delivered by Mr. Frank Kerslake, on "Rabies in Animals, and Hydrophobia in Man." On Nov. 1, the Sunday Lecture Society have arranged with Mr. W. L. Bicknell, M.A., to deliver a lecture on "Underground Russia: Authentic Prison Experiences in the Dominions of the Czar."

The Anniversary Meeting of the Mineralogical Society will be held in the rooms of the Geological Society, Burlington House, on Tuesday, Nov. 10, at eight o'clock.

Prof. Virchow was presented with the first Virchow gold medal last week. For this medal contributions have been sent from all sections of the medical world throughout the civilised nations. Frau Virchow was presented with a silver replica, and bronze copies were sent to the various scientific bodies subscribing to the fund.

Prof. Helmholtz has received a complimentary despatch from the German Emperor conferring upon him the titles of Privy Councillor and Excellency.

News has been received at the Meteorological Office, Rome, from Pantellaria, stating that a new volcano has been thrown up from the bed of the sea not far from the coast of the island, and that it is ejecting masses of stones and débris to a considerable height.

It is stated that at the beginning of next year telephonic communication will be opened between Brussels and Amsterdam. The line will pass through Antwerp and Rotterdam, where telephone stations will also be established.

Yeast has been tried at the Alfred Hospital, Melbourne, as a remedy in typhoid fever by Drs. Embling, Lemprière, and Barclay Thomson. In the report Dr. Thomson says: "Thirty-seven cases have been treated. Ten were severe, the temperature reaching or exceeding 104°; eight moderately severe, temperature reaching or exceeding 103°; eleven were mild, although the temperature reached 103°; eight were very mild, the temperature never being above 102°. In all recovery took place without any relapse. When commencing the use of the yeast, it occurred to me that if the theory that relapses are due to reinfection from the intestine is correct, then there should be none under the use of the yeast, as all the bacilli would be destroyed in the intestinal tube. This is so far borne out, for there was not a relapse in the thirty-seven cases under yeast; while in the 107 cases otherwise treated in the hospital there were sixteen relapses."

The Lauffen Frankfort electric transmission plant is now said to be working well at a pressure of 17,000 volts. There has, however, been one accident, resulting in the death of a workman who entered the transformer house against the rules, and was altering a lamp.

A firm in Marburg propose to utilise a waterfall of 180ft. at St. Lorenzen, 18 miles distant, for the production of current to be transmitted to their works. The fall is equal to about 600 H.P., and it is calculated that 450 H.P. can be transmitted.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

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A REMARKABLE METEOR.

[32825.]—I FIND that the meteor seen by me on the 11th, as described in your columns last week, was observed in other parts of Wales. For instance, Mr. E. J. Cope writes me as follows from Brecon: "The sky was cloudy, but the meteor *appeared* to be this side of the clouds. It lasted about 15 seconds, and then vanished behind a very black cloud on the horizon. It was so bright, that you could see to read small print, and it looked to be about the size of the moon. The centre was Y^2, the outer portion YG^3, and the tail Or^4. The tail was composed of large granules. Time 6.35." Mr. Cope appends a diagram.

Llanelly. **Arthur Mee, F.R.A.S.**

[32826.]—I WRITE a few lines in haste to say that, being at Acklington, Northumberland, on Saturday evening, Oct. 10, as I was leaving the station I saw a remarkable meteor, very similar to that just pointed out to me as recorded in your paper of Oct. 16. The sky being much overcast and cloudy, I saw a bright light, of varying intensity, in the clouds; but I doubted whether it might not proceed from the station lights, until I got on the road, when I took it for a display of the Northern Lights, and then suddenly a flash, as of summer lightning, came about us, and I heard a woman exclaim, "What light is that?" It did indeed very much resemble the Aurora Borealis in the clouds, and after the flash the appearance soon passed away. **E. Hudson Edman.**

Thornton-le-Moor Rectory, Caistor, Oct. 19.

[32827.]—ON Sunday evening, October 11th, at 6h. 5m. p.m. local mean time, a very large and bright meteor passed in sight here. The sky was clear, but the strong twilight, by hiding all stars, prevented its course being noted in the usual manner. I was able, however, to measure (very roughly) the following: Position, when first remarked, about half a point south of east (true meridian); altitude at same time 20°. Altitude at disappearance (from explosion in a shower of sparks), 15°; horizontal angle between these points, 40°; lat. of place, 31′ 4″ North; long. 6° 46′ 58″ West; time of flight estimated by my wife, 6 secs.; by me, 4 secs. It was bluish-white, far brighter and larger than Jupiter. I did not see its first appearance, it being already in full brilliance when I noticed it.

E. M. R.

WOLF'S COMET—NUMBERING OF π ORIONIS.

[32828.]—I SAW Wolf's comet last night with a 3½in. Dollond, power 40, so easily that I fancy it might be seen with much less aperture.

Your chart of the comet's path, given on p. 105, seems to follow Proctor's numbering of the six stars in Orion, marked π. His atlas numbers them, reading from north to south, 4, 2, 1, 3, 5, 6. But Dien's atlas, Heis's atlas, and Cottam's charts, number them, reading the same way, 1, 2, 3, 4, 5, 6; while McClure's Klein numbers them (without the Greek letter) 7, 2, 1, 3, 8, 10. **B. Noble.**

Newcastle-upon-Tyne, 13th Oct.

[32829.]—MR. LANCASTER (32790) seems to think it improbable for this comet to be seen with less than 4in. I managed to get a sight of it on Sept. 26 in beautiful air with a 3in. and a power of about 40. On that date at about 9·45 I began searching for it, and continued to do so without success till 10.30.

It then occurred to me that if I waited till Taurus got higher above the horizon I should have a better chance of seeing the comet. I therefore suspended seeking it, and engaged in other observations till about 12 hours. About that hour I commenced the search, and found the comet at 12h. 15m., near 63 and 70 Tauri, and just visible as a nebulous speck of the tenth degree of faintness. As to being able to see it with less than 1in., as Mr. Moore has done, I, with my 3in. stopped down to 2in., failed to see it. I tried for the comet again on Oct. 3, but the weather was not of the best, and I failed to see it.

E. Reginald Blakeley.

Dewsbury, Yorkshire.

"F.R.A.S." AND PROF. VINCE.

[32830.]—IN the last letter of "A Fellow of the Royal Astronomical Society" in your columns, he gives an anecdote about Vince, of which it might be desirable to mention the source, particularly as the writers of the "Dictionary of National Biography" are proceeding so rapidly and steadily with their task, that they seem to be almost within measurable distance of even the letter "V," late as it is in the alphabet.

"F.R.A.S." speaks of Vince's Devonshire pronunciation. In Rose's "Biographical Dictionary" it is stated that Vince was born of poor parents at Fressingfield, in Suffolk—a county which, I believe, does not border on Devonshire. Nor can I find any record of his having had any connection with the latter. With regard to his sentiment apropos of duelling, I presume most of us now would agree with him, except that he might, perhaps, have used a stronger expression. If anyone were to call me, for instance, a liar, the fact of his doing so would of itself prove him to be so great a liar that whatever he chose to say would not be of the slightest consequence to me, and, beyond telling him so, I should not feel called upon to take the least notice of it. But my sole object now is to suggest to "F.R.A.S." that if he has access to any particulars respecting the private life of Vince, he should communicate them. **W. T. Lynn.**

PECULIAR RAINBOWS.

[32831.]—REFERRING to "R. S. M. D.'s" letter (32806, p. 157), I may say that I saw here a very similar rainbow to the one he describes, in August last.

There had been heavy rain all the afternoon, but shortly before sunset the rain ceased, and the sun shone out brilliantly from between two heavy banks of clouds not very far above the horizon. A very fine rainbow soon appeared with a reflected bow above it, and shortly afterwards two additional bows appeared inside the primary one. The red and orange colours of the two lower bows were, however, so overlapped by the violet of the upper bows as to be completely hidden. The lowest bow was very unsteady, and kept diminishing and increasing again in brightness every few seconds during the ten minutes or so which the phenomenon lasted.

Ashtead, Epsom. **A. K., F.R.A.S.**

VIOLIN-MAKING.

[32832.]—IT is quite a pleasure to see "A Student" (letter 32698) looking at violin-making from a point from which, as far as I know, none has done. The experience that I have in the matter shows me that violin-making is in the hands of excellent workmen, but that they know scarcely anything of the acoustical and not even mechanic proportions required to make a good violin. This is merely an assertion of mine, but I can prove it. Of course the violins which are made now are all very near those of the old masters from which they are copied; but near in this respect is really worse than far away, because a little farther still would make it right. The science of acoustics, or the law of vibration as I call it, is known only by the leaves and branches up to now, but the tree is still out of sight. It is astonishing to see the height that the science of engineeeing has attained, and yet the law of vibration—the most important in the science—is not studied. I crave permission here to ask the engineers of "Ours" whether it be known that mechanical proportions (i.e., lever No. 1), for instance, are correct only when the machinery or body is at rest, and that for the harmonious working of a machine may be wrong in its proportions of length, form, thickness, &c. "A Student" asks (No. 1): Has this analogy been noticed before? Not that I know of, and I think I have read all that has been written about the violin. However, I do recollect having seen something similar stated — namely, that the length of the breast taken as the ground tone, across the upper part of a fifth, and so on; but the internal space has only been tried by the blowing over the *f*-hole. (No. 2) To a certain extent, yes. But the air inside the body of the violin is set in vibration by the body, and the body having to resist the tension of the strings arranges itself into acoustical proportions when set in vibration quite independent of the mathematical proportions which in your calculations depend on lines only. **J. H. Schucht.**

ARTIFICIAL INCUBATION.

[32833.]—"INCUBANS" flatters me by suggesting that I can add anything to the knowledge possessed by our readers on the subject of incubators. It is true I have experimented for amusement in this line; but I cannot speak as to the possibility of making a financial success of artificial incubation, though I cannot see why this should not be done, and on a very large scale indeed. I have used many forms of incubator, but none with the absolute success of the first one I had. This was not self-regulated; it was simply a large tank well packed in a stout wooden case with felt, the tank holding some 10gals. of water. The drawer under this tank was very freely supplied with air, the bottom of the drawer and of the incubator being of perforated zinc. There was also a close row of holes in the wooden case, all round the incubator, just below the tank and above the level of the eggs.

I kept this incubator in a room, which was of a tolerably unvarying heat, being near the kitchen range, and I had a big saucepan on an iron tripod, with a lid fitting tight and a tap at the bottom, standing on the top of the case. The tap from this saucepan was over the filling tube of the tank, and there was a little gas-stove under the saucepan; the saucepan held about four gallons of water. Connected with the lid there was a small pipe, which descended under the perforated bottom of the machine, and as the gas-stove was always burning with a small flame, there was always a little cloud of steam ascending into the egg-drawer. At morning and evening I turned on the gas-stove until the water in the saucepan boiled, then drew off four gallons of water from the tank, and replaced it with the boiling water from the saucepan. I suppose that every man must find for himself the details of the proper heat of the tank, distance of eggs from the tank, temperature of room, &c.; but boiling water is always the same temperature here below, and this fact is the basis of safety in the non-regulating incubator. My eggs were an inch from the tank, and the tank usually was at about 150° Fahr. at the top, which means not quite so hot at the bottom.

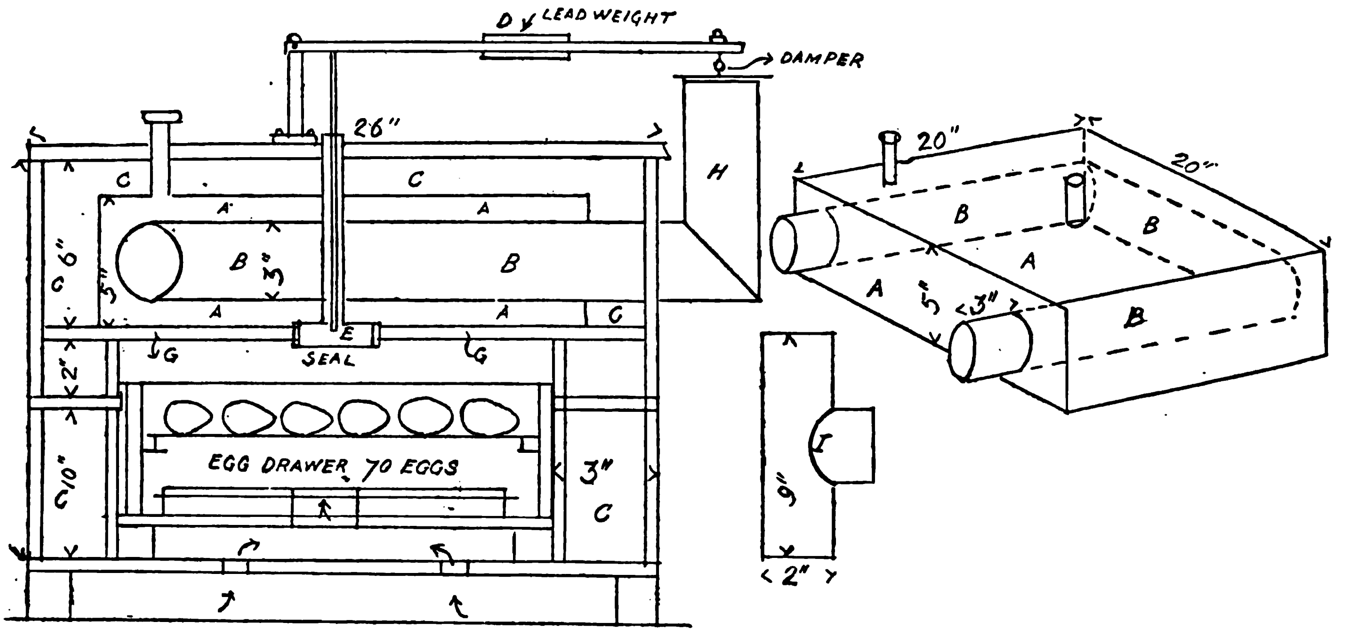
I kept the egg-drawer, at the level of the eggs, at from 104° Fahr. down to 100° quite easily, the temperature of the room being about 65° Fahr., and I hatched out fully 90 per cent. every time.

In Vol. XXXIX. of this our paper, page 235, there is a sketch of the only thermostat I have used with success, though, of course, there are many others and better ones—Hearson's, for example—and in the same volume, on page 471, there is a drawing of the self-regulating incubator, which I used for some time with success, having the thermostat attached, and with the addition of the automatic regulation of ventilation in case of overheating.

My experience is that it is not easy to give too much air to the eggs; if the heat is kept up to 104, the free access of air under the machine over the whole surface of the bottom is necessary, and this air must always be moist, steam gently rising under the machine being the best way to secure this; but the presence of a tray of water under the egg-drawer, and some arrangement by which the air entering below is obliged to pass over this film of water, answers the purpose almost as well.

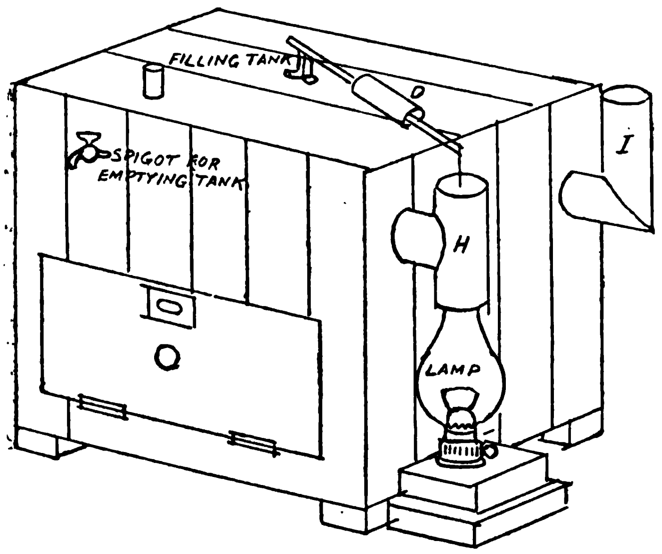
I have found that under hens there is no loss of weight in the eggs, such as is nearly always found in the incubator: we cannot prevent a little evaporation from the egg in the earlier and more fluid part of the life of the egg; but it is necessary to reduce this evaporation as low as possible, and, as the greatest risk is during the earlier days, the first week, I have found (contrary to the advice given in the letter of "Incubans") that it is best to surround the eggs with more moisture at first: it is necessary all through, but specially at first. I have had good results by preventing evaporation by a very slight oiling of the eggs, but it is necessary to avoid choking the pores of the shell up with oil, a little lanoline (an animal fat) smeared on the hands and then all apparently rubbed off again, and then handling the eggs daily with the fingers is sufficient. The hen certainly oils her eggs, as may be seen by dipping them in water after a few days' incubation.

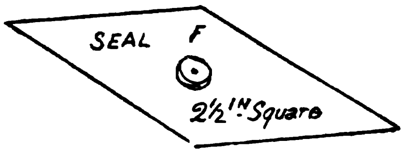
With regard to the question of turning the eggs, the hen turns them very frequently. She pushes the outer ones with her beak, and makes them take

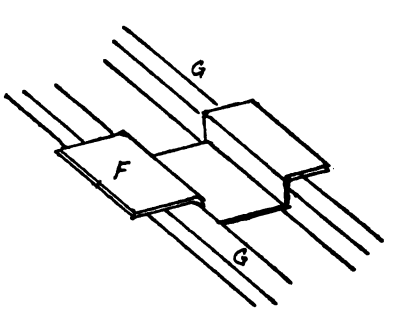


Section of Incubator—(Scale one-eighth to 1in.)

A, Zinc Tank, 20in. square, 5in. depth; B, Sheet-Copper Pipe, 3in. dia.; C, Sawdust; D, Weight on Lever; G, ¾in. Iron Rod.







General Appearance of Incubator.

the place of the inner ones. The eggs are shifting very frequently during the day, and this causes not only turning, but the exposure of the eggs in turn to an alternating temperature, those next her body being the hottest, of course; but the outer eggs being far cooler. If a marked egg be placed close to the hen, it will be found to have travelled to the outer part of the nest before many hours have elapsed, and will again go close to her after a few hours' exposure to a cooler part of the nest.

I think that the daily cooling of the eggs is therefore a great necessity, and it should be done twice a day, the eggs being gently rolled round at the same time, without lifting or shaking. In practice, I do this by having the space of one row of eggs empty in the drawer. A slight tilt of the drawer will roll them to one side, partially turning them round, and I prefer to cool them by placing a frame containing a non-conducting substance, such as felt, between the eggs and the hot tank, at the same time opening the bottom of the incubator, which is made to drop out; this avoids the loss of heat from the drawer and tank which the removal of the drawer causes; but in the latter stages of incubation the eggs do not lose vitality by removal and very considerable cooling.

I should think that the artificial incubation of eggs on a large scale, and by means suitable for unskilled persons to conduct, is quite feasible, and the best means and the least expensive would be a room with a number of tanks supplied with boiling water by pipes running round the room, the water being heated by a fixed boiler and fire in a shed outside or attached to the room. It would not be difficult to learn the requisite external and internal temperature of the room, the tanks, and the boiler, and the intervals of changing the water necessary to keep the tanks at the proper heat.

I have often wished to find time to work out a contact incubator, one in which the water should be only in small bulk, and kept at the temperature of 104 by a regulator, the containing part of the machine being a rubber bag, which should rest on the eggs, touching them at one point only with a surface at the natural temperature; the eggs should be placed upon a bed of damp earth, and free ventilation secured by chopped straw under them. I am convinced that the surrounding of the eggs with an atmosphere of hot air, is the cause of the too great evaporation and drying up of the eggs, which is the great fault in our incubators, and a closer imitation of nature would avoid this. I have not heard of any experiments in this direction, but perhaps there may have been such.

Gerard Smith.

Craigholm, Upper Clapton, Oct. 16.

INCUBATORS.

[32834.]—In the "E.M." just now there are inquiries about incubators, and, as I constructed one for myself early this year which was a success, I venture, with your permission, to let all the readers of the "E.M." have the use of my plans. I hope they will be understood, as I am quite a novice yet at drawing.

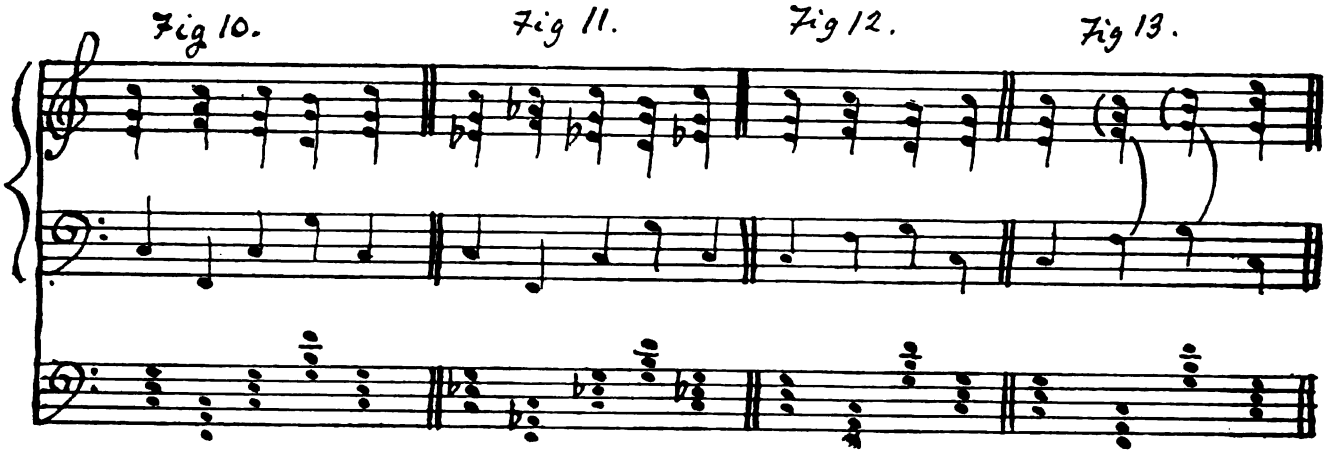
I have marked them all; but should anyone not understand them, I will be pleased to send sketch of any part. The piece marked "Seal E" is constructed of two sheets of very thin brass. When finished, it is not more than ⅛in. in thickness, and is filled with ether, and soldered up; it lies in the iron piece marked F. The part F is supported on two ¾in. square iron rods, marked *g*; these rods support tank across the centre, and are 3in. apart. H is the funnel; I is a sort of tie-piece, and goes on at the lamp end, and has a lid, or damper, suspended from the end of lever; the rod J is pointed at both ends, and goes between the seal and lever. The ether boils at 90°, lifts the lever and damper, and lets the heat pass off; but as soon as it cools, down comes the damper, then the heat must pass through the pipes. It has been a great success, and no trouble.

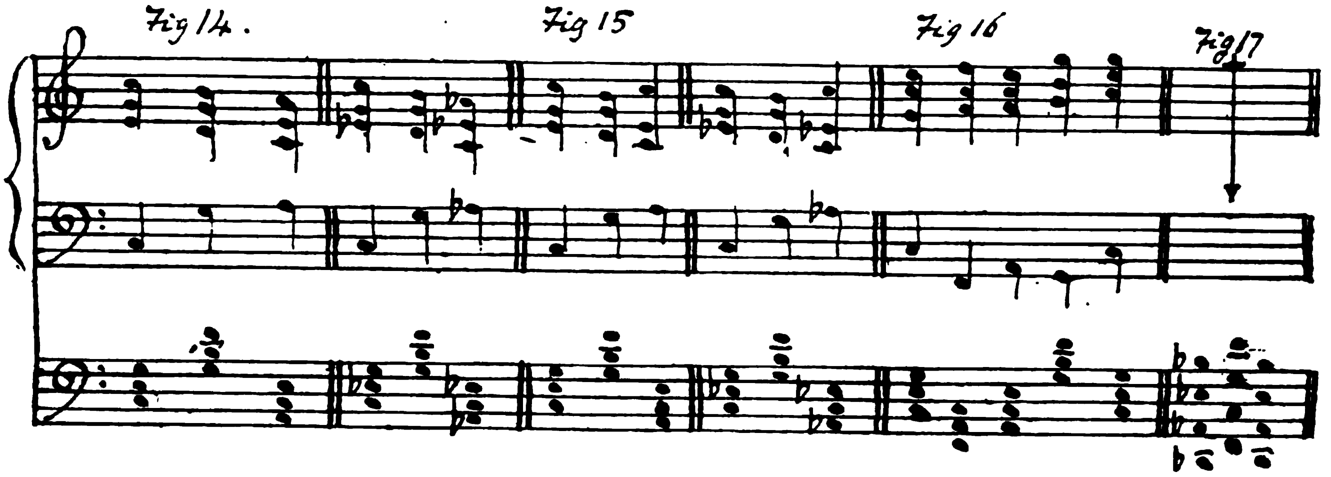
Cottoun, Glencarse, Perth, N.B. **Fraser.**

TO "SIGMA."

[32835.]—"Sigma's" letter (32742) on Lightning Space and Ether, &c., is most amusing. We must, in accordance with the dictum of Immanuel Kant, demand of "natural" science that it substitute at all points mechanical causes (*causæ efficientes*) for intelligent causes (*causæ finales*), considering that mechanics alone provide a real explanation of phenomena. Therefore, how are we to explain the transmission of heat, light, and electricity from the sun and stars to us? We know that these forces or energies are modes of motion in "matter"; how, then, can they be transmitted to to us except by and through matter? I feel compelled to postulate for an "ether" a space-filling matter, whatever may be its nature or properties. It appears to me an absurdity as great as the creatures living in two-dimensioned space to think of any kind of motion passing through a "vacuum" of, say, only 90 millions of miles. I should like "Sigma's" or other "non-ethereal" gentleman's opinion on this "matter."

Spiritualists are too much in the habit of conceiving force and energy as something "apart" from matter, which can be taken in and out, like a horse from a cart—a most erroneous opinion, reminding me of the railway company who charged a





less rate of carriage as "empties" for discharged accumulators than for charged ones.

In conclusion, we have no "evidence" whatever, anywhere, of will, force, or energy as acting "separate" and independent of matter or a material medium, nor of matter entirely, absolutely void, or deprived of force. F. W. H.

THE PRINCIPLES OF HARMONY.

(*Continued from page* 136.)

[32836.]—In my last paper the analytical meaning and the relations of the two tonic chords, the two subdominants, the relative minor tonic, and what I have ventured to call (following Parkinson) the relative major tonic chords explained, the experimental postulates being:—(1) That the direct intelligible concords are the fifth and major third (ignoring the octave); and, (2) The most natural progressions consist in varying the meaning of some note of the last chord, preferably the root or the fifth.

It was assumed that the interval of minor third is not directly intelligible. It is here, however, convenient to point out that the reasoning is not invalidated if this be disputed, so long as it is admitted to be less definite in meaning than the major third. Its character is less firm and clear than the major third, which is all that the argument requires.

Just as the major and minor subdominant chords progress to the major tonic chord, so do the two tonic chords progress to the major chord of the dominant; that is, the major chord of the fifth of the tonic. This chord naturally leads back to the tonic chords. Fig. 10 shows the tonic progressing to the subdominant, returning, then going to the dominant, and finally to the tonic, in the major mode; and Fig. 11 exhibits the same progressions in the minor. The reason why the chord of the dominant is major will be understood from the progression of the major tonic to minor subdominant, treated of in the last paper. The concluding chord may, of course, be major. The chords of the subdominant and dominant, both leading to that of the tonic, as a position of rest, whence they have both proceeded, determine this central chord as the tonic chord of the key of C. Only when they have both been heard is the key settled: it is otherwise indefinite. Still stronger is the influence of the key felt if, after the subdominant, we spring at once to the dominant, and thence to the tonic. But in this case the position of the upper parts of the dominant should be so chosen that the tonic chord reappears in the position to which the subdominant would lead, as in Fig. 12, not as in Fig. 13. It will be seen that the chords of the dominant and subdominant are disconnected, and in disconnected chords care must be exercised in the progression of the parts: otherwise the faults become audible as sequence of octaves and fifths, as shown by the ties in the last example. Indeed, the advice of Dr. Hiles is never to use disjointed progressions of chords without adding a dissonant note to one of them, to obviate the abruptness of the progression. If this rule is disregarded, as it must be when consonant chords alone are under consideration, it is a safe plan to make the fifth of one chord become the octave in the next, or *vice versâ*, as the case requires. The progression No. 12 can be reversed, but as the dominant chord has two notes dissonant with the tonic, a restless character is imparted to it which leads one to expect the tonic chord to follow; hence the progression from the dominant to the subdominant is not so satisfactory as the reverse motion.

The chords of the relative tonics, A minor and A flat major, are composed of notes entirely consonant with the tonic C, and form alternative positions of rest for C E or C E flat, as the case may be. To fill this alternative function, their intervals should hold the same relative position as would the tonic chord; not in another position, as would happen when they are derived by progression from the chords of C major or minor, in which case they are determined as *other than* tonic chords. If these chords be approached from the dominant, this would entail the falling of the leading-note, as the third of the dominant, B, is called, to the octave of the bass A flat or A. To obviate this progression, contrary to the character of the leading-note, it is more usual to omit the octave in the upper parts and allow the B to rise to C, thus doubling the third of the chord. Fig. 14 shows these progressions with the leading note falling; Fig. 15 with the B rising to double the third, C. The alternative positions of Fig. 15 are also possible positions, in which the chords of C could follow the dominant. Modern theorists, however, prefer to avoid the doubling of a third in consonant chords, with some exceptions, among which these progressions may be included. The reverse of these progressions is also practicable, the dominants being major, and falling on the tonic.

The chords so far studied fall into three systems, giving the materials for three modes of C; that with the tonic, dominant, and sub-dominant all major, gives the major mode; that with the dominant only major gives the minor mode; and that with the tonic and dominant major, the sub-dominant minor, the minor-major mode, as it is called by Hauptmann.

Compositions are not professedly written in this last mode, though by the use of accidentals the construction of passages of considerable length is seen to be of this character.

The notes thus far determined are the smallest possible number to constitute a key, to show a tonic chord in the centre between the dominant and subdominant chords. If progressions be so chosen as to exclude those which decide the key—that is, of dominant and sub-dominant, with or without the tonic, the key remains undecided. Thus, though Fig. 16 is presumably in C major, the key is not perfectly defined, through the interposition of the chord of A between the sub-dominant and dominant chords. If, instead of the chord of A, the chord of C had been used, as in the first chord, the key would have been decided, as can be easily verified. The progression would also be free from a technical fault, to which I need not further allude. It follows that if we introduce relative sub-dominants to the relative tonics A, A flat, we shall not determine a new key as long as we omit the dominants of these keys. The scheme of sounds will then be as in Fig. 17 (without the B flat). The additional notes will be denoted by italics, *D*, *D* flat, to distinguish them from D, the fifth of the dominant. The *D* thus introduced differs from the other D in pitch by a comma $\frac{81}{80}$, and the construction of the table is such that whenever two notes, nominally the same, appear with an apparent interval of two octaves between them, there is this commatic difference, the higher note occupying the higher position. The higher D is $\frac{9}{8}$, the lower *D*, a minor third under ($\frac{5}{6}$) the fourth, F ($\frac{4}{3}$), therefore, equal to $\frac{10}{9}$. Now $\frac{9}{8} = \frac{81}{80}$ of $\frac{10}{9}$. These added notes are called the *sub-auxiliary* notes of the mode (Parkinson), and do not appear in the scales of C. We have now, besides the scales of C, the notes of the "descending scale" of A minor; and, with the exception of B flat, the notes of the scale of A flat major. (In a former communication I omitted to point out that the *D* of the scale of A minor is not the same D as of the scale of C.) We may now add the B flat, secure that we shall not unsettle the key of C as long as we avoid progressions of the relative dominants and relative sub-dominants, with or without the relative tonics, which would transform these into actual, independent keys. The diagram, Fig. 17, is nearly as symmetrical as was the simpler Fig. 8; it still exhibits vigorous connections of thirds and fifths, free from all approximation or doubt. In my next, I shall complete the list of sounds naturally connected with the mode of C, explain the natural compound chords, and, if space permit, pass on to the subject of chromatic chords, to which the present matter is a necessary preliminary inquiry.

Arts Club, Manchester. R. C. Phillips.

(*To be continued.*)

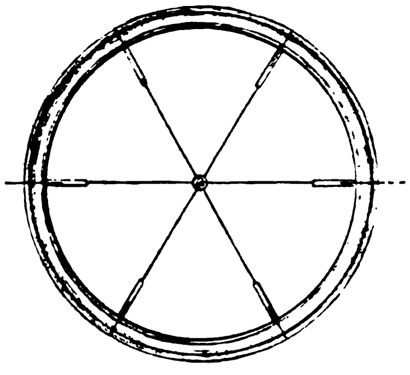
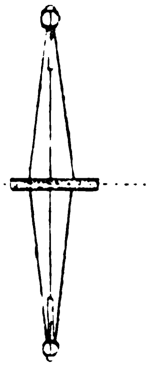
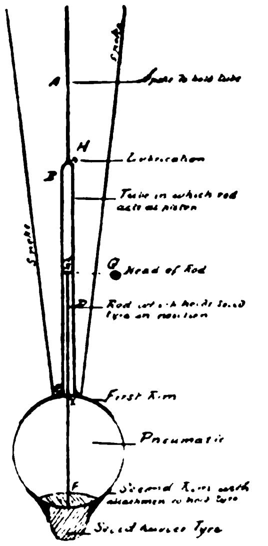


Fig I



Section

Fig II


Spoke
A
Spoke to hold tube
H
Lubrication
B
Tube in which rod acts as piston
Spoke
G
Head of Rod
D
Rod which holds Solid Tyre in position
E
First Rim
Pneumatic
F
Second Rim with attachment to hold tyre
Solid Rubber Tyre

Section enlarged

Fig III

PNEUMATIC TIRES.

[32837.]—My suggestion to Mr. Chas S. Beal (letter 32787) would be to plant on the pneumatic a spring-steel rim, with attachment to hold solid rubber tire. To keep it in position, and to prevent slipping to either side, I propose the following:—Fig. 3, A, spoke, on end of which a tube, B, about double the diameter of pneumatic in length, fitted on to first rim with screwed socket, C, so that it may be taken off for cleansing. In this works a rod, D, which passes through hole E in first rim, and screwed into second rim at F. On the end of rod in tube there is a brass head, G, which fills the tube easy, with hole through for passage of air, the whole forming cylinder and piston. At the joint of spoke and tube there is a lubricator, H.

By using, say, six of these, I believe the additional solid tire would be held firmly in position, and thus make a protection to the pneumatic from stones, broken glass, &c., and at the same time distribute the contact pressure, as far as practicable, equally over the rim. The working of the machine would also be made easier, as the contact area is much reduced. J. M. G.

CABLE TRAMWAYS.

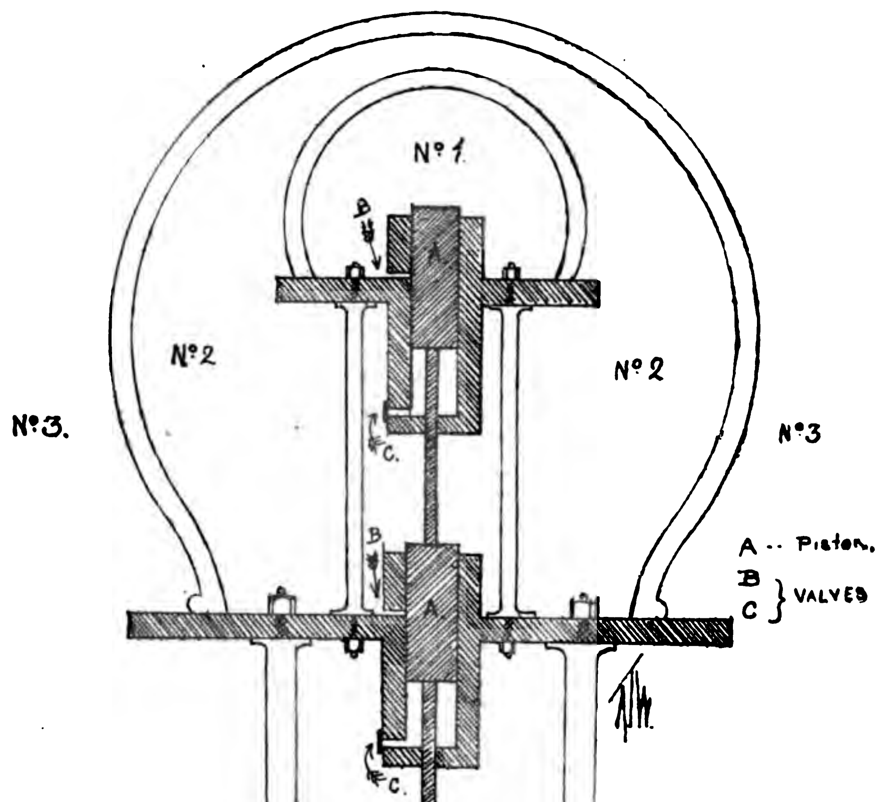
[32838.]—In these days of electric, cable, and other tramways, I think it would be very interesting if we could go back 53 years, and see the old London and Blackwall Railway at work, with its two wire cables, each of a length of seven miles, and its service of trains every quarter of an hour. There were powerful stationary engines at the Minories and at Blackwall, with two large winding drums at each place, the line being a double one. An extension was soon made, at an enormous cost, from the Minories to Fenchurch-street, and the trains were worked by impetus and gravity. Hempen cables were first used; but, owing to frequent breakages, wire ropes were substituted. These were covered with hemp to prevent the noise of the revolving pulley-wheels which supported the rope at intervals of a few yards between the rails. After a time this covering wore off, and was not replaced. The train at starting from either terminus consisted of nine or ten carriages, one being detached and dropped at each intermediate station, as Shadwell, Stepney, &c. The main train passed along without stopping. On the return journey these separate and detached carriages were attached, by means of an ingenious "grip," to the cable, and were hauled back one by one, the guard in charge throwing off the rope as the revolving drum was approached. Sometimes this could not be effected, and serious accidents occurred. Lever and not screw brakes were used in those days. For starting the stationary engines the needle telegraph was employed as a signal when all was ready, a message being sent from one end to commence winding at the other. When the rope had nearly all run off the drum, a tell-tale signal gave notice to stop.

I believe all the mechanical contrivances were designed by Mr. George Bidder, C.E., and were certainly most ingenious. The weight of the two wire ropes—each over seven miles long—must have been enormous. If any description of this early railway could be obtained, it would be most interesting—the width of the gauge, the design and horsepower of the fixed engines, the size of the winding drums, the form of the grip, &c. Perhaps you would kindly publish in your columns any facts and figures you can obtain, and also give a few illustrations showing the machinery employed.

Clare, South Australia. John W. D. Bain.

RE THE VACUUM.

[32839.]—The space above the mercury in a barometer is called a vacuum; but as energy does not exist without matter, and light passes through this space, it is evident that it contains matter, and, therefore, cannot be a vacuum. Is it possible to obtain an absolute vacuum?—i.e., unoccupied space. An ordinary air-pump will not do it, for this reason: that at some point it will be impossible to remove any more gas, because the amount of gas let into the cylinder of the pump, even when compressed at the end of the cylinder, will not have a greater pressure on the valve to open it than the pressure of the air to keep it closed. But if, instead of trying to empty the vessel direct into the air, we try to empty it into another vessel which is itself exhausted into the air, we shall be able to obtain a greater difference of pressure between the inner vessel and the air than could be obtained direct. If x represents the pressure of the air, and y the difference in pressure between any vessel and the one into which it is exhausted, then if we have n vessels, the pressure in the innermost vessel will be represented by $(x - ny)$. It is easy to see that, mathematically, ny can be made greater than x; but practically ny cannot be greater, but may be equal to x; so, provided a compound air-pump can be made, there appears no reason to doubt the possibility of reducing the pressure to nil.



Suppose, now, that the pressure was reduced to nil. The gas would have no inclination to expand any more, provided the temperature remained constant; nor would the gas now occupy an infinite space, for, though every time the pressure was halved the volume was doubled, the expansive force of the gas would at some point equal the force of cohesion, and at that point the expansion would stop. And since there is no reason for us to think that energy in the form of gravity would cease to exist, it seems reasonable to conclude that, besides reducing the expenditure to nil, we would create an absolute vacuum, through which no light would pass.

On account of the cost I cannot myself try the experiment; but in hopes that someone will care to try it, I enclose sketch of a compound air-pump, as referred to above. It is with a view of hastening the death of the "ether jelly" theory that I propose this experiment, which, should it be successful, will settle the question for ever.

11, Old Broad-street, E.C. A. T. Wheeley.

CHIMING CLOCK.

[32840.]—The somewhat complicated mechanism of chime clocks can be considerably reduced by adopting the locking-plate in place of the rack for letting-off the quarters and the hour. The great advantage, as most readers know, claimed for the rack in the striking train is that if, by any mischance, the clock stops, or the striking is let off accidentally, it invariably strikes the correct number of blows at the next hour, because the striking depends upon the position of the snail and hands, and not on the number of blows last struck, which latter the locking-plate arrangement does depend on; therefore the clock has to be struck all round again or the hour hand moved (independently of minute hand) to the hour corresponding with the number of blows last struck. A good clock, however, should not stop once in a year, and if it should strike wrongly on this account (which it probably would not do), it could be set right with very little trouble. As regards the quarters, the locking-plate here has a distinct advantage over the rack, because if each quarter chimes a different tune, as Westminster or eight bells, repeating the quarters will, of course, cause a complete confusion in the chimes, which is some trouble to put right again. This cannot happen with the locking-plate. If it chimes the incorrect quarters, it can be set right by simply "chiming round" until the correct one is reached. A few chime clocks are, I believe, made with a locking-plate for the quarter train; but the majority use the rack, and all English clocks use the rack for letting-off the hour. Being able to *repeat* the hour, which can only be done with the rack, a cord being attached outside the case for that purpose, was, I presume, invented for telling the time in the dark. I should think, however, striking a light would be now no more trouble, and certainly more efficient.

I am not advocating the disuse of the hour-striking rack, except on the score of simplicity. The simpler a clock is, the less likely it is to get out of order, and the easier it is for an amateur to make. I refer chiefly to those who do not feel themselves competent to tackle the rack, yet might feel inclined to try their hand at the locking-plate. Where clocks are made in wholesale quantities, it is no doubt just as easy to fix and make a rack as a locking-plate arrangement, and perhaps more suitable for the people who buy them, and who practically know nothing about clocks. I possess a chime clock constructed partly from details given some years ago in the "E.M.," without racks, snail, standard, &c. It has never failed to chime or strike correctly, and from the simplicity of its parts, any error could be at once detected. Some of these clocks, especially when gongs are used, require a rather heavy weight—40lb. or more on double line. There appears to be a diversity of opinion as to whether copper wire in strands or gut line is the better of the two. No. 15 B.W.G. would be about the size. Will readers give their opinion? **G.**

A NEW GAS-ENGINE.

[32841.]—I was much struck by the sketch of the gas-engine on p. 178 of your last issue. Could we not have a little more information on the subject?

Is the engine of the silent or compression type? Has it a governor? Is there a hot-tube ignition? Does the foundation form the water tank?

25, Grange-road, Eastbourne. **F. A. M.**

[It is a pity the maker does not quickly advertise in "Ours." Hundreds of people are waiting to buy the first cheap, good gas-engine that is put on the market.—Ed.]

EXTEMPORE MICRO-ERECTOR.

[32842.]—Beginners find a difficulty in operating under the compound microscope, owing to the reversed appearance of the object. They will be glad to know that an effective substitute for an erecting glass is a ½in. or ¼in. objective, inverted, and resting on the eyepiece. By its means scales and diatoms may be arranged, vegetable vessels isolated, and delicate dissections made.

H. E. Ebbage.

WASTED FOOD.

[32843.]—With reference to letter 32796 by J. Gerrard, under the title "Wasted Food," which appeared recently on p. 156, "E. M.," I think the following book would suit his purposes:—"British Edible Fungi: How to Distinguish and Cook Them," with coloured plates of upwards of 40 species, by M. C. Cooke, M.A., &c., published by Kegan Paul and Co., London. **T. A.**

WINDING MAGNETS.

[32844.]—This hint may be useful to some. Instead of using paper to cover any defective spot in the wire, or to cover the iron core, use ordinary tracing linen; shellac holds to it well. It is as thin as paper, does not tear, and any architect or engineer will give you a piece to try with. **Lynx.**

SCIENTIFIC ADVERTISING.

[32845.]—I have had the curiosity to refer to the passage indicated by "F.R.A.S." in his letter (32810) as validating his attack upon an official of the R.A.S. It is part of the annual account of work done at Mr. Common's observatory, Ealing, and is as follows:—"Both the grinding machines have been kept in constant work. A 36in. mirror of 11ft. 3in. focal length has been made for the Science and Art Department, South Kensington." Mention is also made of work done on three 30in. mirrors, and on two 20in. mirrors, for whom intended is not stated; but one of the 30in. mirrors was made with a spherical curvature to test flat-mirror surfaces, and seems probably designed for Mr. Common's own use. Evidently the mention of the special bête noir of "F.R.A.S."—namely, *South Kensington*, has provoked his anonymous attack. There can be no other reason for it. If, indeed, Dr. Turby is right in his guess as to the identity of "F.R.A.S." the position of the latter on the council of the R.A.S. condemns him of negligence in allowing the passage in question to appear without contest in the printed report, which has to be adopted at the annual general meeting. It seems to me that the passage quoted is only indicative of a pardonable pride in the amount of work turned out by an amateur. Whether Mr. Common makes any profit or not on the manufacture of mirrors I do not know, nor could I see any reason for objecting to it if he did; but of this I am convinced: that it is far better that his grinding tools should be much employed than that they should deteriorate from want of use. **A. Freeman.**

Murston Rectory, Kent, Oct. 16.

REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[74632.]—**Varley's Universal Galvanometer.**—Many thanks to Messrs. Cheesman and Culley for their replies to my query. At the same time, I should like to point out that R_4 is a separate bobbin of wire underneath the base of the instrument, with connections as shown in Fig. 3, p. 344, the object of which I should like to know. Also for what test terminal G is used? Are Varley's sets of resistance coils B.A. ohms? **A. W. C.**

[75000.]—**American Organ.**—Would "Practical Organ Builder," who says in last week's issue that he has used "thousands" of those pallet springs at one shilling a set, explain whether they were used in organs built in America or in the low-priced rubbish made in this country? Perhaps he will also kindly tell us where the springs are made. **Etienne.**

[75256.]—**River Punt.**—I now come to a plug for the punt. Most people know who live by the river how inconvenient it is to have to remove the boards of your punt or boat (as the case may be), and "bail out," and running the risk of scratching your boat. With my plug all that is necessary to drain your punt is, to take it to your landing stage, tie up one end, and so the water may run down; then remove the bar, lift one part out of the other, and out runs your water in three minutes. If you have to bail out the water, you will find it a very tedious job. Fig. 1 shows the plug complete, with the rod (C) out. Fig. 2 shows the top part (*a*) ready to drop into B, passing through the staples ready to be fastened down by the rod C. H are the staples, R an indiarubber band fastened round A, so as to make it water-tight. Fig. 3 shows side view of the plug. Fig. 4, part (B) ready to be screwed down to boat, the rod being taken out, and part (A) dropped in. Fig. 6 is the appearance of plug when fixed in boat. Fig. 6 shows plug fixed in (P) punt. The rod (C) can either be fixed on the plug or in the boat, so that there may be no chance of losing it. The plug does not damage punt. You need only cut a square hole in corner of punt, so as to enable B to fit in. I shall be pleased to show Mr. Brewer a model of one of my plugs. **C. G. M. Bennett.**

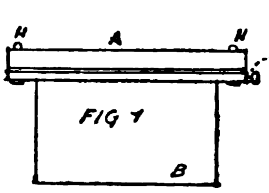
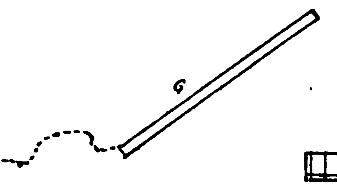


FIG 1



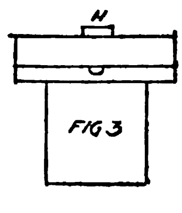


FIG 3

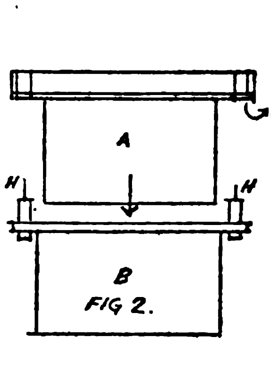
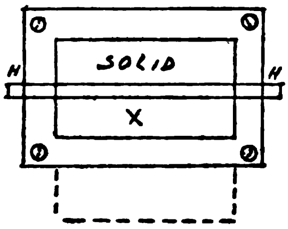


FIG 2.

FIG 4



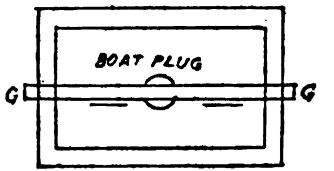
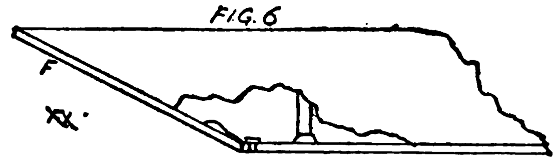


FIG 5

FIG. 6



[75266.]—**Raising Water.**—The water can probably be raised by means of an hydraulic ram, but it is useless to attempt an answer without more details. There are several illustrations in back numbers. Possibly a windmill and pump might be made to answer if a storage tank could be erected, or an intermittent supply would suit. **Nun. Dor.**

[75267.]—**Crown Iron in Concrete.**—Premising that I do not know what "crown" iron is except as a trade brand, I should think that an iron rod protected by 2in. of concrete would not be very much affected by differences of temperature. "Hoop" iron is frequently (almost invariably in good work) used for strengthening brickwork longitudinally, but I never heard that its expansion and contraction, according to the temperature, dislocated the bricks. I think "M." may safely put his iron rod (diameter of which he does not give) into the concrete wall. **Nun. Dor.**

[75273.]—**American Organ.**—With reference to what Mr. Schofield says at the end of his reply, on p. 180, I have only to say that I do not want to know how he fits "couplers to harmoniums." I asked him to explain for the benefit of the readers of the "E. M.," and as I stated definitely some years ago, I am not going to publish my name and address, as I am not in the trade, and I don't want to be worried, as "Sigma" was, by a lot of private letters which it might seem discourteous to leave unanswered. I will reply to any definite question to the best of my ability through these columns over the signature **Organon.**

[75276.]—**Carbonising Wool.**—Thanks to "W. A. G." for reply, which I can follow, but should like details of drying closet. What material is used for shelves inside, as I believe the acid will destroy both wood and iron. To "Sea-side."—I wish to carbonise rags, which are half wool and half cotton; quantity, say, from ½ to 1cwt. at each operation (this could be made any quantity). I should like to hear from "Sea-side" in your next a full description of the muriatic acid gas process. **Fibre.**

[75296.]—**Amateur Soap-Making.**—I suppose this querist need only add the ordinary carbolic acid of commerce to his soap to obtain what he wants: it will be brown enough. **M. T.**

[75298.]—**Valves for Water-Engine.**—What sort of a water-engine? If it is an engine by which motive-power is obtained by the action of water, then the ordinary slide-valves, as used in steam-engines, will do as well as anything. **N. M.**

[75333.]—**Fishing Nets.**—I notice that "Eos," in reply to this query, is not quite up to date in his information. For many years hemp and flax fishing nets have given place to cotton except for the heavier seine (inclosing) nets and trawls. The Irish, Scotch, Manx, and English drift fishermen use cotton, and in Mount's Bay the mackerel seines are being recruited by cotton in place of hemp twine. Nearly all cotton nets used by the abovementioned fishermen are cured by several dippings in a hot solution of cutch before using, and an occasional dip after, quantity varying in different districts, in Mount's Bay 3lb. to 4lb. per net of about 20lb. weight being used at each tanning. Sometimes creasote, tar, or oil is used with the cutch, or after. At Yarmouth and Lowestoft, where day herring fishery is carried on, the cotton is used white, and is cured by saturating with raw linseed oil, taking about a month to dry.

W. P.

[75318.]—**Raising Water.**—An overshot wheel 3ft. diameter would answer "Waterloo's" purpose. GEORGE E. CLARK.

[75350.]—**Sections of Iron.**—The following may interest "Ferrum":—The following is a description of the process that I have found best adapted for preparing specimens of iron and steel for microscopical examination. The main feature of the process does not differ essentially from that pursued by Dr. H. C. Sorby, who may be considered the authority so far as this country is concerned in this branch of microscopical science. It was from a lecture by him that I had the pleasure of listening to some ten years ago that I learnt the method that I am about to describe, and I have found it in all cases to give most satisfactory results. Care should be used in selecting the samples from average commercial specimens, and only those whose origin, history, and process of manufacture can be clearly traced should be used at first, otherwise very erroneous conclusions are apt to be arrived at. All specimens that are sufficiently soft to admit of it should be sawn from large pieces, and a Star hack-saw is about the best saw to use for the purpose, as they will cut much harder material than the usual hack-saws of English manufacture. Some of the cast irons which are too hard to saw should be broken into suitable small pieces by a hammer. The samples should then be reduced by filing or grinding to small plates about ¼in. square, and about $\frac{1}{16}$in. in thickness. In this condition they should be carefully cemented with old hardened Canada balsam to the surface of the ordinary 3in. × 1in. glass slips, heat being used to melt the balsam. The slips with the pieces of steel cemented on should then be allowed to become quite cold; the upper surface of the specimen should then be rendered quite flat and parallel to the surface of the glass slip by filing or grinding. If grinding has to be resorted to, it is best done with emery and water on a block of zinc. The filing or grinding is to be continued in every case until it is certain that all the parts of the metal disturbed by the saw have been removed. The samples should next be carefully ground with water on a razor hone until all file marks are removed. They should then be polished with crocus powder (oxide of iron) on a piece of leather—the leather being glued to a piece of wood to keep it straight—until the surface of the sample presents an even and highly-polished appearance, free from all scratches. Each sample, when sufficiently polished, should be at once immersed in a 5 to 10 per cent. solution of nitric acid in water (other acids have been tried, but I always found the one mentioned the best for iron or steel), and allowed to remain in the dilute acid some few minutes; the exact time can only be found by experience, as it varies greatly; but as soon as the surface begins to dull in the least, they should be moved from the acid bath into clean and slightly warm water, and any slight deposit of carbon on them, which will be apparent by the yellowish-brown tint of the sample, carefully washed off, using the tip of the clean finger as a rubber. The sample should then be removed from the water, and a thin cover-glass placed upon it; the thin film of water will keep this in place by capillary attraction. In this condition, after carefully absorbing any superfluous water on the slip by blotting-paper, they should be placed under the microscope and examined with an inch objective, using, of course, condensed light to view them by. If the structure is sufficiently developed, and this after a little practice will be quickly seen, the sample should present a sharp and well defined crystalline or fibrous appearance: if it is patchy the etching has not been carried far enough, and if it shows a worn appearance, it has been too long in the acid bath. In the former case it should be reimmersed in the acid; in the latter it should be put on one side, and the grinding and polishing repeated. If the sample is satisfactory, and its structure well developed, it should be removed from the stage of the microscope, and immersed in alcohol or methylated spirit. This will serve to absorb the water, and also to loosen the hardened balsam surrounding it. In this state it can be removed to another slip, or the superfluous balsam removed. The slips with the adherent samples should be removed from the alcohol quickly, drained on blotting-paper, and flooded with benzine or benzole to drive off the alcohol. Before the benzine has time to evaporate and leave a dry surface on the specimen, Canada balsam dissolved in benzine should be dropped upon it, and the usual cover-glass placed on, and the slips put on one side in a warm place to allow the benzine to evaporate and the balsam to harden. The superfluous balsam should afterwards be cleaned off, and the usual ring of paint put round the cover-glass, and the specimen becomes a permanent object for reference. I have found that the principal thing to be guarded against was exposure of the sample to the air after etching, as if this was done, oxidation soon set in and the sample, as a microscopical object, spoilt. I have prepared many dozens of specimens in this way, many of which I have succeeded in photographing. I inclose three photographs, but I do not think it is possible to reproduce them.

G. F. YOUNG.

[75371.]—**Gas Furnace Casing.**—Your correspondent, T. C. Smith, in transgressing the law that everyone should write only what he knows, sets a bad example, and one which, if followed by others, would render the replies to queries worse than useless. That furnace casings can be made with asbestos and many other useless and objectionable materials, is, of course, possible; but asbestos cannot exist on a properly-burnt fireclay casing, for the very simple reason that it fuses, and forms a flux with the clay at a clear red heat. Ordinary asbestos fuses quite easily in the flame of a common match or wax taper, and a gas furnace casing made with fireclay and asbestos only has the serious objections that it is too good a conductor of heat, and therefore wasteful; that the highest temperatures cannot be obtained in it for the same reason; and it is specially liable to burst when suddenly heated internally. I have tried fireclay and asbestos years ago, and consider it one of the most worthless mixtures ever used for the purpose. 999.

[75377.]—**Blower for Gas Generator.**—The gasoline gas producer worked by weights referred to by "M.R.C.S." is made by Muller, Mary Ann-street, Birmingham; but it is a very much more expensive arrangement than the one your correspondent has in use. THOS. FLETCHER.

[75402.]—**The Harvest Moon.**—I beg very frankly to apologise to "F.R.A.S." for my inadvertence in misunderstanding, and consequently misrepresenting, one of his remarks. At the same time, at the risk of incurring a fresh rebuke for my "purism," I venture to take exception to the mode in which he has set the whole matter before your readers, as being likely to give rise to various misconceptions in the minds of those who are unfamiliar with astronomical relations. He says: "When the moon is in that part of her orbit which makes the least angle with the horizon, she rises for some nights running at nearly the same time. Now this part of her orbit lies in the neighbourhood of the so-called First Point of Aries." Now surely the angle which the moon's orbit makes with the horizon is the angle at which the plane of the orbit is inclined to the plane of the horizon; but at any given moment this is the same for all parts of the orbit. If any one will take a celestial globe mounted with an horizon-flat, and set the pole at the proper elevation for his latitude, and then turn the globe round, he will see that in the course of one revolution (answering to one rotation of the earth on its axis) the Ecliptic, and with it the moon's orbit, including that part which is in the neighbourhood of the First Point of Aries, assume successively all the inclinations to the horizon which at that latitude they can possibly have, and that they do this every day. He will also notice what is the cardinal point in the whole matter, that the inclination is at its minimum when the First Point of Aries is in the east, and only while it is in the east. If the moon has come to that period of her journey when her track lies in the neighbourhood of this point, we get (as "F.R.A.S." most properly points out) the phenomenon of her rising in some phase or other at nearly the same time for three or four successive days, at some time or other in the day or night. If the moon is opposite the sun, and therefore full when she rises, this gives us the Harvest Moon, which, owing to the conditions referred to, can only be seen at the time of the autumnal equinox, just as her rising as a crescent three or four times in succession at nearly the same time can only take place about the time of the vernal equinox, as in that phase she must be near the sun. When the sun is neither at, nor opposite, the First Point of Aries, and the moon in some phase or other is near that point, it may rise with but small retardations for a few days successively at any time of the day or night according to circumstances. If the moon is full at the time of the vernal equinox, she will set at nearly the same time (about sunrise) for three or four days in succession. But the tiro must not fail to observe that provided the First Point of Aries is in the east, the track of the moon, in whatever part of her orbit she may be, is at that moment making the least possible angle with the horizon. Also his celestial globe will show him, when properly set, that since at the Equator the horizon passes through the Poles, and at the Poles coincides with the Equator, the inclinations of the Ecliptic and of the moon's orbit to the horizon at those extremes remains invariable during the revolution of the globe, for which reason there can be no harvest moon at the Equator or at the Poles. C. P. M.

[75420.]—**Motor for Boat.**—I, for one, should be very much obliged if Mr. Smith would kindly give particulars of the simple oil-engine. I have no doubt this would interest many other readers of "Ours." F. J. G.

[75436.]—**Nasik Squares.**—This appears to be the smallest numbers wherewith to make 36 squares nasik, as suggested, p. 161, by "T. S. B." The numbers range up to 49, as in the square of 7; and as the latter would sum to 175, or 7 times the 25 (middle number), the present sums to 150, or

1	17	41	49	33	9
42	47	30	8	3	20
29	10	6	21	40	44
7	19	37	43	31	13
36	45	34	14	5	16
35	12	2	15	38	48

6 times the same omitted middle number. Dividing the whole down the middle, you see that two corresponding numbers in the right and left halves, make 50. The omitted numbers are 25, and those differing 1, 2, 3, 7, 14, and 21 from it.

E. L. G.

[75436.]—**Magic Squares: Nasik Variety.**—In reply to "E. L. G.," p. 181, I proceed to show how a *nasik* magic square of six can be made.

FIG. 1.

1	3	6	7	5	2
6	7	5	2	1	3
5	2	1	3	6	7
1	3	6	7	5	2
6	7	5	2	1	3
5	2	1	3	6	7

FIG. 2.

1	3	6	7	5	2
7	5	2	1	3	6
1	3	6	7	5	2
7	5	2	1	3	6
1	3	6	7	5	2
7	5	2	1	3	6

FIG. 3.

11	33	66	77	55	22
67	75	52	21	13	36
51	23	16	37	65	72
17	35	62	71	53	26
61	73	56	27	15	32
57	25	12	31	63	76

Select any six figures capable of being arranged in two rows of three figures each, so that both rows add alike, and all three columns add alike. The smallest numbers capable of such arrangement are 1, 2, 3, 5, 6, 7. Thus:—

$$\begin{array}{ccccc} 1 & 6 & 5 & = & 12 \\ 7 & 2 & 3 & = & 12 \\ \hline 8 & 8 & 8 & & \end{array}$$

Then arrange them in the top rows of two blank squares, so that the alternate numbers have the same summation (thus: $1 + 6 + 5 = 3 + 7 + 2$), and so that, likewise, the sum of the first and fourth shall equal that of the second and fifth, and that of the third and sixth, 1, 3, 6, 7, 5, 2, fulfils these conditions. That done, the rest is easy to those who understand La Hire's method. Repeat the numbers in all succeeding rows in the same relative order, commencing those in Fig. 1 with the third number in the row above, and those in Fig. 2 with the fourth number in the row above. On superposition, after multiplying every number in one of the squares by a number *not less* than the greatest in the other, we get a nasik magic square. In this instance we have supposed every number in Fig. 1 multiplied by 10. The result is Fig. 3, which adds 264 in each of its 6 rows, 6 columns, and 24 diagonals. The method may be varied in a great number of ways, which I leave to the ingenuity of the reader; but the above is the simplest. If the numbers in one square, instead of being multiplied by 10, are multiplied by 7, and then 7 subtracted from each, the result is a nasik square of 6, of the lowest possible summation—viz., 150. It is scarcely necessary to point out that the square given by "J. S. N." is not nasik. He has made the same mistake as S. J. Burton, and has not rightly understood the difference between nasik and non-nasik magic squares.

New Athenæum Club. T. S. Barrett.

[75448.]—**Electrolysis.**—Thanks to Mr. Smith for reply. My aim in wishing information about this was to see if there was any method similar to the Moebius process for a cyanide solution. The Moebius process separates the gold from the silver in the one operation. By using the platinum plates, we get the gold and silver mixed on the negative plate. I am aware that the gold and silver can be precipitated; but it takes such a long time to do so, that it cannot be used on the large scale. I shall be glad of further information on this subject.

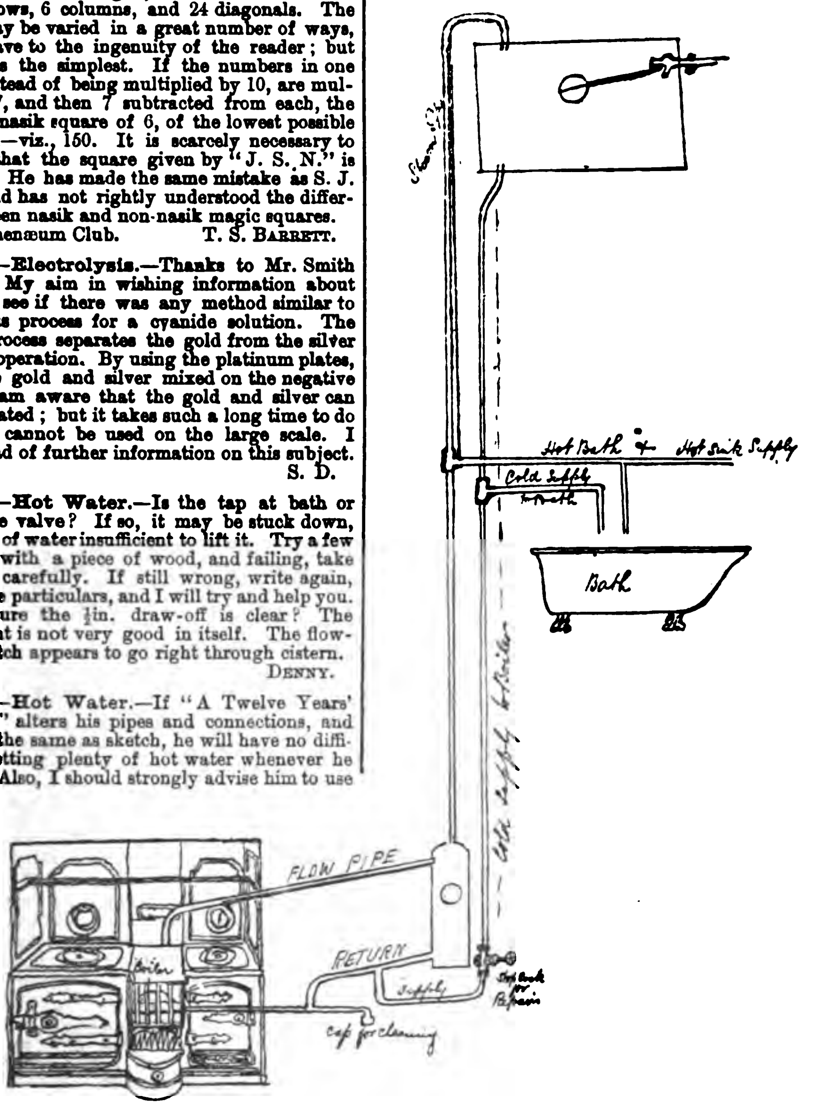
S. D.

[75437.]—**Hot Water.**—Is the tap at bath or sink a loose valve? If so, it may be stuck down, and weight of water insufficient to lift it. Try a few sharp taps with a piece of wood, and failing, take tap apart carefully. If still wrong, write again, giving more particulars, and I will try and help you. Are you sure the ½in. draw-off is clear? The arrangement is not very good in itself. The flow-pipe in sketch appears to go right through cistern.

Denny.

[75437.]—**Hot Water.**—If "A Twelve Years' Subscriber" alters his pipes and connections, and puts them the same as sketch, he will have no difficulty in getting plenty of hot water whenever he wants it. Also, I should strongly advise him to use at least 1in. pipes, and, for a good job, 1¼in. or 1½in. are preferred. I have never in my experience used pipes for this purpose smaller than 1in. I can answer to this working perfect, having practically fitted houses in the same manner.

A. H. Brake, R.P.C.



[75479.]—**Slide-valve Setting.**—It is always best to set traction engine slide-valves when steam is up, because the boiler is then expanded a little in length. If you set the slide-valve with boiler cold you must allow about ¼ or ⅜ more opening to back port.

Traction Engine Driver.

[75479.]—**Slide-valve Setting.**—All valves should be allowed more opening on back where the engine is on boiler, as the boiler lengthens when under steam, and the motion does not. Mark off your engine on guide-bars hot and cold, and find the difference; but all pins, link-reversing lever, and sector must be in good condition, or your valve and beat of engine will be wrong. Sometimes, when reversing-lever is fixed on tender, the bolts of same give way, the tender drops back, so the lever goes with it and throws the valve out of truth.

M. W. S.

[75479.] — **Slide-valve Setting.** — To A. Marriot.—Many thanks for reply, but what I cannot understand is, if I set the valve of spindle to give the same port opening on both sides, as you say in your reply, the exhaust beat is entirely out; the beat from the front port is clearly heard, but the beat from the back port is nearly lost, or only a shattered thud. But if I allow a bare ⅛ more opening on back side than I do on front side, the lost back stroke is recovered—that is to say, if the front port opens to steam ⅜in., the back port must open ½in. to get an equal stroke from both sides. My friend tells me his engine is just the same. I think they came out like it from shop; but I fail to see the cause of it myself, as there does not appear to be any more lost motion on back side than on front side.

Engine Driver.

[75486.] — **Jumper Flies.** — "Sufferer," the provision curer, will, I believe, find the following a far more simple and economical way to rid himself of the pest of jumper flies than any external application (which generally has a deteriorating effect upon the hams): Immediately the hams are removed from the salt and tied for drying they should be hung in a perfectly dark drying-house, and never removed into the light until placed upon the market, as experience has taught me that all kinds of flies have a strong aversion to complete darkness; and, of course, absence of flies means absence of eggs. The hams also mature more perfectly in the dark.

G. Rayner, Provision Merchant.

57 to 61, Hampstead-road.

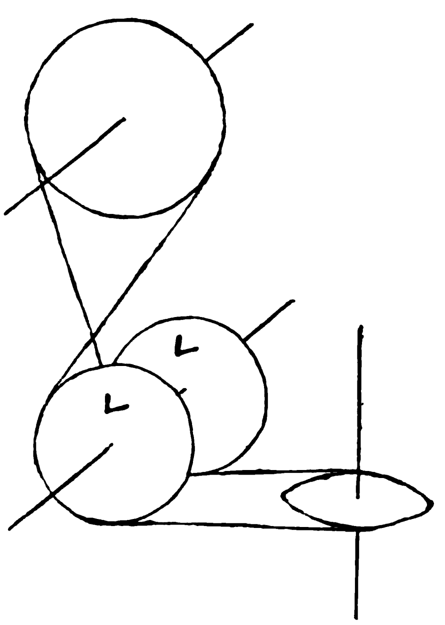
[75488.]—**Screw-cutting.**—If you cut a number of parallel notches round the circumference of a wheel, it is clear that the portions left must be wider at the circumference than they are nearer the centre. In the same way, using a square-ended tool for cutting a square thread, the portion not removed by the tool must be thinner at the bottom than at the top, even in a screw of moderate pitch, but very perceptibly so in high-pitched screws, such as we find in stamping or cutting presses. The tool for cutting the nut for a so-called "square" thread of high pitch requires to have a peculiar shape given to it. Firstly, it must be wider at the end than it is lower down, and the sides must be curved convexically, giving to the tool the general outline of the smaller half of an egg, with a piece of the rounded end cut off. After the thread is got to full depth, the groove requires widening by shifting the tool slightly between the cuts in a direction parallel to the lathe-centre line. As first produced by such a tool, the groove is naturally a parallel one, and requires both sides widening and curving to fit the thread of the male screw. The proper curve can be determined by drilling a hole in an iron bar of same size as the screw, and driving in a plug, and then cutting a screw, of which the plug will form an integral part, and then driving out and using the plug as a pattern for the tool to be adopted for cutting the internal thread itself. Or a simpler plan still would be take a bar of size of the bottom of the finished screw, and let the plug project, and to shape that alone, as if it were a portion of an ordinary male thread.

J. K. P.

[75495.]—**Lift.**—My inquiry was for a load of 6cwt., not ½cwt., as given in "E.M." this week.

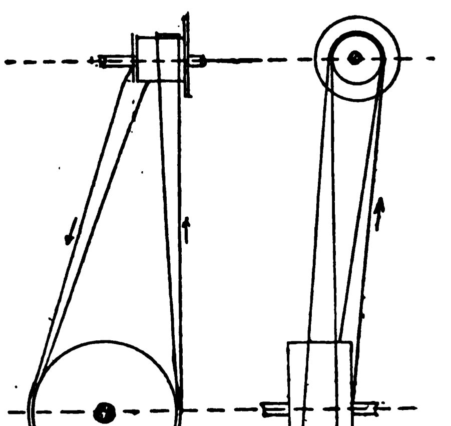
[redacted] S. J. Bishop.

[75515.]—**Pulley.**—I have been for some time working as shown by sketch. The two pulleys marked L are supposed to be live pulleys, and placed close together, as most convenient for the requirements of "C. G." I find this very useful for light work.



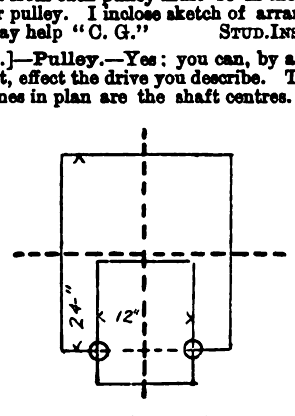
Wm. Hosken.

[75515.]—**Pulley.**—In answer to "C. G.," I may say that it is not only possible, but quite simple, to run two pulleys at right angles to each other with a belt, provided the following condition is adhered to—viz., the point at which the belt is delivered from each pulley must be in the plane of the other pulley. I inclose sketch of arrangement, which may help "C. G."



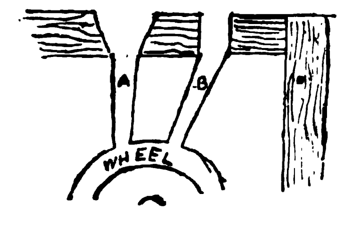
Stud.Inst.C.E.

[75515.]—**Pulley.**—Yes; you can, by a quarter-twist belt, effect the drive you describe. The heavy dotted lines in plan are the shaft centres. Pulleys must be so placed that the belt leaves large pulley, and enters on small one, at one of the points marked with a small circle (o)—which one depends on the



relative directions of revolution. Pulleys must be wide; how wide, you can ascertain by a 1/12 size model in wood with a tape band—I expect 24in. by 18in. and 12in. by 8in. Your strap should be wider than for a straight drive, and should be cut with a curve, the edge that is inside on ascending side of large pulley being the long one; otherwise, you could use a Fullis's (of John-street, Bridgeton, Glasgow) link belt, made with one edge thicker than the other for such drives as yours. There is another belt (patent) made in Germany, single at one edge, and thickened to 3-ply at the other, for this drive. BRITISH BULLDOG.

[75513.]—**Casting in Lead.**—Lead can be cast very well in moulds made of plaster of Paris. Make two wooden frames about 3in. square and ¾in. deep; one of them should have three or four pegs about ½in. long fixed to it to fit into corresponding holes in the other, so that they can always be put together in exactly the same way. Place one of the frames on a perfectly level bench or table, and fill up with plaster. Grease the pattern, and press into the plaster as far as the flange; when the plaster is set, well grease the top surface (without moving the pattern), fit the other frame on the first one, and fill up with plaster, taking care to work all the air-bubbles out with a piece of stick. When quite hard, separate the two halves and remove pattern; then with an old knife or chisel cut two grooves in the bottom half of the mould, the one, A, to receive the metal, and the other, B, for the escape of air, as in sketch. Clamp the two halves together between two pieces of wood in a vice, and pour the metal quickly. If the mould is made hot the castings will be sharper. Be sure that the plaster is thoroughly dry before you pour the metal.



Brighton. T. C. SMITH.

[75523.]—**Logarithms.**—"Esne Caralita" may with advantage obtain Anton Steinhauser's tables of logarithms for 20 places, the first part of which, marked A, will give the required logarithms by simple inspection for all numbers up to 10,000 to 20 places. The tables may be procured through any foreign bookseller in London from the publishers and printers, Carl Gerold's Sohn, Vienna, and are not expensive, considering that they are most convenient, and the best arranged tables to many places I have yet seen. The text is printed in the Roman character, but in the German language. If "Esne Caralita" does not understand that language, I could give the rules for using the tables in English through the ENGLISH MECHANIC, with the kind permission of the Editor. A. D. I.

[75523.]—**Logarithms.**—I wish I could give a more satisfactory answer to this question than what I am able to do. I often need a table of 12-figure logarithms myself; but there are none to be obtained. The nearest approach thereto is Vlacq's table of 10-figure logarithms—a second-hand copy of which cannot, I believe, be purchased for less than two or three pounds, perhaps more. Sherwin's tables contain Sharpe's 61-figure logarithms of all numbers up to 100, and of prime numbers up to 1,097. If the questioner does not require the logarithms of prime numbers greater than 1,097 or of their multiples, this book would just suit him. The fifth edition (1771) can be picked up cheap, on account of the numerous misprints, that detract from its value. For that reason it would be advisable not to depend upon it until the table referred to (four pages in length) has been revised with that contained in the third edition of Sherwin's tables, two copies of which are in the British Museum library. About (I think) a year ago I answered a similar question to this, and I then recommended the use of Peter Gray's tables for constructing logarithms to 12 or 24 places (Layton). But this would only be serviceable if such logarithms were only occasionally required. If often wanted, the computer would soon tire of the labour of repeatedly doing the long-division sums necessary. If some one were to publish a table of 12-figure logarithms, or reprint Vlacq, he would be a public benefactor. But I fear he would have also to be a wealthy man, for the comparatively small demand for such works would probably never repay the outlay. At the present time, for instance, Filipsowki's table of anti-logarithms (G. Bell and Son), which I am never tired of recommending as a most useful book to those who work with logarithms, does not, I am told, sell in any degree commensurate with its merits. T. S. BARRETT.

[75524.]—**American Organ.**—No doubt, since I wrote those instructions for making an American organ which appeared in Vol. XXVI. many "improvements" may have been made, though they can scarcely be called "great and important," as "Practical Organ Builder" puts it. I shall, however, be much obliged if he will give me a list of the patents to which he refers—the names of the patentees will do; but if he can supply the Nos. and dates, that will save much time in searching. I may as well say that I am not in any way interested in the trade. I simply built my own organ, and superintended the building of some others—the materials for which came direct from America.

ORGANON.

[75524.]—**American Organ.**—I send a second reply to this query, which will probably be of use to other readers. Cost of materials for two-manual organ as per specification on p. 164. Two soundboards, 35s.; bellows, 28s.; pedal board (birch), 30 notes, 36s.; pedal soundboard, 30s.; other items, about 30s.; good walnut case, £3 10s. To insure good quality of tone have real American-voiced reeds, not the usual bent reeds. These can be had for 6s. extra for each row (61) of reeds. Clear instructions for making (with drawings) could not be obtained for less than £2 or £3. It is better to pay a little extra for soundboards, and have them selected by a competent man. Be very careful about this, as there are many soundboards sold that are not worth the trouble of making up. I can safely recommend the Munroe or Hammond cavity board. Both of these makes are good. Any information (of general interest) on this subject I am always ready to give.

PRACTICAL ORGAN BUILDER.

[75524.]—**American Organ.**—"Four Years' Subscriber" certainly gives a very good specification of two-manual organ, and I think he cannot do better than follow the plan given in No. 1186. I have built one in accordance with the arrangement there given, and I may say that I am highly pleased with it, the tone coming out exceedingly well. The coupler, swell super-octave to Great, is, to my mind, far before the ordinary way of coupling the octaves. The full organ effect is splendid. I am sure the cost to build an instrument this way is much less than the usual method of construction. Now I have a full-size drawing (that I built mine from); if it is of any use to querist or any other reader, I shall only be too glad to take a copy and send it for the cost of postage, or I can send another arrangement on a more extensive scale (but the cost will be much more to build) either by post or through these columns. If querist will advertise his address or write to me direct, I can give him any help he requires. RICHARD PLANT, JUN.

Parr Bridge Mills, Tyldesley.

[75530.]—**Mould.**—This is a fungoid growth. It may be either Torula herbarum or some closely allied species, or more likely Cladosporium herbarum. Aspergillus glaucus also resembles your description, but is not usually so black.

S. BOTTONE.

[75531.]—**Electric Light.**—No dry cell will do what you require for 1½ hour; but if you have a dynamo or other available power, in the form of electricity, you can use accumulators, sealed, to prevent spilling of the liquid by the jostle of the gig. A plan I should advise, however, would be to have a box chromic-acid battery, one in which, when the elements are in the liquid, forms a covering for the cells, thus preventing spilling. Such a battery of four cells would run two 2½c.p. lamps for three hours with one charge. F. ASKEW.

[75531.]—**Electric Light for Gig.**—Dry cells are not adapted to your purposes, as they run down in less than twenty minutes. But I supply a very excellent form of accumulator, fitted with lamp (about 5c.p.) reflector and bevelled glass front, in japanned metal case, similar to an ordinary bicycle lamp, for 35s. This can be easily charged in the daytime from a three-celled chromic acid or bichromate battery, and when charged will give five or six hours' continuous light. After six months' use the accumulator will be the better for a rinse out, and refilling with fresh solution. Such an arrangement will do all you require, and cannot fail to give satisfaction, which dry cells cannot do.

S. BOTTONE.

[75532.]—**Hydrometer.**—I should think you would be able to find what you want in any book on specific gravity. Why not make yours the same as others? All hydrometers are the same weight. I advise you to get the table of S.G., and mark your stem off. The following specific gravities may be of some use: Sulphuric acid 1·8, nitric 1·5, honey 1·45, blood (human) 1·05, ale 1·04, milk 1·03, seawater 1·03, port wine ·99, castor-oil ·97, proof spirit ·93, olive oil ·92, turpentine ·87, brandy ·84, alcohol ·80. C. G. M. BENNETT.

[75533.]—**Alcohol-Proof Cement.**—Plaster of Paris mixed with glue. SM.

[75533.]—**Alcohol-Proof Cement.**—Mix quicklime in fine powder with sufficient white of egg to form a thin paste, and use immediately.

J. T. M.

[75533.]—**Alcohol-Proof Cement.**—Ordinary plaster of Paris (fine) is largely used for fixing tops on flasks, &c., and is, I think, quite satisfactory.

Brighton. T. C. SMITH.

[75533.]—**Alcohol-Proof Cement.**—All the old recipe books give the following:—1. Take a piece of quicklime, slake it to a dry powder, and rub in a mortar with white of egg to consistency required. 2. Pipeclay worked with painter's drying oil. 2. Fine linseed meal, pure and simple, mixed with water. The first is the best—I have tried them.

F. G. LL.

[75534.]—**Printer's Roller Composition.**—To "ROTARY."—If you will advertise your address, I shall be pleased to put you right, gratis.

LYNX.

[75541.]—**Piano Sound Subduer.**—Damp the wires with a strip of felt. SM.

[75541.]—**Piano Sound Subduer.**—Envelop the piano in thick baize or blankets, front, back, sides, top, and bottom. You can carry this to such an extent that you cannot hear your false notes.

J. H. SCHUCHT.

[75541.]—**Piano Sound Subduer.**—Procure a piece of stout flannel as long as the piano action, and hang it or lay it (according to whether your piano is a vertical or horizontal one) between the hammers and the strings. This will effectually deaden the vibrations. S. BOTTONE.

[75542.]—**Silica.**—The presence of silica in common lime may be taken for granted. The determination of the amount is rather a tedious operation.

J. T. M.

[75542.]—**Silica.**—Dissolve the lime in weak chlorohydric acid; fuse any residue with three times its weight of sodium carbonate. Dissolve in acid. Evaporate to dryness on water-bath; redissolve and filter. Silica is left as a white powder, which must cause effervescence when fused with sodium carbonate. SM.

[75544.]—**Tea Drinking.**—I am very doubtful whether the tannin in tea is injurious to a fairly healthy person. Tannin coagulates albumen, and makes a leathery compound with gelatine, fibrine, and similar substances; but it is not certain that this effect takes place in the living stomach. Still, it is well to avoid tea-drinking along with a meat meal. Any one suffering dyspepsia should avoid tea. If a small quantity of calves-foot jelly were eaten just before or after tea, the tannin would probably combine with it, and not with the ordinary food; or a little isinglass might be put in the teapot while the tea is being made. S. BOTTONE.

[75545.]—**Tea Drinking.**—If you are afraid of the tannin, do not drink tea. Tea should never be taken at the same time as meat and other albuminous foods. What are the "other injurious qualities"?

SM.

[75545.]—**Tea Drinking.**—Why drink the tea? It is not the tannin that is injurious, but the alkaloid thein. The Indian teas now so much consumed contain a much larger quantity of this alkaloid (which has a most potent effect on the nervous system) than the weaker teas we used to have from China. F. G. LL.

[75546.]—**Body Vermin** may be effectually got rid of by the application of white precipitate ointment, which any chemist will make up.

S. BOTTONE.

[75546.]—**Body Vermin.**—Lice do not posse lungs, but breathe by means of spiral trachea, proceeding from holes on the sides of the body. It i stated that oil, by clogging these holes, will suffoca the animal. A mercurial ointment is, however, i most common use. Any druggist will supply wh you require. SM.

[75546.]—**Body Vermin.**—Wash the child with common carbolic-acid soap, and lather th freely with it. This means destruction to all ki of insect life. For the first bath, when the child enter the institution, add 1lb. of common wash soda to the bath. This, combined with the so will remove all offensive residue from perspiratio and render the skin soft and healthy. Carboli acid soap is the finest of all soaps for the skin, a the only one which will remove perspiration. should be used by everybody when taking a bath.

S. K.

[75547.]—**Theopathy.**—The word is compound from *Theos* (θεος) God, and *pathos* (παθος) sufferi or feeling. It is employed to designate a capac for religious worship. SM.

[75548.]—**Incandescent Lamps.**—Lamps a made which are quite as good as the Ediswan; b they cannot legally be sold in this country befo 1893. It will then be possible to buy them for l than 2s. each. SM.

[75548.]—**Best Incandescent Lamps.**—Y are not the only one who would feel the benefit cheaper lamps; but, alas! until the lamp monopo has run out we can do nothing. Edison-Swan h the field, and their patents have not yet expir

Until then we cannot hope for anything different in lamps, at least. F. Askew.

[75548.]—**Best Incandescent Lamps.**—The best incandescent lamps are undoubtedly those made in Belgium; but you cannot legally buy them here, because all incandescent lamps are subject to Edison and Swan's patent. In a year or two the patent expires, and then you will get excellent lamps at 1s. or 1s. 6d. each. S. Bottone.

[75549.] — **Accumulators.** — Secondary cells ought to be thoroughly insulated from the ground, and it is usual to employ glass cells, but not always. Wood cells are likewise used. Sm.

[75549.]—**Accumulators.**—It is not necessary to have the cells of glass. Glazed earthenware, teak, &c., are also extensively used. Glass is more convenient, as it enables one to see the state of the plates, &c., but teak boxes are nearly always used for tramcar and launch work. S. Bottone.

[75549.] — **Accumulators.** — You can use wooden cells lined with guttapercha or well soaked in melted paraffin wax; but metal of any description is very unsuitable. Accumulator installations to be successful should be very carefully insulated, and every chance of short-circuit carefully guarded against. This would be very difficult, if not impossible, to do were the cells made of any material that is a conductor. Glass is generally used because it is acid-proof, cheap, and a very good insulator.

Brighton. T. C. Smith.

[75549.]—**Accumulators.**—It is not absolutely necessary to use glass cells; but these are to be preferred for many reasons, among which may be mentioned the fact that the conditions of plates, liquid, &c., can be seen better than when wood is used, beside there being less chance of leaking. I should condemn iron, on the ground that there is more chance of the plates short-circuiting, and an action caused by the acid on the iron. Of course, there are cases where glass would be inadmissible—such as tramway or other travelling purposes—but glass is to be preferred where practicable.

F. Askew.

[75551.]—**Moulds for Metal Casting.**—The process for producing fine artistic casting, described by me in the Society of Arts *Journal*, as referred to by "Brightonian," is hardly one for ordinary amateur work, and was given only as a simplification of the ceraperduta process used by art founders for producing original artistic work which it was impossible to mould by any ordinary process. The only point of interest to the amateur was the method of obtaining a perfect surface to the metal; this is done by obtaining some of the finest moulding sand, agitating it in water, allowing the coarser parts to settle, and then pouring the top off. When the lighter suspended part of the sand settles, pour off the water, dry the sediment perfectly, and mix it with petroleum oil. This makes a paint with which the face of the pattern must be coated, and the ordinary sand is used to back it up in the usual way. Before the mould is used it must be dried and heated sufficiently to evaporate the oil, and the metal must be poured in whilst the mould is hot. Asbestos in not necessary for ordinary work: it is only required when moulding difficult statuary from the original wax model, which is afterwards melted out. Thos. Fletcher.

[75552.]—**Phonograph.**—I fail to perceive what the querist means by saying that in the "latest" form of phonograph the record is taken on wax, and there is only one diaphragm. The recorder, he says, is made of steel with a blunt point. Why does he not read the articles which have recently appeared by Mr. Gillett? I had the pleasure of being present at "Little Menlo" when Col. Gouraud gave an exhibition of the phonograph, and it certainly had two separate diaphragms, one, the "recorder," carrying a chisel-pointed cutter; the other, the repeater, having a round or bulb-pointed needle communicating with the repeating diaphragm. The cylinders were of something much harder than paraffin-wax. Perhaps the querist has seen something later; but as his question stands it is a fair puzzle. S. R.

[75553.]—**Waterproof and Sea-Water.**—For cleaning all kinds of waterproof goods having a rubber surface, try rubbing on a little vaseline with a bit of cloth or rug.—Nun. Dor.

[75554.]—**Saturation.**—Vide Latin dictionary, *Saturatus*—filled, satisfied, glutted, gorged, &c.—*e.g.*, a sponge is saturated with water when it can hold no more without dripping. Water is saturated with a salt when it can take up no more in solution. A steel magnet is, by analogy, said to be saturated when it can take up no more magnetism (sic) to make it stronger. F. G. Ll.

[75554.]—**Saturation.**—Saturation means the state of being "full up," "fully satisfied." Hence, a piece of iron is said to have reached the saturation point of magnetism when no increase of current sent around it will increase its magnetism. A shunt-wound dynamo may be distinguished from one which is series-wound by the fact that the field-magnet wires are connected to both brushes, and that the current is taken directly off these brushes to the terminals. In the series machine, the current is taken off one brush and one field-magnet wire. See my book, "The Dynamo," for full explanation and sketches. S. Bottone.

[75556.]—**Astronomical Watch.**—I do not know how far it would meet "Georgos's" requirements, but I have found a sidereal watch made by Webster, 5, Queen Victoria-street, near the Mansion House, very convenient for finding purposes in the observatory. George Knott.

[75556.]—**Astronomical Watch.**—If "Georgos" will regulate his watch so that it will gain 3 minutes 56·56 seconds on his mean-time clock, then look for sidereal time at mean noon in the *Nautical Almanac*, and set his watch to this, making the proper allowance for his longitude, east or west, he will have a watch showing sidereal time. My centre seconds watch keeps very good time indeed. H. A.

[75556.]—**Astro. Watch.**—Watches and chronometers may be made to show sidereal time; but astronomers usually use clocks, and they have 24-hour dials. There are so many good makers of either clocks or watches, that it would be difficult to say which would be the best to purchase from; but if "Georgos" were to purchase the *Horological Journal* for this month, he would find many makers advertising. A deck watch would certainly be accurate. This class of watch, if intended for the navy or mercantile marine, would have to go through a very crucial test—a test such as no ordinary or common watch could be expected to pass. Deck watches are of the very best workmanship. It is true that the centre seconds watch does not give so close a rate as the ordinary seconds, on account of the excessive vibration in the long and slender centre-seconds hand. They vibrate so much that if one of these watches be held to the ear, the hand will be found to hum just like a tuning-fork. At the same time, it must be noticed that some of the watches which have passed the Kew trials very successfully have been centre seconds.

Detent.

[75557.]—**To "Sm."**—I do not remember the question. I have not the No. by me; but I think it was something about boiling electrified water. If so, the charge would be carried away by the steam. Sm.

[75558.]—**First Aid.**—To give detailed information in reference to the questions put by G. Hargett would involve a too lengthy reply; but a very useful and instructive manual, giving all the information required, is "Shepherd's First Aid to the Injured," which may be obtained from the Chief Secretary, St. John's Ambulance Association, St. John's Gate, Clerkenwell, London, E.C. I think the price is 1s.; post free, 1s. 1d.

Geo. H. Wartnaby.

[75559.] — **The Stars.**—The inquiry of your correspondent "Thomay" is interesting, but difficult to answer, owing to the difficulty of comparing the light of northern and southern stars, and also to the fact that the light of many southern stars has not been measured photometrically. Sirius has been photometrically measured as considerably brighter than any northern star, and is generally classed as brighter than any southern star, though one or two observers have given the preference to Canopus. This fact seems to establish the claims of Canopus to the second place, and a like consensus of opinion places α Centauri third. η Argûs, when at its maximum, certainly outshone the latter star, but this is not its normal condition. We next arrive at a batch so nearly equal that photometric determinations differ—viz., Arcturus, Rigel, Wega, and Capella. Betelgeuse, when brightest, seems to me almost equal to these, but the star is undoubtedly variable, and I have seen it fainter than Aldebaran. The most promising claimant for the eighth place is Procyon. Below this I doubt whether, in the absence of photometric measurements of southern stars, we can safely go. Of those visible in this country, the next four appear to be Altair, Betelgeuse, Aldebaran, and Spica Virginis, though it is doubtful whether some of them are not surpassed by Regulus or Antares. In closing this reply I may inform your correspondent "Didasculus" (75543) that he can easily found the rule which he desires on the fact that the number 1,001 is divisible by 7. The rule may be thus stated: Subtract the number of thousands from the last three figures (repeating the operation if necessary), and if the result is divisible by 7, so is the original number.

W. H. S. Monck.

[75560.] — **Pin-hole Camera.** — Pin-hole camera differs only from the ordinary kind in having no lens and no adjustment for distance. The pin-hole may be made in a card by means of a needle. Every other process is the same as usual.

Sm.

[75560.]—**Pin-hole Camera.**—The size of the hole depends entirely on the distance at which you intend to put your sensitised paper, and, consequently, the size of the image you intend to produce. As a general rule, you may say the aperturre, or hole, may be $\frac{1}{200}$ of the distance at which you place the dark frame in the camera. Say the distance between your camera front and dark slide is 4in., then a needle prick $\frac{1}{50}$in. in diameter will be about the right size. You will not find any paper sensitive enough to give a picture in reasonable time. Eastman's films, or ordinary dry plates, will give a picture from a view that is fairly lighted, in a time varying from one to ten minutes. The distance of the object is immaterial, since all will be equally well (or badly) in focus. The resulting picture must be developed, fixed, and washed, just as any other picture. S. Bottone.

[75560.] — **Pin-hole in Camera.** — "Mud Puddle" should cut a cardboard diaphragm with a small central hole, say $\frac{1}{4}$in.; over this gum a bit of tinfoil, then, with the finest needle he can get, prick a hole in the centre of the tin foil. The exposure will have to be long. Of course the negative will require to be treated in the usual way.

H. A.

[75565.]—**Resounding Room.**—Stretch wires across out of reach. Sm.

[75565.]—**Resounding Room.**—You might try stretching a few thin wires across the room under the roof. I have not tried the above plan myself, but I have seen and heard of it being used in several places with benefit.

Brighton. T. C. Smith.

[75566.] — **Armature Winding.** — To Mr. Bottone.—Damp the paper with a wet sponge. Brush over it a little thin, hot glue, and apply at once to the core, and swathing it round with a bit of clean rag; allow to dry thoroughly in a warm place; then varnish copiously. To secure the wire, in binding, have a soldering iron ready, get an assistant to hold the starting end while you make a turn or two, and then lightly solder the starting end to the coil or two laid on. Wind on as much as you want, and solder lightly all over.

S. Bottone.

[75567.]—**American Organ.**—State name of maker of the organ in question, then I shall be better able to give useful advice. If made by a good American maker let it alone, for you cannot (at least, no amateur can) improve the tone of any organ that comes from a first-class maker. If the reeds are merely "bent," and not voiced, get some-one (who actually knows how) to voice them to the required tone. Practical Organ Builder.

[75567.] — **American Organ.**—I suspect this querist has bought one of those A. organs with the "important improvements." He must have the reeds properly voiced. I shall look with some interest for replies to this query, for the only "improvements" with which I am acquainted consist in the one thing—reduction in price, and consequent reduction in quality. "M." had better put up with the evil he has, than risk the chance of introducing others. Organon.

[75571.]—**Dry Cell.**—Voltage 1·5 nearly; life, 20 minutes to half an hour, on the short circuit; six months to a year, if only used intermittently. Can be recharged from a battery or dynamo. Not suitable for lighting, except very low voltage lamps, for very short intervals, say one or two minutes, at a time. S. Bottone.

[75572.]—**Limits.**—Denote the expression by u, and, to save trouble in printing, let $\log_e x = z$. Then, expanding the second factor of u by the exponential theorem, we have—

$$u = \frac{x}{a}\left(\frac{z}{2x} + \frac{1}{2}\cdot\frac{z^2}{4x^2} + \frac{1}{2\cdot3}\cdot\frac{z^3}{8x^3} + \&c.\right)$$

$$= \frac{1}{a}\left(\frac{z}{2} + \frac{1}{2}\cdot\frac{z^2}{4x} + \frac{1}{2\cdot3}\cdot\frac{z^3}{8x^2} + \&c.\right)$$

Now, when $x = \infty$, $z = \infty$, and, since all the terms in the series are positive, the limiting value of u is infinity, that being the value of the first term.

Charing. J. R. C.

[75577.]—**Small Furnace.** — If your correspondent will remove the front bars of the fireplace and replace them with fire-bricks built up from the level of the bottom bars to a height of 12in., he will have a good and useful furnace. To cause the draught a piece of sheet-iron is necessary, cut to fit the front opening above the bricks, so as to close the entire opening, except that below the grate bars. This sheet should hang on a nail at the top, and must have one or two handles for easy removal. The power depends on the height of the chimney. If it is not less than 15ft. or 20ft., gold, silver, and copper can easily be melted, using ordinary gas-coke as a fuel. For cast iron either charcoal fuel or a taller chimney will be required. I built a furnace in this manner thirty years ago in a bedroom fireplace, and had it in use for many years. Thos. Fletcher.

[75578.] — **Paint for Iron.** — If "Director

R.R.L." advertises his address, I will send him a sample that has stood gas-house heat and fumes. Has he tried fireproof paint? Colonist.

[75580.]—**One-Man Power Electro-motor.**—To Mr. Bottone.—Drum armature, 2in. diameter, 4in. long; upright field-magnets, 4in. wide, ½in. thick, 5in. high, with 3in. wire space on each limb. Armature wound with two layers of No. 18 d.c.c., in six sections (about ½lb.) Field-magnets wound with 4lb. No. 14, connected in series. This will take about six ampères at 24 volts to develop 1-man power, or say 12 quart chromic-acid cells.
S. Bottone.

[75581.]—**Electric Light, Cost of.**—To Mr. Bottone.—Supposing you have four lamps 10c.p. 25 volts, you will need a dynamo capable of giving at least 36 volts and four or five ampères, taking nearly ½H.P. to drive. Cost of water-motor, £10; cost of dynamo, £3 or £4; then you will want 13 cells of accumulators, say £1 10s. each, or £19 10s. The outlay would not be doubled to get double the output. I have never found the ordinary house-tap any use for this purpose—not sufficient pressure. S. Bottone

[75582.]—**Electrical Cylinder Machine.**—It is the glass rod which supports the prime conductor that is at fault. Dry it very carefully with a hot flannel, and give it two or three coats (allowing each to dry thoroughly before applying another) of good shellac varnish in a warm, dry room. Report results for the benefit of other sufferers.
S. Bottone.

[75582.]—**Electrical Cylinder Machine.**—There is something wrong with the prime conductor. Is it provided with a row of points at the end next the cylinder? If not, supply one, and see that there are no points or jagged edges at any other part. To make an electrical machine do its best requires practice. The glass parts, and especially the pillar of the conductor, should be frequently wiped with a dry, warm cloth, as a trace of moisture on the glass impairs insulation. The rubber should not be insulated. The cylinder will be sufficiently insulated if it be kept dry.
J. T. M.

[75583.]—**Softening Rubber Washers.** — If these are of vulcanised rubber, and thoroughly oxidised, nothing can restore them; but if only slightly attacked they may be softened by carbon disulphide. Sm.

[75584.]—**H.P. of Cylinder.** — The nominal horse-power is obtained by squaring the diameter in inches, and dividing the product by 10. Sm.

[75586.]—**Simplex Dynamo.**—The reason is self-evident. The dynamo does not give sufficient current to feed all the lamps. Remedy: Drive a few hundred revolutions per minute faster.
S. Bottone.

[75588.]—**First Aid.**—The book you require is called "First Aid to the Injured," by Peter Shepherd, M.B., price 1s., or post-free 1s. 1d., from the St. John's Ambulance Association, St. John's Gate, Clerkenwell, E.C. S. Bottone.

[75590.]—**Electrical.**—None. Such an arrangement of plates would only give two volts, and no two-volt lamps are made. S. Bottone.

[75590.]—**Electrical.**—Four such cells in series would light a 6volt 5c.p. lamp, but there is no lamp made that would run from one cell. Again, a double carbon single zinc element is much to be preferred to your arrangement. F. Askew.

[75592.]—**Condenser.**—75 sheets of tinfoil, 7in. by 5in., will do nicely. S. Bottone.

[75592.]—**Condenser.**—A 60-sheet condenser, 5in. by 6in., will give good results. F. Askew.

[75594.]—**Dynamo Winding.**—To Mr. Bottone.—The drum armature gives the best results, but your armature is hardly long enough for a good drum. Better wind it as a ring. Put 4lb. No. 20 d.c.c. on the armature, and 12lb. No. 22 on the fields. Connect up in shunt. This should enable you to light, at a moderate speed, say 1,500 to 1,800 revs. per minute, five or six 16c.p. lamps of 48 to 50 volts. S. Bottone.

[75600.]—**Astro. Eyepiece.**—The single lens has a decided advantage over the compound eyepiece in showing the finest planetary details, but the object observed must be kept well in the centre of the field; hence this form of eyepiece is best suited for an equatorially-mounted telescope. My own is a crossed double convex lens, as it allows the curves to be not so deep as in the case of the plano-convex, and it works admirably. Of course I only use this eyepiece on special occasions, a Huyghenian being best for general work. H. A.

[75603.]—**Dynamo.**—To Mr. Bottone.—The dimensions of your dynamo, especially the short armature, are not adapted to a drum armature machine. However, put 3oz. or 4oz. of No. 22 on the armature, and 2lb. No. 22 on the field. Connect up in shunt. You may be able to light up two lamps of 5c.p. each, 10 volts 1·5 ampère.
S. Bottone.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75072. Photo-Tracing Process, p. 558.
75074. Street Telescope, 558.
75077. Oval Bradawl Handles, 558.
75080. Electric Gas-Lighting, 558.
75087. Water Meter, 558.
75096. Tangent Galvo., 558.
75106. Gauging and Mensuration, 558.
75110. Guitar, 558.
75113. Theatrical Stage, 558.

75274. Steam-Engine for Boat, p. 73.
75278. Cut-out, 74.
75279. Coil Boiler, 74.
75290. Electric Clock, 74.
75300. Dutch Bogie Expresses, 74.

QUERIES.

[75604.]—**Lubricant for Rubber.**—Can anyone tell me what is the best lubricant for making rubber slip easily when being forced through a hole?—Laundry.

[75605.]—**Incandescent Lamps.**—Can a 16c.p. lamp be run by hand-power? or if not, what is the highest c.p. that can be run?—J. C. S.

[75606.]—**Mounting Microscopic Objects.**—I wish to draw attention to a difficulty in mounting the above. Take, for instance, the feathered antennæ of moths. I wish to know which would be the easiest way of mounting dry? Some people would wish it to be first soaked in potash, and after that to be mounted in Canada balsam; but the best of this object is the nervules that are seen projecting from the branches when magnified, and if it was done as stated above, these nervules would be soaked entirely away. Another difficulty is the mounting of animalcules. Could there be a way of mounting them with the wheel visible, like there is in a rotifer? Also, I have a difficulty in mounting whole insects, such as forcing out their legs, wings, wing-cases, antennæ; the difficulty is that when one wing is forced out, while getting the second one out the first one falls into its place again. If some of our kind readers could help me in mastering the above, I should be glad.—J. A. Bellringer.

[75607.]—**Dynamo.**—To Mr. Bottone or Mr. Askew.—Would you be good enough to inform me the style and dimensions of dynamo to charge 10 accumulators containing 13 plates (six negative and seven positive), 5½ by 3½, in the shortest time? I reckon, when fully charged, the above accumulators will give at least 18 volts and 10 ampère-hours. Is this correct?—Litharge.

[75608.]—**Biunial Lantern.**—Will some reader inform me how to make a biunial magic lantern with lower lens on a tray slide, so that it can be drawn out to allow objects to be placed between? I have a ¼-plate photograph lens with four glasses and a lens the same size and shape, but with only three glasses—viz., two in the front and one in the back. Can I use these for the biunial? I do not know how to find the focus of a lens, nor how to determine the distances of the slide holder from the condenser and from the object lens. I have two double 4in. condensers complete in brass cells.—A. Turner.

[75609.]—**Force Pump.**—Will some reader kindly show me by rough sketch how to make delivery of force-pump constant instead of being intermittent?—Beginner.

[75610.]—**Electric Fire Alarm.**—Can anyone give me some practical directions for making a self-acting electric fire-alarm? I have succeeded in constructing some simple electrical machines, such as a time alarm striking arrangement, &c., and I want now to attempt a fire alarm.—C. J. Hunt.

[75611.]—**Black Magic Mirrors.**—To "Eos."—Can "Eos" give me any information about the black ovoid magic mirrors mentioned by Col. Fraser in "Twelve Years in India," as prepared by the Muttra-Wallahs at Muttra in Agra, India, and in one of which he saw events that he verified afterwards? Can these mirrors be obtained in Europe?—Miroir.

[75612.]—**Interest.**—A person obtains £150 from a money lender. For this he pays back £200 by quarterly instalments of £40. What rate of interest does he pay on the amount? Formula and method of obtaining same requested. An actual case.—Discere Cupio.

[75613.]—**Self-Winding Clock.**—Will any kind reader give me dimensions and sketch of pendulum for a clock that was purchased from the Self-Winding Clock Company, as I have lost the one belonging to it.—No Name.

[75614.]—**Electric Lighting.**—I wish to well light a room 9ft. by 12ft. I have a 2-man Bisschop gas-engine. What size dynamo and kind of lamps are most suitable? Can I run lamps direct from dynamo, or must I charge accumulators?—Bisschop.

[75615.].—**Tempering Clay for Common House Bricks.**—My father has found the men do not turn out bricks satisfactorily, and this I put down to using not properly tempered clay. I will explain how they are made: First, the clay is dug out of the pit and placed aside near the moulds; it is then worked up with water (nothing else), and thrown into another heap, where it is scooped down and rolled into round pieces about the size of a man's head; it is then thrown hard into a proper brick mould, carried or wheeled away to dry, after that burnt. They turn out with cracks in them, and more especially the hand-machine ones. Will someone give me some advice?—Geo. A. Morgan.

[75616.]—**Dynamo.**—Would Mr. Bottone, or some other kind reader, inform me how to wind the castings for a dynamo, and what size wire to use, and how to fit the same up? Also what candle-power will it give? The magnets are 10in. long, 3⅝ the armature hole, ⅜ thick, 2½in. wide; the armature is 3⅜ outside measurement, ⅜ thick, 2in. wide.—Alf. Beginner.

[75617.]—**Stannic Ware.**—Can any reader kindly say of what the above ware consists?—F. Warren.

[75618.]—**Tea Urn.**—Will some reader inform me how urns are bronzed to a copper colour? The process in use for gasfittings will not stand the heat and wear to which they are subjected.—F. Warren.

[75619.]—**Rome.**—Would any of your readers kindly say which are the best books on Rome, and where the most complete history and description of St. Peter's is to be found.—A. W. J.

[75620.]—**Boiler.**—I have a boiler, locomotive type. Boiler, 1ft. long, 6in. diam.; firebox, 5½in. long outside by 8in. wide outside; grate-area, 6in. by 4in. It has three ⅝in. flues, and three ⅜in. flues; but will not draw. What size flue or flues would you advise? I can use a 2in. or 4in. chimney, 20ft. high. What power ought I to get out of it? It holds 13lb. of water, 5lb. of which I can use; 30lb. working pressure. Am I to braze the flue in, or how?—Boiler.

[75621.]—**Volcanoes in the Moon.**—I have read that Herschel supposed he saw one in a state of eruption. Is this considered to be correct, or might it have been a defect in the instrument used in those days?—J. C. S.

[75622.]—**Hot-Water Boilers.**—Which would be the best type of boiler to heat a small lean-to house, about 14ft. long by 9ft. wide; either the so-called slow-combustion, a coil set in brickwork, or the saddle-boiler type? Any hints would greatly oblige.—J. C. S.

[75623.]—**Paper Chemically Prepared to Receive Marks.**—Can you kindly inform me of any chemical solution which, if paper be dipped into it and dried, will cause the paper to receive a mark when any metallic point, as gold, silver, copper, or any metal is pressed on it, as in the act of writing? I have seen a self-recording barometer, in which a metallic point presses on a revolving cylinder of apparently prepared paper, and leaves a blue mark. Can any one say how it is done?—R. J. H.

[75624.]—**Condy's Fluid Stain on Linen.**—Can any of our numerous readers inform me how to remove the dark brown stain caused by spilling Condy's fluid on linen, without injuring same?—Henry.

[75625.]—**To Mr. Bottone.**—Will you kindly tell me the size and amount of c.c. wire to put on field-magnets and armature of a small Manchester dynamo? The F.M.'s are of wrought iron ⅜in. in diameter and 2in. long. Armature built of stampings 1⅜in. diameter, 2in. long. —Henley.

[75626.]—**Shunt Formula.**—Will some of our electrical readers kindly give me a formula for calculating the gauge of wire on the F.M.'s of a shunt dynamo, knowing the ampère turns and mean length of convolution of the testing coils, and the E.M.F. of the armature? If convenient, with a practical example.—A. H. R.

[75627.]—**Magnetised Steel Wire.**—A steel wire, 12in. long, is magnetised and broken into two parts, 8in. and 4in. long respectively. How will the two parts differ from each other magnetically? Would they, if similarly placed with respect to a small compass needle, produce equal deflections?—Wooden.

[75628.]—**Arctic Moonlight.**—To Mr. Wake or "C. P. M."—While spending a holiday this summer within the Arctic circle, I found that for several days the moon did not rise at all. Will Mr. Wake or "C. P. M." kindly say (1) Whether this arises from a similar cause to that which prevents the sun from rising in these latitudes in mid-winter; (2) What is the longest period during which the moon would remain invisible at any given latitude—say, for example, 70°; and (3) Is there any book which gives a popular explanation of the phenomenon?—A. T.

[75629.]—**Battery for Small Motor.**—What is the best and cheapest battery to work a small motor? And what can I do to prevent the zincs in a bichromate battery from burning away so quickly, as it gets expensive?—H. White.

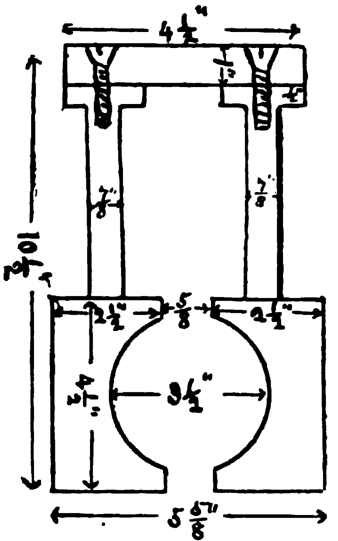
[75630.]—**American Organ.**—I have an American organ of four sets of reeds and fourteen stops. Can it be enlarged by the addition of, say, four more sets—viz., two Bass, two Treble, Violoncello, Gemshorn or Bassoon, Viola, and Wald Flute or Highland Pipe. If it can be, I should be glad to have directions how to do it. There are false stops in the organ that could be utilised by altering the names on them; the work I would do myself.—Organist.

[75631.]—**Displacement.**—Will some reader be kind enough to give me the formula or other means for determining the displacement of a model yacht (48 on l.w.l. × 12), if it can be found from the drawings alone? —Formula.

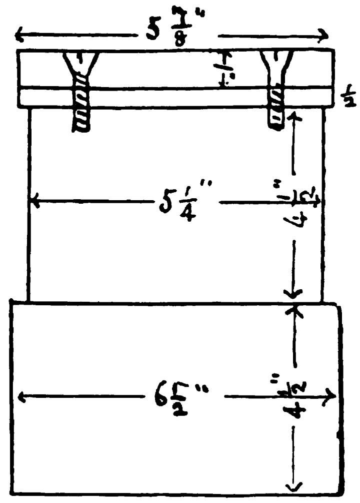
[75632.]—**To "Eos."**—Will you kindly give some information as to an Indian drug called Kreat Halviva? It is a bitter, recommended for sea-sickness, headache, indigestion, &c. What, if any, ill effects may be expected from its continued use?—M. W.

[75633.]—**Sledges.**—I want to make a few sledges to let out on hire next winter for ice-carnival purposes, &c. Some to carry one person only, and others to carry two persons tandem. All of them to be capable of being pushed by a skater behind, or pulled from front by two or more, by means of a cord and cross-bar, in the style of those shown in *Graphic* Christmas Numbers, and in other papers. Preferably with ash runners. Must be light, easy of transport, not too expensive, be comfortable for passengers, and have a nice appearance. Can any reader help with description, plans, or dimensions? I am a fairly good amateur carpenter.—A Yokel.

[75634.]—**Dynamo.**—Would Mr. Bottone be kind enough to give me the following information? Inclosed is the drawing of the field-magnets and yoke of a small dynamo or motor I wish to make. It will be seen that I



FRONT ELEVATION.



SIDE ELEVATION.

have unluckily made the cores rather thin for the size of poles, and want to know if the F.M.'s are for that reason useless? Also how should I wind the F.M.'s and armature, so as to give a potential of about 10 volts, and as much current as possible? I should like to have eight coils on my armature; is it necessary to have a laminated core on such a small machine, and would it be advisable to have compound winding, as I at one time would like to use the machine as dynamo, and another as a motor for driving a lathe. Any information will much oblige.—Lonely Workman.

[75635.]—**Water-Power.**—Books on this subject state the efficiency of waterwheels, for each kind, in terms only of the head of water, or "fall" in feet, together with the quantity of water passing, expressed in cubic feet per minute, taking no account of the size of the wheel itself. But in the case of undershot wheels, has not the diameter of the wheel considerable influence, and how much? It would seem that a weight of water, or an impulse, acting at the end of a long lever (the radius of the wheel) must have a greater effect than when acting on a short one. In other words, should not an undershot wheel of, say 20ft. diameter, yield more actual power than a similar wheel of 12ft. diameter upon the same fall?—Ajax.

[75636.]—**Insulation.**—Will you kindly inform me whether there is any substance which, if placed between a permanent magnet and a piece of iron or steel, would entirely insulate the one from the other, supposing them to be about ⅛in. apart or thereabouts? Or, in other words, a substance which would intercept the magnetic current passing between a magnet (permanent) and a piece of iron or steel?—S. L. Thomas.

[75637.]—**Electrical Problem.**—The E.M.F. of a battery was 15 volts and its internal resistance 10 ohms. The external resistance consisted of four wires in multiple arc of 27, 49, 58, and 75 ohms respectively. Find the strength of current in battery, and in each of the wires. Show working out.—A. W. C.

[75638.] — **Path of Neptune.**—To Mr Sadler (letter 33811).—Please say if you are correct as to the distance of Neptune, from D M, + 19·716, on Feb. 15, 1892? Is not this really about 30'? May I ask the favour of your kindly giving the co-ordinates of this star from the "Durchmusterung"?—W. L. Walter.

[75639.]—**Model Yacht.**—I am making a small model yacht of brass frames, plated with sheet tin. The plates run fore and aft, the edges and ends of the plates come close together, with a butt strap at the back: They are then soldered together. I find great difficulty in getting the solder to run into the seams so as to stick: I have tried both spirits of salts and rosin as fluxes; but neither does properly. I should be greatly obliged if any of "Ours" would tell me how to get the solder to stay in the seam. The dimensions of her are as follow:—Length 4ft., depth 6in., and breadth 6in., the plates are about 2in. wide by 18in. long. Would any reader please tell me what diameter of screw-propeller would be suitable for her?—Nesslak.

[75640.]—**Mean Distance of Moon.**—Will "F.R.A.S." kindly explain why it is that the moon's mean distance as stated in various works (e.g., "Astronomy for Amateurs," p. 106), is not an arithmetical mean between its greatest and least distance, whilst in the list given by "F.R.A.S." (No. 1386, p. 175), the mean distances of the planets are such arithmetical means?—Gamma Draconis.

[75641.]—**Uranus—Neptune.**—Differing values of the distances of these planets are given (Neptune's, for instance, being put at from 30·363 to 30·0566). Perhaps "F.R.A.S." will be good enough to state upon what determinations the values he gives are based and their dates; and as a further favour, say with what degree of accuracy the tables represent the motion of Neptune, and if there is any progressive disagreement in longitude either additive or subtractive, shown by comparison of the calculated and observed places.—Gamma Draconis.

[75642.]—**Metallic Compound.**—Will anyone tell me what is the composition of the metallic fittings of gasogenes, and how are they worked to shape, and what is the tensile strength—e.g., What should the thickness of the side of a vessel be to withstand 100lb. internal pressure per square inch?—Many Years' Subscriber.

[75643.]—**Sailing.**—I have a rowing-boat on Llangorse Lake; the boat is 18ft. long and 3ft. 6in. wide; I should like to turn it into a sailing-boat. I should be much obliged if any of "Ours" would let me know what shape and size sails would be best?—F. W. A.

[75644.]—**View of Moon from the Equator.**—What is the longest time the moon can be seen from any part of the Equator?—A. Studier.

[75645.—**No Rent.**—The trustees under my grandfather's will have neglected to see that the rents were paid for the past five years. I am aware I can claim the arrears in full of them, but can I also claim the interest on the arrears for the full time—five years?—H. T. S.

[75646.]—**Surfacing for Wood Engraver's Blocks.**—What is the composition of this, and in what manner is it applied so as to get a fine, white, even surface suitable for lead-pencil drawing or tinting in water-colour, previous to engraving.—Engraver.

[75647.]—**To Mr. Bottone.**—(1) I wish to make a volt-meter to indicate 50 volts on principle described by you a few weeks ago in "E. M.," but I intend to replace rack and cog-wheel by a silk thread passed round a wheel on spindle, the other end being fastened to iron core, and a weight on an arm in place of spiral spring. Please say if above will register alter. currents, what wire, and how to calibrate—and oblige. (2) Is it possible to measure the pressure of an Indian coil? If so, what voltage would a ½in. spark coil give? (3) What prevents the current of a high-tension dynamo from leaping from terminal to terminal as in a spark coil?—G. M. S.

[75648.]—**Impure Food.**—Is bacon injurious? It is said that the Jews never suffer from cancer because they do not eat bacon. Do people who eat much bacon suffer in any way from its effects? Will some one say if there are any other impure foods which should be avoided besides bacon? Any information on this subject will oblige.—Kit.

[75649.]—**Bath.**—I want to put on hot water to a bath which is 20ft. above kitchen boiler. There is not room for a hot-water cistern at the top of the house. I have heard that the hot-water cistern is sometimes fixed near the ceiling of the kitchen. Is this an efficient arrangement? Is there any nuisance from escaping steam? Will some one explain the principle of this system or say how it acts? The pipes here always freeze in a hard winter. Could it be made to fill boiler by hand in frosty weather? My grate is an open London range. Will it be necessary to replace it with a kitchener?—Selex.

[75650.]—**Leclanche Battery.**—Will Mr. Bottone kindly inform me how to construct a series of Leclanché cells to make up a medical battery on the most economical plan? As, being a poor mechanic, price is a consideration. —Nervous Debility.

[75651.]—**Ferrotype Diaphragm in Transmitters.**—This is mentioned in the "E.M." 6th March last (p. 26) as suitable for transmitters on the Hunnings principle, but nothing is said about removing varnish from the plate. 1. Is it necessary to clean the whole of the side next the coke, or will a small space in the middle suffice? 2. Is not the bare iron liable to oxidise and impair the contact? And, if so, would it answer to attach a small disc (or button) centrally to the back of the diaphragm, or to make the diaphragm itself of tin plate? I wish to avoid the expense of platinum.—Mu Nu.

[75652.]—**Gramme Dynamo.**—I have a Gramme dynamo, wrought-iron field, wound with 30lb. No 9 d.c.c., with a 7in. armature, charcoal-iron rings, wound with 5½lb. No. 14, running about 2,000 revs., and supplying an arc lamp 11mm. carbons. Can any of our readers give me information as to its actual output in volts and amps, as I have no means of testing? Also say if I could run two arc lamps, and how many incandescent lamps of 16c.p. would it light when not running arc lamp, and what voltage would be best to get? The machine is well made, and runs without heating, and very little sparking. —Output.

[75653.] — **Clockmaking.** — Many thanks to "F. J. G." for answer to my query, from which I gather that a lathe would answer the purpose better than a mandrel for small clockwork. I would be much obliged if he would tell me what kind and size of lathe, and also what tools are necessary to get for that class of work.—A. H.

[75654.]—**Forming Accumulator Plates.**—To Mr. Bottone.—I have made a two-cell accumulator composed of seven plates to each cell, 7in. by 5in., half lead and half peroxide. Can I form them with a six-cell bichromate battery? If so, will you kindly inform me how to proceed? Your book, "Instrument-Making for Amateurs," only treats of small or pocket ones.—J. Worrell.

[75655.]—**The Silver Market.**—What constitutes, or where is the silver bullion market, where "bars, &c.," are bought and sold at the prices quoted in the papers? The "bullion dealers" themselves charge higher prices. Where do they buy—is it at the Bank of England?—Walter Mills.

[75656.]—**Five-Candle Lamp.**—I want to light a 5 candle-power incandescent lamp for about a quarter of an hour at a time. Would a Leclanché battery be suitable, and how many cells would be wanted to light a 4-volt lamp; also best size of cell? I find most kind of cells are a great deal of trouble. I have used Leclanché cells for bells, and find they give very little trouble, so should like to use them for the lamps if possible.—Midland.

[75657.]—**Fixing Hand-Rest to Lathe.**—Would any reader kindly say the best way of fixing a hand-rest to a gap-bed lathe? I cannot fix it underneath, and a nut on the top would be very inconvenient.—Emerald.

[75658.]—**Bichord Piano.**—I should be obliged if any reader will tell me the cause, and a simple remedy for a jarring, accompanying the note when struck. It is as though there was something touching the string. I have taken all the action out, and examined each hammer, and they fall about ⅜in. back after striking.—A. W. L.

[75659.]—**Plating Solution.**—I have made a silver plating bath which deposits its metal nicely, and of a good colour; but when I brush the work the silver comes off. I have made up several solutions before, and never experienced this trouble. I used distilled water for everything except washing the precipitate, which was done with the South Hants Water Company's water. The cyanide is of a darker colour than any I ever used before. It is called gold cyanide, and costs 5s. per lb. in London.—Centre Pinion.

[75660.]—**Fan Blast.**—Will any reader help me to make a fan blast 10in. diameter outside, giving, in the first place, the size of the blades and what No.; second, what space there is left round the sides for the circulation of air; thirdly, the inlet; and fourthly, outlet.—Trio, Sunderland.

[75661.]—**Fruit-Farming.**—Could any reader say what are the prospects in fruit farming in Washington, Oregon, California (especially oranges)? Which is the best State on the Pacific coast for fruit farming? Where could I get any reliable information from? What is the price of land in general?—Enquirer.

[75662.]—**Telescope.**—When I turn my telescope on to any bright star, there is a large flare on one side. As I revolve the object-glass in the cell, the flare revolves at the same time. Could "F.R.A.S." or any other reader suggest a cure for the above?—Object Glass.

[75663.]—**Observatory and Definition.**—My observatory is placed at the end of a large terraced lawn on the east and west of which are a quantity of low-growing shrubs; a large oak tree stands some 80ft. to the north-west. Would these shrubs in any way tend to interfere with definition? Although I have an uninterrupted view from N.N E. to S.W., I have not been able to get a decent view of Jupiter this opposition, and wondered if surrounding shrubs do "materially" affect telescopic work. Perhaps "F.R.A.S." will kindly give me his opinion.—H. A.

[75664.] — **Model Electro-Motor.** — Would Mr. Bottone favour a young beginner with a few explanations and sketch of commutator for the four-poled motor he gave directions to "Somerset Lad," as I should like to make a simple one of this kind to start itself, and oblige? —A Surrey Lad.

[75665.]—**Skin Eruptions.**—"Mallet," reply 75173, recommends for skin eruptions to take 1oz. Epsom salts, and 1oz. powdered magnesia, put these into a jug, and over them pour one pint boiling water; let cool, then pour the whole into a glass bottle. Dose, about a wine-glassful, fasting, in the morning, two or three times a week. A friend of mine, who is troubled with an eruption on his hands, has tried this prescription, and found it become very thick; he added more water to it, but after all it acted very powerfully on his bowels, producing diarrhœa. Will Mr. Mallet kindly say whether the above are the correct proportions of the substances that should be used, or should the mixture become thick as it has done in this case? Or can Mr. Mallett suggest any likely cause why the results of taking the substance should not have been as successful as would be expected from his letter?—A Subscriber from the First Number.

[75666.]—**Mullein.**—I hoped to hear someone say a good word for Verbascum thapsus. A plant that appears so near akin to those that produce for us the useful medicines digitalis and hyoscyamus must surely have some virtues. I have now before me part of a chemist's catalogue, giving this description. "Verbascum Thapsus.—A new remedy for consumption. Dr. Quinlan says it is invaluable in increasing weight. Extractum verbasci fluidum. Dose, 10 to 60 minims." Will some reader who has used the plant speak as to qualities, and tell me weight of leaves required to, and mode of making a tincture from it, dose, &c.?—Learner.

[75667.]—**Lathe for Grinding Lenses.**—Would any of "ours" kindly inform me what kind of a lathe or lathes are required for grinding and polishing lenses, especially object glasses?—J. C.

[75668.]—**Dynamo Getting Hot.**—I am driving 12H.P. engine for electric light, Elwell-Parker's dynamo, 100 volts. The brush-holders and arm get very hot after about two hours' work. I notice the holders slip on the arm rather easily; I cannot tighten them, and I notice when working there is a slight vibration. Will any reader please advise?—A Young Beginner.

[75669.]—**Snakes.**—Will some reader of this popular paper recommend me a work on foreign snakes, their habits, food, and haunts—more especially the venomous species? If the publisher could also be stated, so much the better. I have applied for a great number of natural-history catalogues of books of late from different publishers, but have not seen in them any mention of such a work as that described above.—Autolycus.

[75670.]—**Contents of Gas-Holder.**—I should feel obliged to readers of the "E. M." if they will give me the contents in feet of a gas-holder 12ft. in diameter by 8ft. high. Also, what horse-power gas-engine, driven by Dowson's gas, is required to drive one of Gwynn centrifugal pumps with 12in. fan, 8ft. of 5in. suction pipe, and 15ft. of rising main for delivery? What is the difference of power lost by using Dowson gas and coal gas? What horse-power steam-engine would be required for the above work, and which is cheapest—gas or steam? Any information on the above will oblige.—Kentish Jolly.

[75671.]—**Influence of Light on Edge-Tools.**—The statement is made that edge-tools lose their sharpness by exposure to sunlight, and even moonlight. The assertion is also made that those in the "trade" will never buy chisels, &c., which have been exposed in shop-windows. As your paper goes all over the world, may I ask some of your readers to test the matter by exposing, say, a chisel, a lathe cutter, and a razor. The assertion is that by exposure to sunlight they assume a blue colour, the keen edge disappears, and the tools are rendered "absolutely useless" until retempered.—Dubitans.

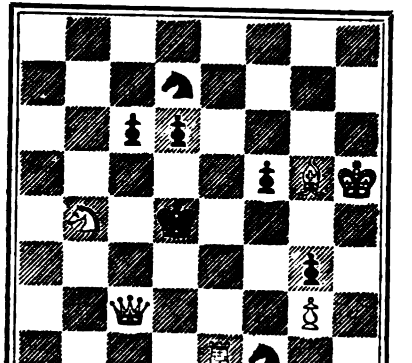
[75672.]—**Modelling Wax.**—Could any of our readers tell me what to put to beeswax to make it tough, hard when cold, but not too brittle, and non-greasy? I should feel very grateful for the information. I am not at all particular as to colour of the composition.—Wax.

CHESS.

All communications for this department must be addressed to "J. Pierce, Knollside, Yawl, Lyme Regis, Dorset."

PROBLEM MCCLXXVII.—By J. Rayner.

Black.



White. [6 + 7

White to play and mate in two moves.

Solution to 1275.

White.	*Black.*
1. Kt-Q B 8.	1. K-Q 4 (*a*)
2. Kt-Q 6.	2. K takes P
3. P discovers mate.	
2. Kt-Q 6, &c.	(*a*) 1. P-Q 7 (*b*) K-K 5 or B 4
2. R Kt 5 (ch), &c.	(*b*) 1. Aught else

NOTICES TO CORRESPONDENTS.

Correct solutions to 1275 by W. Jay (one dual and one triple), Biène (ditto), T. Guest (dual), F. H. Guest (dual); to 1274 by R. W. Houghton (dual), T. Guest (ditto), W. Jay (ditto), F. H. Guest (ditto).

T. Guest.—We are pleased to know that you think so highly of 1274. It is, as you say, very difficult and beautiful. It is not worth while giving the score, as the tourney will be concluded with two more problems. We propose at once to commence a fresh one with the offer of the following prizes:—1. Greenwell's "Chess Exemplified"; 2. Pierce's "Chess Problems and Supplement"; 3 Baxter's "Chess Problems"; 4. Rayner's "Two More Chess Problems" and Rowland's *Chess Annual* for 1891. There must be at least twelve entries. The same rules will be observed as before as to scoring, &c.—that is, for two-movers, two marks; three-movers, five marks; if duals in the latter, two marks for each dual, three for triplets, &c.; for second solutions, two marks. A problem, if impossible of solution, is cancelled from solution competition. We are open to receive names of competitors. There is no entrance fee.

Liverpool Weekly Mercury.

CHESS COLUMN.

The second Problem and Solution Tourney will be commenced in November. It will be divided into two sections for two and three-move direct mates respectively. All classes of competitors are invited. The prizes will be of a substantial character in cash or chess works at the option of the winners. For rules see the October issues of the *Weekly Mercury*.

The *Liverpool Weekly Mercury* will be sent, post paid, for 1s. 8d. per quarter.—[Advt.]

To obtain a dark finish on oak and ash, inclose in a box or closet with some saucers or plates of strong ammonia. The fumes will darken the wood.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, October 21, and unacknowledged elsewhere:—

J. F. Vickery.—W. H. Goulding and Co.—Cassell and Co.—W. H. R.—Legatee.—L. T. G.—McDuff.—Regulus.—W. F. Harrold.—Old Subscriber.—Anxious.—C. S.—A. Austin.—Marienberg.—J. E. Gore.—Inertia.—C. Fre.—R. R. B.—Loco. No. 2.—G. A. Audsley.—A Fellow of the Royal Astronomical Society.—Electric.—T. S. Barrett.—C. G. Bennett.—H. P. Slade.

James Cox. (Neither models nor the articles themselves are required by the British Patent Office. All that is wanted is a specification describing the invention, and it is important that it should be drawn up in concise and definite language.)—Bush. (If you purchase the rights in a patent, it must be properly assigned and the requisite papers be lodged at the office. Get an agent to do such work. The fee is not much.)—E. A. F. C. (In what part of the world do you mean? So far as is known, the moon has no connection with the weather.)—Thomas Walsh. (Possibly if you invert the tube and strike it gently on the floor the column of mercury will unite and the bubbles escape. If not, try warming it in the flame of a spirit lamp. Some additional mercury will probably be needed, as the tube must be quite full before reinverting.)—Telescope. (The ray of light is bent, not broken up. If the two rays combined they would make one of greater volume. See any of the textbooks if you cannot refer to back volumes.)—Astro. Telescope. (Could be used, but is scarcely suitable.)—Amatuer. (For strength and constancy there is probably no better battery than that known as the chromic-acid, as frequently explained in recent numbers.)—Gramo. (Either magnetise by drawing a magnet over them or by passing them into a coil of wire through which a current is flowing. The method is described in nearly every textbook, and in many back numbers.)—Inquirer. (It would take too much space, and has moreover been explained many times. Briefly, the steam being condensed on contact with the water, acquires so much momentum that it forces the water past the valve in spite of the pressure of steam in the boiler. The question has been frequently debated and various hypotheses are put forward, which you can find in most of the textbooks, or in back volumes. How to cure them when faulty, is rather too wide a question. The nature of the fault must, at least, be stated.)—J. W. Bury. (We do not know what you mean. Wherever there is a "bearing" there must be some amount of friction. Submit your design to some of the skilled mechanics you can find in the town whence you write.)—J. T. P. (No space for such a subject. It is mentioned in many works. Probably by "nebulous theory" you mean the "nebular hypothesis.")—Metal. (Yes, stamped out; sometimes in fly-presses, sometimes in rolling machines. Any of the well-known makers of machines of the kind will give information as to speed and price.)—J. M. (Instructions for browning gun-barrels have been given several times. Perhaps the best are those on p. 456, Vol. XL. Jan. 23, 1885; but that volume contains other replies on pp. 329, 390.)—D. D., H. M., and G. C. (There are many small dynamos illustrated and described in back volumes, and even in recent numbers. You must give some idea of the power you want; but apparently you want a motor rather than what is understood by a dynamo.)—H. J. (Do you mean "wash-mills," or what? There are several works on bleaching, scouring, and dyeing in which machines are described; but the best matter of this kind will no doubt be found in some of the Encyclopædias.)—X. Y. (Procure a catalogue from E. and F. N. Spon, Strand, W.C., also one from Longmans, Paternoster-row, and one from Crosby Lockwood and Son, Stationers' Hall Court, E.C.)—Penholder. (It is usually fastened on with paste. Use a padded stick to press it on the sides. 2. Yes, orange shellac; but you can buy the varnish cheaper than you can make it in small quantities. See the indices of back volumes.)—H. H. (Try Sampson Low and Co., St. Dunstan House, Fetter-lane, E.C., or Trübner and Co., Ludgate-hill. The Logarithms, we suspect, can be had second-hand only. Most of Proctor's works were published by Longmans, Paternoster-row.)—J. J. (You must really give some more definite description. It is useless to waste space in guessing what you mean by "horny substance.")—Benjamin Pycroft. (What do you mean by a "compound of orange quinine wine"? The usual thing is about a scruple of sulphate of quinine dissolved in a bottle of orange wine.)—Rosshire. (We think you can obtain all you require, with instructions for making up, from Lancaster and Son, Colmore-row, Birmingham.)—A New Reader. (We do not know the price of the work on "Telescope Objectives" noticed last week; but you can easily ascertain by applying to Messrs. Cooke, Buckingham Works, York. Any of the manuals of astronomy will answer your other questions, which have, however, been answered recently.)—Neophyte. (You could no doubt get a few lessons in the evening from a bicycle repairer; but the "whole art" means simply a training as a mechanic, working at the forge and the vice. Many amateurs, however, do better work than professionals; but those amateurs work for the love of it. You can obtain much information from a perusal of back volumes, but it is absolutely necessary to have practical experience in the shops. No doubt if you advertised for lessons, some one would reply; but the work specified is mainly fitting, as the parts are purchased from the large makers.)—Geo. Blunden. (Better follow the dimensions given. To say you "cannot get the size" specified is nonsense. Any blacksmith will make suitable bars for field-magnets to any reasonable size—certainly to a section of 1in. by a ½in.)—An Anxious Mother. (It is, no doubt, acne. Let her consult Dr. Allinson through the *Weekly Times and Echo*, and live as he directs. Ointments are of no use except, as you truly say, to "irrateate and fetch the skin off."—F. Barton. (You will find King, Mendham, and Co., or F. C. Allsop and Co. reliable. Both advertise on our front page.)—A. S. L. (Glad to hear from you again. Kindly send what you offer at your leisure.)—Joseph Skyes. (Thanks, but no space to spare.)—Walter M. Hardie. (In type.)

Medical Electricity for Self-Application.—Harness' Electropathic Belt is the only genuine curative Electrical appliance recognised by medical and scientific authorities as a bona fide reliable cure for nervous disorders, liver and kidney diseases, rheumatic affections, ladies' ailments, &c. Sufferers may obtain full particulars of this world-famed Electric Belt by writing to the Medical Battery Company, Limited, 52, Oxford-street, London, W.

USEFUL AND SCIENTIFIC NOTES.

Under the heading of "Oils" in the list of imports into India it appears that there has been, during the last five years, the extraordinary increase of 87 per cent. This is attributed mainly to the rapidity with which indigenous vegetable illuminants are being displaced by imported mineral oils.

For the convenience of visitors ascending the peak of Teneriffe, a good stone hut is to replace the present wooden one at Alta Vista (10,900ft.) This will be plainly furnished and warmed with a kitchen stove. Alta Vista is 1,280ft. below the Peak, and can be reached on horseback; the remainder of the ascent must be on foot.

Softening Steel.—Make two iron moulds a little larger than the piece of steel to be softened. Fill them with clay, imbed the steel in the clay, and close the mould by winding a piece of wire round it to exclude the air. After heating the whole to a red heat, thrust the moulds among the coals, or in the ashes, to cool. The steel will then be soft enough to be cut with a knife.

To Repair Broken Negatives.—Place the negative, gelatine side down, on a plate rather larger than the negative. Coat the edges of the fragments with warm Canada balsam; join them together, using strong pressure. Remove the excess of balsam, then cover the negative with another plate exactly the same size, and previously coated on one side with this varnish: sandarac 3 grammes, mastic in tears 3 grammes, sulphuric ether 50 grammes, benzole (pure) 25 grammes. Lift together the three plates, turn them over, remove the large one that has served as a support, scrape off from the gelatine side the balsam that may have exuded, then surround the two plates with strips of gummed paper. Heat slightly the fragments before joining them together. This process will yield a print upon which no trace of breaking is to be seen.—*L'Amateur Photographe.*

Water as a Medicine.—The human body is constantly undergoing tissue change. Worn-out particles are cast aside and eliminated from the system, while the new are ever being formed, from the inception of life to its close. Water has the power of increasing these tissue changes, which multiply the waste products, but at the same time they are renewed by its agency, giving rise to increased appetite, which in turn provides fresh nutriment. Persons but little accustomed to drink water are liable to have the waste products formed faster than they are removed. Any obstruction to the free working of natural laws at once produces disease, which, if once firmly seated, requires both time and money to cure. People accustomed to rise in the morning weak and languid will find the cause in the imperfect secretion of wastes, which many times may be remedied by drinking a full tumbler of water before retiring. This very materially assists in the process during the night, and leaves the tissues fresh and strong, ready for the active work of the day. Hot water is one of our best remedial agents. A hot bath on going to bed, even in the hot nights of summer, is a better reliever of insomnia than many drugs. Inflated parts will subside under the continued poulticing of real hot water. Very hot water, as we all know, is a prompt checker of bleeding, and besides, if it is clean, as it should be, it aids in sterilising our wound. A riotous or rotten stomach will nearly always gratefully receive a glass or more of hot water.—*Hall's Journal of Health.*

The English Mechanic

AND WORLD OF SCIENCE AND ART.

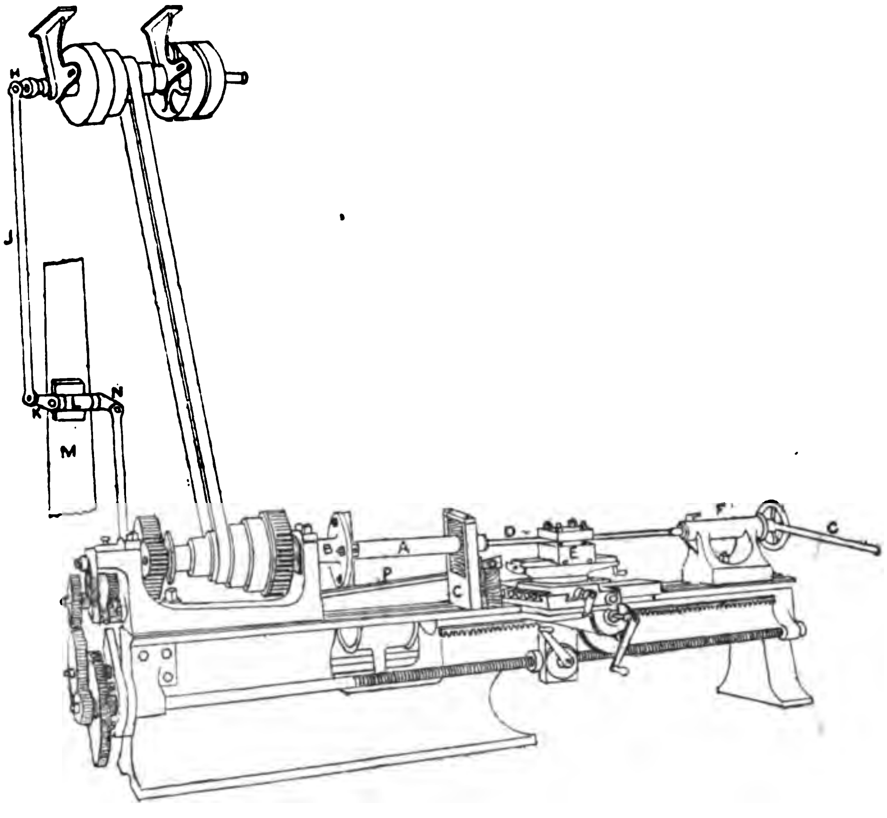
FRIDAY, OCTOBER 30, 1891.

BORING HOLES IN LONG POSTS.

THIS is a special kind of work, apparently difficult, requiring a special rig up, but simple enough when understood. I append sketches of the method in which I have seen it done during several years past. The class of work to which it is applied is chiefly the central posts or pivots of revolving cranes, and the holes are bored in order to allow the vertical slewing-shaft to pass down through the post, or in some cases to allow steam to pass from a detached boiler to the cylinders. The holes may vary in size from 1in. or 1¼in. to 2½in. or 3½in. in diameter, and in length from about 2ft. to 6ft., or even more.

The general arrangement, which, of course, is sometimes slightly modified by circumstances, is shown in its essential features in Fig. 1. In this figure, A is the post or pivot that is being bored. One end of it is gripped in the jaws of the jaw-chuck, B. The other end turns in the wood blocks of the fixed steady, C, which is lubricated with soft soap and blacklead. D is a D-bit provided with a shank sufficiently long to allow the bit to penetrate to the required depth in the pivot. The bit is prevented from turning round by being pinched in the tool-holder E of the slide-rest. It is thrust forward to its work by the poppet F. The end of the shank is either pivoted on the centre of the poppet mandrel, or else it terminates on the right-hand side of the tool-holder E, and then a stiff distinct bar is pivoted on the poppet centre, and its opposite end is thrust against the right-hand end of the D bit. The poppet being bolted to the lathe-bed, and the mandrel turned forward, the bit is thus fed into the work. As considerable pressure is necessary for the feed, a lever G is fastened to the hand-wheel of the poppet, and the turner operates upon this. Since the shank of the D bit is pinched in the tool-holder of the slide-rest, the latter is not bolted to the lathe-bed, but is left to slide freely along it in unison with the feed movement imparted to the poppet mandrel.

It would be impossible to bore such holes without very ample lubrication, and the arrangement used for this is as follows:—At one end of the countershaft a small crank, H, is fixed. This, of course, turns with the shaft, and imparts vertical up-and-down movement to the rod J. This rod imparts a radial movement to the crank K, pivoted in the bearing L, attached to any convenient pillar, M, permanent or temporary. The crank N is keyed on the same pivot as crank K, and moves in unison with it, and gives motion to the ram of a small force-pump, portable or otherwise, fixed upon a tank of water. This pump is not shown in the figure, being behind the headstock; but any pump combined with a tank will serve the purpose. The ram forces soapy water up from the tank through an indiarubber hose into a small copper pipe attached to the opposite end of the hose. These being behind the lathe-bed are not seen in the figure. This copper pipe, about ¾in. in the bore, is laid along in a groove cut for its reception in the shank of the D bit, into which it is secured with a bit of binding wire, and this travels with the bit, the rubber hose allowing ample freedom of movement. It passes right down to the termination of the hole, and lubricates the point of the bit. Unless some precautions were taken, the water running out of the hole would flood the lathe with dirt. So across the saddle a piece of channel iron O is laid, just underneath the open end of the post, and made to slope well towards a piece of shuting, P, which returns the soapy water into the tank.



Since the pump forces the water in under considerable pressure, there is also a strong return current, and this forces the chips back to the mouth of the post, and throws a large proportion of them outside into the shoot O, whence they can be easily removed. I cannot in this general and rather rough sketch show the details of the operation properly, and therefore illustrate the essential features of the tools and appliances in enlarged figures. The D bit commonly used is shown at Fig. 2. The angles of the nose are important: they should not be more than 6° or 7° from a right angle. The top rake of the lip A, should make an angle of from 15° to 18° with the perpendicular, suitable for the various qualities of wrought iron and mild steel, of which pivots and posts are made. The shank is usually of wrought iron, welded to the steel D bit. At C is shown the groove along which the copper pipe is laid. When boring, the bit is laid with the flat face of its shank downwards on the tool-holder as in the upper view of Fig. 2. The object of this is to clamp the bit in a perfectly rigid position under the stress of cutting.

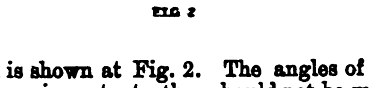


FIG 2

Fig. 3 shows a composite form of D-bit, used for boring the largest holes. The end A occupies three-parts of a circle, and its guidance is therefore perfect. But the essential feature of the bit is that the cutting portion is in a separate piece, B, screwed to the main body. The main body is therefore in effect a tool-holder, and the bit of steel, of which the tool itself is composed, may be of very superior quality. Again, when boring large holes in wrought iron and mild steel, the borings mostly come off in shavings rather than in short chips, and these choke up the hole, so that frequent withdrawal of the tool becomes necessary. The larger the holes, the heavier and stiffer the shavings. Hence the reason why the lip of B is formed in the centre of the cutting end to break up chips and render their delivery more easy. C is the groove for the copper lubricating tube.

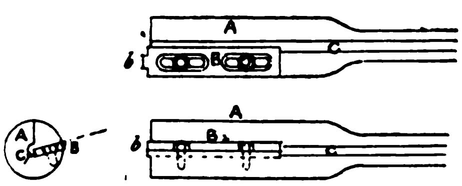


FIG. 3.

In this bit there is also greater facility for the removal of the shavings than in the first shown. A great advantage of the form in Fig. 3 over that of Fig. 2 is, that in the former the copper pipe passes right out to the front of the bit, and the pressure of the water tends to drive the borings back out of the hole. In the latter case the pipe stops short of the cutting-edge, and the water tends, in the first place, to drive the borings inwards.

The actual cutting-tool is shown enlarged in Fig. 4. In this the form of the bolt slot holes is seen. The wider slots are made to receive the thickness of the heads of the bolts, so that they shall chiefly be below the surface of the tool, and not impede the return of the shavings.

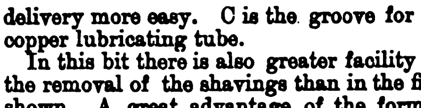


FIG. 4.

Fig. 5 shows the apparatus as rigged up to turn the handwheel of the poppet for thrusting the bit forwards. One portion of the boss of the wheel is embraced by a clip A. Between its jaws the bar B is thrust, and held with a screw. Through a boss in this bar a common bolt, C, is tapped, and, bearing against one of the arms of the hand-wheel, affords the necessary leverage for turning it slowly round.

Fig. 6 shows the steady. The main part A is a casting with vee'd vertical edges, within which the blocks of wood B B are fitted. They are kept in place by the plate C screwed down. The steady is secured underneath the bed of the lathe with a nut on the screw D. E is the pillar being bored.

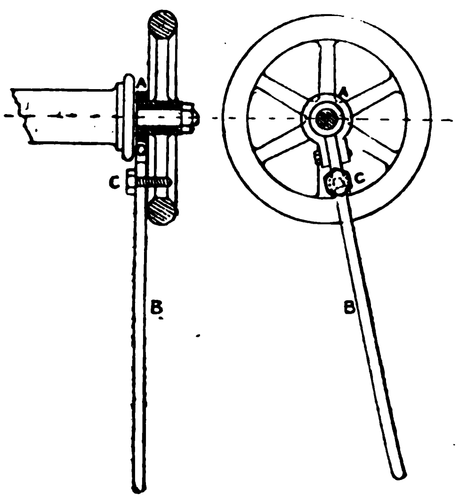


FIG 5

The time occupied in boring a hole varies as much as 100 per cent. with the quality of metal. On an average, from 6in. to 8in. per hour is bored. But if the metal is unsound, spongy, spilly, as it is apt to be in large forgings, the point of the bit will become broken, and time be lost. It is awkward if a bit of the broken steel gets embedded in the hole being bored. After having bored from 4in. to 6in., the tool must be withdrawn, and the chips cleared out, a piece of bent wire being used for the purpose. The deeper the hole, the more frequently must the withdrawal take place. The hole is commenced with a common drill, flat or twist, to a depth of about 3in., and then the D bit is brought into requisition.

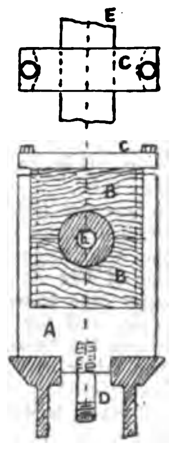


FIG 6

The hole is not bored right through, but half way in from each end in turn, so meeting in the middle, and if done carefully the alignment is practically perfect.

In the case of large holes—say, those ranging from 2½in. to 3½in. diameter, and especially when the metal is not sound, it is safer to take two cuts. The hole would then be roughed out to within, say, ⅛ or ¼ of the finished size, and completed with a second bit of the correct size. J. H.

ASTRONOMICAL NOTES FOR NOVEMBER, 1891.

The Sun.

Day of Month.	Souths.	At Greenwich Mean Noon.		
		Right Ascension.	Declination South.	Sidereal Time.
	h. m. s.	h. m. s.	° ′ ″	h. m. s.
1	11 43 40·47 A.M.	14 25 37	14 26 24	14 41 56·85
6	11 43 43·71 ,,	14 45 23	15 59 38	15 1 39·62
11	11 44 7·42 ,,	15 5 30	17 26 9	15 21 22·40
16	11 44 51·88 ,,	15 25 57	18 45 8	15 41 5·19
21	11 45 57·35 ,,	15 46 45	19 55 48	16 0 47·97
26	11 47 23·21 ,,	16 7 54	20 57 24	16 20 30·76

The method of finding the Sidereal Time at Mean Noon at any other station will be found on p. 367 of Vol. LII.

Spots and faculæ are now observable on the Sun's face whenever he is visible.

The Zodiacal Light may still be seen, especially during the earlier part of the month, to the south of east before sunrise.

There is a Partial Eclipse of the Sun on the last day of the month; but as it is invisible in this country, the mere mention of it here will suffice.

The Moon

is New at 6h 32·6m. in the evening of the 1st; enters her First Quarter at 8h. 46·4m. a.m. on the 9th, and is Full 16·2 minutes after midnight on the 15th. She will enter her Last Quarter at 8h. 25·8m. on the morning of the 23rd.

Day of Month.	Moon's Age at Noon.	Souths.
	Days.	h. m.
1	29·5	11 33·6 a.m.
6	4·7	3 43·6 p.m.
11	9·7	8 15·3 ,,
16	14·7	*12 41·3 a.m.
21	19·7	4 31·2 ,,
26	24·7	8 9·8 ,,

* Early morning of 17th.

The Moon will be in conjunction with Mercury (1° 27′ North of him) at midnight on the 1st; with Venus at 8h. p.m. on the 2nd (Venus 0° 13′ S.); with Jupiter at 7h. p.m. on the 10th (Jupiter 4° 9′ N.); with Saturn at 2h. p.m. on the 25th (Saturn 2° 40′ S.); and with Mars at 5 p.m. on the 27th (Mars 2° 3′ S.) There will be

A Total Eclipse of the Moon

on November the 15th, which will occur under very favourable circumstances; and, should the night prove fine, will be well seen from beginning to end.

		h.	m.	
First contact with the Penumbra........	Nov. 15	9	36·7 p.m.	G.M.T.
First contact with the Shadow..........	,,	10	35·1 ,,	
Beginning of Total Phase	,,	11	37·4 ,,	
Middle of the Eclipse	Nov. 16	12	18·9 a.m.	
End of Total Phase	,,	1	0·4 ,,	
Last contact with the Shadow		2	2·7 ,,	
Last contact with the Penumbra		3	1·1 ,,	

Calling the moon's diameter 1, the magnitude of the Eclipse will be equal 1·386; in other words, at the time of the middle of the eclipse, the moon will be immersed 1·386 of her own diameter in the earth's shadow. The first contact with the shadow will occur at a point on the moon's eastern limb, 55° from her North Point. The last contact will happen 95° towards the west from the North Point of the Moon.

The student is advised to note particularly whether, soon after the First Contact with the Shadow of the earth, the contour of that shadow on the moon's disc is rigidly circular; as suspicions have been entertained that large ranges of terrestrial mountains have, on former occasions, slightly distorted our shadow, and been distinguishable as breaking its otherwise symmetrical curve on the moon's face.

At noon on Nov. 1 the moon is on the boundary which divides Virgo from Libra, and enters the last-named constellation immediately afterwards. Having traversed the whole width of Libra, she arrives, at 10h. a.m. on the 3rd, at the western edge of the narrow northern spike of Scorpio, and having traversed this, passes, at 11h. 30m. p.m., into Ophiuchus. She leaves Ophiuchus at 10h. 30m. a.m. on the 5th for Sagittarius, and Sagittarius in turn for Capricornus at 2h. a.m. on the 8th. She remains in Capricornus until 8h. 30m. p.m. on the 9th, at which hour she enters Aquarius. Her journey over Aquarius terminates at 9h. p.m. on the 11th, when she quits it for Pisces. As she travels across Pisces she arrives, at 1h. p.m. on the 12th, at an outlier of Cetus, which she then enters, and is travelling through it until 8h. 30m. a.m. on the 13th, when she enters Pisces again, only, however, to plunge for the second time into another portion of Cetus at 8h. a.m. on the 14th, and when she finally gets out of this at 1 p.m. the same day, it is to emerge into Aries. She is in Aries until 9h. 30m. p.m. on the 15th, and then she passes into Taurus. It is not until 1h. p.m. on the 18th that her journey through Taurus finishes, and she enters Gemini. She leaves Gemini for Cancer at 11h. a.m. on the 20th, and continues in Cancer until 1h. a.m. on the 22nd. At the time last mentioned, she crosses the boundary into Leo. Here she remains until 1h. 30m. a.m. on the 25th, when she enters Virgo. She does not finish her course over this great constellation until 7h. p.m. on the 28th, when she leaves it for Libra. As at the beginning of the month, her journey through Libra terminates at the western edge of the spike in Scorpio, which she reaches at 6h. p.m. on the 30th. She obviously has not crossed it by midnight, when the month terminates.

Mercury,

After November 3rd, is an evening star; but from his great and increasing South Declination, is but poorly placed for the observer. His angular diameter increases almost imperceptibly from 4·6″ on November 1st to 5·4″ by the end of the month.

Day of Month.	Right Ascension.	Declination South.	Souths.
	h. m.	° ′	h. m.
1	14 30·1	14 42·2	11 54·4 a.m.
6	15 7·5	18 10·0	0 5·8 p.m.
11	15 39·0	20 38·4	0 17·6 ,,
16	16 11·0	22 41·4	0 29·8 ,,
21	16 43·3	24 16·1	0 42·4 ,,
26	17 15·8	25 19·5	0 55·1 ,,

The path indicated in the above ephemeris commences in Libra and extends over a good deal of that constellation, as it also does over the whole width of the northern part of Scorpio, and terminates in Ophiuchus. Mercury will be some 3° north of Antares on the evening of the 18th.

Venus

is an evening star too, in the same sense as Mercury; but, like him, is very indifferently placed for the observer, her position becoming worse and worse as the month advances. She is slightly gibbous, too, even were she well visible, and is altogether an uninteresting object in the telescope. Her angular diameter increases, quite imperceptibly from 10″ at the beginning of the month to 10·4″ by the end of it.

Day of Month.	Right Ascension.	Declination South.	Souths.
	h. m.	° ′	h. m.
1	15 11·2	17 33·5	0 29·2 p.m.
6	15 36·6	19 19·4	0 34·8 ,,
11	16 2·4	20 52·0	0 40·9 ,,
16	16 28·8	22 10·0	0 47·5 ,,
21	16 55·5	23 11·9	0 54·6 ,,
26	17 22·7	23 56·6	1 2·0 ,,

As in the case of Mercury above, the path of Venus commences in Libra, crosses Scorpio, and terminates in Ophiuchus.

Occultations of (and Near Approaches to) Fixed Stars by the Moon.

Day of Month.	Star's Name.	Magnitude.	Disappearance.	Moon's Limb.	Angle from Vertex.	Angle from N. Point.	Reappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.
			h. m.		°	°	h. m.		°	°
4	B A C 5709	6	†4 51 p.m.	N. by E.	8	343				
4	26 Ophiuchi	6	†4 56 ,,	N. by E.	8	342				
7	ω Sagittarii	5	5 21 ,,	Dark	84	78	6 37 p.m.	Bright	248	231
7	A Sagittarii	5	7 6 ,,	Dark	102	81	8 7 ,,	Bright	225	196
8	B A C 7237	6	4 34 ,,	Dark	89	99	5 48 ,,	Bright	234	233
10	τ^1 Aquarii	6	6 31 ,,	Dark	28	37	7 33 ,,	Bright	270	268
10	τ^2 Aquarii	4	†8 25 ,,	NW by N	328	318				
16	53 Tauri	6	†6 55 ,,	S.S.E.	158	200				
16	56 Tauri	6	†7 21 ,,	N.N.W.	338	20				
16	κ^2 Tauri	6½	9 33 ,,	Bright	25	63	10 21 ,,	Dark	289	322
16	κ^1 Tauri	4½	†10 0 ,,	N.N.W.	337	13				
17	τ Tauri	4½	5 46 a.m.	Bright	106	63	6 39 a.m.	Dark	239	198
17	118 Tauri	6	10 37 p.m.	Bright	39	79	11 33 p.m.	Dark	289	322
20	λ Cancri	6	†8 13 ,,	N.	4	36				
22	η Leonis	3½	‡9 51 ,,	Bright	81	114	10 41 ,,	Dark	307	343
23	42 Leonis	6	†7 32 a.m.	S.W. by S	211	190				
25	ν Virginis	4½	2 37 ,,	Bright	43	86	3 1 a.m.	Dark	7	45
29	5 Libræ	6	6 28 ,,	Bright	165	196	7 17 ,,	Dark	258	284

† Near approaches. ‡ The Moon has not yet risen.
An illustrated description of the above table will be found on page 367 of Vol. LII.

Jupiter's Satellites.

Day of Month.	Satellite.	Phenomenon.	H.	M.	S.	Day of Month.	Satellite.	Phenomenon.	H.	M.	S.	Day of Month.	Satellite.	Phenomenon.	H.	M.	S.
1	I	Ec R	7	37	53 P.M.	10	*III*	*Oc R*	4	30	P.M.	18	II	Sh I	10	28	P.M.
2	*I*	*Sh E*	4	49	,,	10	III	Ec D	6	21	17,,	18	II	Tr E	10	41	,,
2	II	Oc D	7	39	,,	10	III	Ec R	9	28	55,,	20	II	Ec R	7	23	26,,
3	*II*	*Ec R*	12	51	0 A.M.	11	II	Tr I	5	15	,,	22	I	Oc D	9	48	,,
3	III	Ec R	5	27	25 P.M.	11	II	Sh I	7	50	,,	23	I	Tr I	6	56	,,
4	*II*	*Sh I*	5	11	,,	11	II	Tr E	8	8	,,	23	I	Sh I	8	18	,,
4	II	Tr E	5	38	,,	11	II	Sh E	10	40	,,	23	I	Tr E	9	15	,,
4	II	Sh E	8	2	,,	13	*II*	*Ec R*	4	46	18,,	23	I	Sh E	10	35	,,
6	III	Tr I	11	10	,,	14	I	Tr I	10	34	,,	24	*I*	*Oc D*	4	17	,,
6	I	Oc D	11	34	,,	14	*I*	*Sh I*	11	53	,,	24	I	Ec R	7	53	43,,
7	I	Tr I	8	42	,,	15	I	Oc D	7	55	,,	24	III	Oc D	8	48	,,
7	I	Sh I	9	57	,,	15	*I*	*Ec R*	11	29	11,,	25	I	Sh E	5	4	,,
7	I	Tr E	11	1	,,	16	I	Tr I	5	3	,,	25	II	Tr I	10	22	,,
8	*I*	*Sh E*	12	15	A.M.	16	I	Sh I	6	22	,,	26	IV	Sh E	5	18	,,
8	I	Oc D	6	2	P.M.	16	I	Tr E	7	21	,,	27	*II*	*Oc D*	4	30	,,
8	I	Ec R	9	33	32,,	16	I	Sh E	8	40	,,	27	II	Ec R	10	0	45,,
9	*I*	*Sh I*	4	26	,,	17	*III*	*Oc D*	4	53	,,	28	*III*	*Sh I*	4	24	,,
9	I	Tr E	5	29	,,	17	I	Ec R	5	58	3,,	28	III	Sh E	7	40	,,
9	I	Sh E	6	44	,,	17	IV	Oc R	6	23	,,	29	II	Sh E	5	14	,,
9	IV	Sh I	7	27	,,	17	III	Oc R	8	21	,,	30	I	Tr I	8	52	,,
9	II	Oc D	10	7	,,	17	III	Ec D	10	23	32,,	30	I	Sh I	10	13	,,
9	IV	Sh E	11	6	,,	18	II	Tr I	7	47	,,	30	*I*	*Tr E*	11	10	,,

Ec, Eclipse; Oc, Occultation; Tr, Transit of Satellite; Sh, Transit of Shadow; D, Disappearance; R, Reappearance; I, Ingress; E, Egress. The printing of a phenomenon in *italics* indicates that its visibility is rendered doubtful, either by the brightness of the twilight, or by Jupiter's proximity to the horizon.

Mars,

for the purpose of observation with the telescope, is invisible, a remark which also applies to Uranus.

Jupiter

is an evening star, and but for his South Declination would be very fairly situated for the observer. He should, of course, be observed as near to the Meridian as possible. His angular equatorial diameter diminishes from 44·4" on November 1st to 40·4" by the 30th.

Day of Month.	Right Ascension.	Declination South.	Souths.
	h. m.	° ′	h. m.
1	22 41·3	9 47·9	7 58·0 p.m.
6	22 41·3	9 46·7	7 38·4 ,,
11	22 41·6	9 43·4	7 19·1 ,,
16	22 42·3	9 38·3	7 0·1 ,,
21	22 43·3	9 31·3	6 41·4 ,,
26	22 44·6	9 22·6	6 23·0 ,,

The almost insensible path thus indicated is described to the South-west of the 4th magnitude star λ Aquarii.

Neptune,

is about as well placed for the observer as he can be, rising before 6p.m. at the beginning of the month, and some two hours sooner at the end of it, and coming into opposition to the Sun at 3 a.m. on the last day of November.

Day of month.	Right Ascension.	Declination North.	Souths.
	h. m.	° ′	h. m.
1	4 27·8	20 6·6	1 47·6 a.m.
6	4 27·3	20 5·4	1 27·4 ,,
11	4 26·8	20 4·1	1 7·2 ,,
16	4 26·2	20 2·8	12 47·0 ,,
21	4 25 6	20 1·4	12 26·8 ,,
26	4 25·1	20 0·1	12 6·5 ,,

The short retrograde arc indicated above lies in that perfectly blank region in Taurus to the north of the Hyades.

Saturn

does not rise until about 2h. 48m. a.m. on November 1st, nor till about 1h. 7m. a.m. at the end of November. Hence any ephemeris of him would be valueless to the ordinary astronomical amateur, and we should dismiss our notice of the planet with this remark, but for the fact that his ring only reappeared on October 30th, and he hence prevents a curious and scientifically important spectacle. He should be looked for in the E.S.E. before sunrise, and followed until the twilight becomes too strong for observation. He will be found due east of the 3·7th mag. star β Virginis.

Minima of the Variable Star Algol

will occur on the night of the 2nd at 11h. 29m., on the 5th at 8h. 18m. p.m., on the 8th at 5h. 7m. p.m., on the 20th at 4h. 22m. a.m., on the 23rd at 1h. 11m. a.m., on the 25th at 10h. p.m., and on the 28th at 6h. 49m. p.m., as well as on other occasions when the phenomenon will be invisible.

Shooting Stars

are, as is well-known, usually associated by the ordinary observer with the months of August and November. The night of the 13th is that on which the familiar shower of "Leonids" (so-called from their appearing to emanate from a point in the "sickle" in Leo), are to be looked for; but we must reiterate a warning often given in these columns, that it is useless for the student to begin his watch before midnight when the constellation from which they seem to emanate is rising. That these meteors are travelling in the same orbit as Tempel's little comet (I. 1866) is now a well-worn story. The second shower of meteorites will happen on the night of the 27th. This travels in the orbit of Secchi's comet (III. 1853). Both of these showers wax and wane in splendour, and no particularly grand display need be expected this year. Minor showers appear at the beginning of November, from the 16th to the 20th, and again on the 30th.

Greenwich Mean Time of Southing of Thirteen of the Principal Fixed Stars on the Night of November 1st, 1891.

Star.	Souths.			
	h.	m.	s.	
α Cygni..	5	54	48·58	p.m.
α Cephei	6	32	57·84	,,
ε Pegasi..	6	55	55·58	,,
α Aquarii	7	17	4·47	,,
Fomalhaut	8	8	23·23	,,
Markab..	8	16	3·72	,,
ι Piscium	8	50	58·98	,,
α Andromedæ	9	19	18·98	,,
α Cassiopeiæ	9	50	48·57	,,
Polaris..	10	36	4·13	,,
α Arietis	11	17	16.58	,,
α Ceti ..	*12	12	40·52	a.m.
α Persei..	*12	32	35·88	,,

* Early morning of 2nd.

The method of ascertaining the Greenwich Mean Time of Southing of either of the stars in the above list for any other night in November, as also that of determining the local instant of its transit at any other station, will be found on p. 368 of Vol. LII. It must, however, be noted that the rules there given are not rigidly accurate when applied to Polaris, or, in fact, to any close circumpolar star, though they will probably be found quite sufficiently so in actual practice.

Wolf's Comet

is now travelling down in a southerly direction, and its brightness is slowly, though steadily, decreasing. It is in Eridanus, and on the night of the 1st is a little to the north, and just to the east, of the 4·3 mag. star μ Eridani, with which it is in the same low-power field on the 3rd, travelling subsequently in a south-westerly direction. Instead of occupying needless space with a map of a very barren region of the sky, we append a daily ephemeris of the comet, for Berlin mean midnight, for the first third of the month.

Day of Month.	Right Ascension.	Declination South.
	h. m.	° ′
1	4 40·9	2 36·7
2	4 40·6	3 6·8
3	4 40·3	3 36·6
4	4 40·0	4 5·9
5	4 39·7	4 34·8
6	4 39·3	5 3·1
7	4 38·9	5 31·0
8	4 38·4	5 58·3
9	4 38·0	6 25·0
10	4 37·5	6 51·1
11	4 36·9	7 16·7

The Comet rises about 8h. 10m. p.m. on the 1st, and about 7h. 50m. p.m. on the 11th.

GEOLOGY FOR STUDENTS.

By **Edward Aveling**, D.Sc. Lond., Fellow of University College, London.

Chapter XVII.—Archæan Rocks.

A. DERIVATION. — The oldest known strata, wherever they are met with, are called the Archæan rocks. These rocks are certainly not of the same age in all parts of the earth. The British Archæan rocks, e.g., are younger than the North American. Hence it is best not to speak of any Archæan system, but to speak of Archæan rocks.

The word Archæan is derived, as we have seen, from *αρχαιος* (archaios), ancient. Other names used for these rocks are pre-cambrian (Chap. XVI.), azoic, eozic (without living things; or presenting the dawn of life. Chap. XVI.), Laurentian. The last name is given to them on account of their great development in the basin of the river St. Lawrence in North America.

B. What.—(1) *Structure.*—The Archæan rocks are metamorphic, and consist in the main of gneiss and schists (mica schists, talc schists, chlorite schists). The gneiss is very often traversed by veins of graphite, and the granite is often of the graphic form (p. 82). In Fig. 63 is shown a piece of gneiss with interstratified graphic granite. The rock here figured was taken from near Cape Wrath, the extreme north-west point of Sutherland, Scotland.

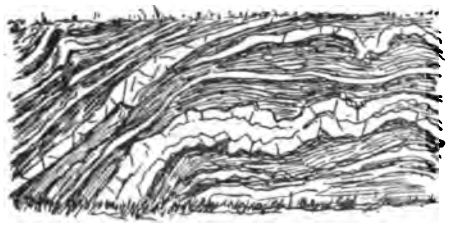


Fig. 63.

The strata are usually inclined, contorted, and lie unconformably to the Silurian strata that succeeded them. Fig. 64 is a diagram section across the west of Sutherland; *g* to the left represents Archæan gneiss; *s* in the middle represents red sandstone and conglomerate, which may be Archæan, or may be Silurian; S to the right is undoubtedly Silurian.

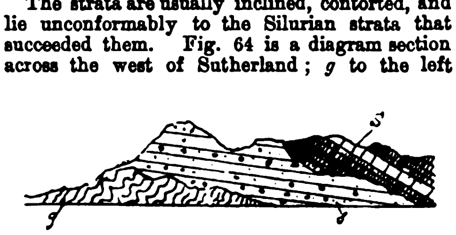


Fig. 64.

Fig. 65 is a diagram section across the Wrekin, in Shropshire—a craggy hill, 2½ miles south-west of Wellington. A is Archæan, and is probably the cone of an extinct volcano; *a a* are also probably Archæan; S L and S T are both Silurian.

(2) *Composition.*—To understand the composition of the Archæan rocks, we must first note the formations into which these rocks are roughly divided. Table IX. will help here:

TABLE IX.

Divisions of Archæan Rocks.

Archæan	Huronian	Schists
	Laurentian	Upper—Felspar, with beds of limestone. Lower—Orthoclase gneiss, with bands of crystalline limestone.

The Archæan rocks are divided into the Laurentian formation below, and the Huronian above. The meaning of the name Laurentian has been explained. The Huronian formation takes its name from being largely developed on the eastern shores of Lake Huron. The Laurentian formation is again divided into two groups—the lower and upper. The rock composition of these groups and of the Huronian formation is given in the table. The thickness of the lower Laurentian rocks is about 18,000ft.: that of the upper Laurentian rocks about 12,000ft. The Huronian rocks vary in thickness between 10,000ft. and 20,000ft.

The Archæan rocks are represented in Great Britain, as we shall see when we come to the "Where" of them. But it should be borne in mind that the British Archæan rocks are probably much more recent than the Archæan rocks of Canada.

A great many ores of metals occur in these formations. Magnetic iron ore (Fe_3O_4), ores of silver, copper, arsenic, zinc, manganese, cobalt, are all met with.

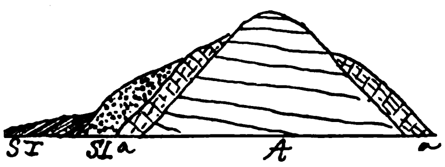


Fig. 65.

C. Where.—In reality Archæan rocks are met with all over the globe. We shall now give the list of the chief places where they appear.

1. Europe. *a.* British Isles. (i.) England. Working, as usual, from south to north, from west to east. The Eddystone rocks, the dangerous reef in the English Channel 14 miles south-west of Plymouth. The central ridge of the Malvern Hills, between Worcestershire on the east and Hereford on the west. The Wrekin in Shropshire. Charnwood Forest in Leicestershire, five miles south-west of Loughborough.

(ii.) Wales. St. David's in Pembroke. The great Merionethshire anticline between Barmouth and Harlech, and Dolgelly and Harlech. Harlech dome. Lleyn promontory, that separates Cardigan Bay on the south from Carnarvon Bay on the north. Llanberis, Carnarvon, Bangor, Anglesea.

(iii.) Scotland. The outer Hebrides, especially Lewis. The western coast of Scotland from the Island of Tiree, one of the inner Hebrides, off the coast of Argyleshire, on the south, to Cape Wrath on the north.

(iv.) Ireland. Wexford and Wicklow, notably at Bray Head. Hill of Howth on the north side of the entrance to Dublin Bay. Galway in the west. Donegal in the north.

b. The Continent. The southernmost and most westerly appearance of the Archæan rocks on the Continent is in the Sierra Nevada, the mountains running nearly parallel to the curve of the Mediterranean shore in the south-eastern part of Andalusia, the southern province of Spain. The Pyrenees, Sardinia, Corsica, the Vosges Mountains, between Lorraine and Alsace, the Taunus Mountains to the north-west of the Vosges, in Germany, between Wiesbaden and Homburg, the Central Alps, Bavaria, Bohemia, Saxony, the Erzgebirge (ore mountains), between Bavaria on the south and Saxony on the north, the Carpathian Mountains in the east of Austria, the Scandinavian Range, Finland, Podolia, in South-west Russia, just over the Austrian frontier, North-west Russia from the White Sea to the Petchora river, the Ural Mountains.

2. Asia. Ceylon, Madras, Bundelkhund, Bengal, Assam (in all a range of nearly 2,000 miles), the central rocks of the Himalayas, Northern China.

3. Africa. Madagascar, Algeria, Eastern Egypt.

4. America. (*a*) South: The Andes of Chili, Brazil, Guiana, Venezuela.

(*b*) North: In North America the Archæan rocks form the nuclei of many mountain ranges. They appear in Texas, Arkansas, the Blue Ridge mountains that run through Virginia and Pennsylvania, the Laramic range of the Rocky mountains in Wyoming, the Appalachians, the Adirondacks. From the region of the great lakes they extend to the Arctic Circle. In Canada they are especially noticeable, and most especially near Lake Huron, on the north bank of the river Ottawa, and in the basin of the river St. Laurence, Nova Scotia, New Brunswick, Newfoundland, Labrador.

5. Oceania. (*a*) Australia. In the south-west of Australia. In Southern New Zealand, notably at Canterbury and Otago, both on the east coast.

D. Palæontology.—As we have seen, the Archæan rocks are often called azoic, or at most eozoic. It is open to question whether any genuine remains of living things occur in the Archæan rocks. But there are (1) large quantities of graphite, or plumbago, or black-lead in them; (2) iron ores; (3) the disputed Eozoon canadense; (4) marks that are considered by some geologists to be the remains of the tracks of lowly-organised worms.

(1) The Graphite Beds. In more recent formations, when large masses of graphite occur, they are held to be the result of metamorphosis of steam-coal or anthracite. This latter, in its turn, is generally the result of the metamorphosis of coal. And coal is undoubtedly of vegetable origin. The presence of graphite in the Archæan rocks is, therefore, held by some as evidence that in Archæan times vegetation existed.

(2) The presence of iron ore is also regarded by certain geologists as indirect evidence of the existence of plant life. Decomposing vegetation, undoubtedly, does cause the precipitation or throwing down of iron oxides.

(3) Eozoon Canadense, Fig. 66. This organism or non-organism occurs in the crystalline limestone of the Lower Laurentian group. It presents a number of concentric rings of calcium carbonate (calcite), which are supposed to be the skeleton of the lowly-organised animal, and of serpentine, which is supposed to be infiltrating matter, filling up the many chambers of the shell of Eozoon. *ηως* (eos), dawn; *ζωον* (zoon), animal. *Canadense*, Canadian.

In the next chapters we shall study, in some little detail, the divisions of the Vegetable and of the Animal kingdoms. Then we shall point out the class to which Eozoon is said to belong. Here it is only necessary to say that if Eozoon was an animal, it was a gigantic creature of very low organisation, with a protoplasmic body of many segments, connected one with another by protoplasmic cords or stolons. Around this protoplasmic body, a calcareous or chalky shell was formed, necessarily of many chambers, each of which corresponded with one segment of the living, protoplasmic body within. In the walls of this shell were holes, or foramina (*foramen*, a hole), through which fine extensions of the protoplasm were protruded. Protoplasm is the simplest form of living matter,—"the physical basis of life," as it has been called; is granular, semi-fluid, contractile, and made up of the chemical elements, carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus. It must be remembered, however, that the organic nature of Eozoon is greatly questioned.

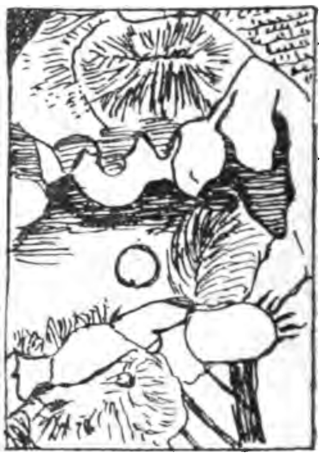


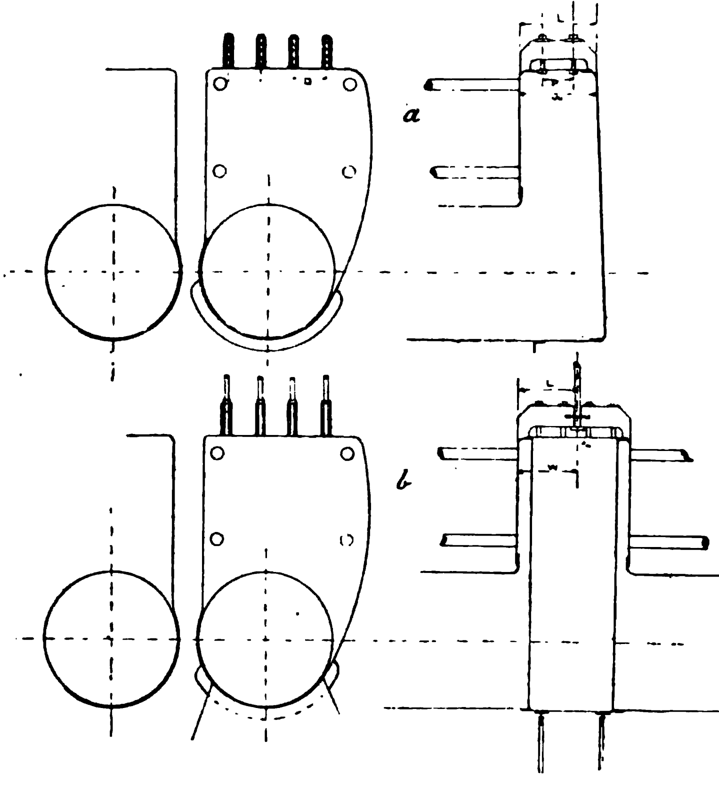
Fig. 66.

(4). In some of the Archæan rocks, certain markings occur that are thought to be worm-tracks.

E. How.—All that can be positively said of Archæan rocks is that they are older than any other aqueous or sedimentary rocks. But they are themselves of very different ages in different regions. Possibly they represent the first crust formed as the molten masses of the earth began to cool down. They have had other and younger strata deposited upon them, and have only come to the surface as result of elevation of themselves, or denudation of the overlying rocks.

In Charnwood Forest, in Leicestershire, we see a number of hills surrounded by strata of rocks quite different from those making up the hills themselves. These hills are the remains of mountain peaks of very old Archæan land, that have been swamped by the waters, whence have

FIG 6



been deposited the sedimentary rocks now filling up the spaces between the peaks.

F. Use.—The metallic ores mentioned above, and apatite, phosphate of calcium, met with in the Scandinavian Archæan rocks, are the chief industrial products of these strata.

PRACTICAL HINTS IN BOILER DESIGN.—IV.

By W. C. Carter.

In the staying arrangements, explained in Article III., we were able in each case to continue our stays through the boiler and obtain an attachment for them direct from the boiler itself. It is not always convenient to do this, as in the case of combustion-chamber crowns, and similar positions, where we have close at hand an effective abutment, from which we can obtain the necessary reaction or support. When this is the case, by constructing a suitable form of girder, we can avoid the necessity of prolonging the stays, and save a great waste of material. Another consideration which must always be remembered is, that it is not advisable to attach stays at *points* to the cylindrical shell plating, as its strength depends upon the equality of pressure upon it in all directions, which gives it the natural cylindrical shape. By applying additional pressures to the shell by means of stay-attachments, the equilibrium of pressure is disturbed and the strength suffers. We should, therefore, as far as we can, avoid attaching stays to the shell, and make the internal portions of the structure self-supporting; but when absolutely compelled to this course, care must be taken to stiffen the shell adequately to prevent distortion if the pressure transmitted by the stays is considerable. This will be more clearly understood by referring to Fig. 6, which shows at *a* the staying of an ordinary combustion-chamber crown in a large marine boiler. The sides being flat, or nearly so, are stayed according to the rules for flat surfaces. The bottom, being semicircular, may be considered self-supporting, provided that it is so stiffened by angle-bars that it cannot flatten or collapse under the external pressure, being similar to the furnace in its conditions. We have, therefore, only the crown to consider, omitting the tube plate for the present. The crown is first stayed as a flat plate, and when we have settled the pitch and size of the stays, the question arises, "Where shall they be attached?" The first thought is to run them all through the crown of the shell, and in the case of boilers of small diameter this is often done; but, as we have seen above, this is not the most desirable arrangement, and we must therefore look for some other points of support. The nearest points that are available are the tube-plate and the combustion chamber back (Fig. 6), and to these we fit carefully a girder for each row of stays, and attach their upper ends to it by means of nuts and washers. We have now the equivalent of a girder supported at both ends, and loaded with a succession of weights, each weight being equal to the total pressure on the portion of plate carried by each stay, and the calculation becomes simply that of the strength of a beam of rectangular section. The method of calculation is to be found in any textbook of applied mechanics, and the formulæ involved are conveniently combined in the rule given by the Board of Trade, which is as follows:—

$$\frac{\text{Constant} \times \text{depth}^2 \times \text{Thickness}}{(\text{Width of C. Chamber} - \text{Pitch of Stays}) \times \text{Distance between girders} \times \text{Length of girder}} = \text{Working Pressure} \ldots\ldots \text{(xiv.)}$$

In this formula the total weight carried by the girder is expressed by the factors $(W - P) \times D \times W P$, as it is assumed that a stay equal to half the pitch is carried directly by the points of support, and the strength of the girder is expressed by $\frac{d^2 T}{L}$.

To find thickness of girder:—

$$\frac{W P \times (W - P) \times D \times L}{C \times d^2} = T \ldots\ldots \text{(xv.)}$$

To find depth:—

$$\sqrt{\frac{W P \times (W - P) \times D \times L}{C \times T}} = d \ldots\ldots \text{(xvi.)}$$

L must be measured in feet, all the other dimensions in inches. The constants are 500, if there is only one stay; 750, if there are either two or three; 850, if there are four; and are based upon a working stress of 9,000lb. per square inch for wrought iron. If steel plates are used, a proportional increase may be made in all the constants of 10 per cent., provided the girders are formed of double plates, as shown, thus avoiding the necessity of working them in the fire. In this case, of course, T will equal the thickness of both the plates. If the girders are made of wrought iron, they may be forged in one piece, with bosses formed to receive the stays, but this is an expensive method, and seldom adopted. Although we have a rigid support for our girders in the tube-plate and back-plate of the combustion chamber, we must not load them indefinitely, for fear that they may fail by crushing under the pressure of the girder feet. When, therefore,—owing to the width of the combustion chamber being unusually great, as in double-ended boilers, and the pressure being high,—we find that the pressure upon the tube-plate section, after deducting the holes *inside* the tubes, exceeds 7,500lb. per square inch for iron, or 10,000lb. for steel, we have passed the limit of safety, and must carry the excess of pressure from some other point. We are then driven to hang a stay from the crown of the boiler shell. The best method of attaching such a stay to the girder is to form a T-end upon it, as shown at *b*, Fig. 6, and divide the girder into two portions, each of which may then be treated as though there were two separate combustion chambers, each of half the total width. In this arrangement we have also an excellent example of the power of self-adjustment that should characterise a good staying arrangement. The principle is that of the whippletree of a coach, which makes it impossible for either horse to shirk its work. It will easily be seen that in screwing up the stays in this arrangement it is possible to make quite certain that each member is effective. Whereas, if the hanging stay were finished in a single eye, and the girder were in one piece, as is often done, it is impossible to be sure whether the girder is bearing properly at the ends while the hanging stay is duly strained, or whether it is so slack as to be useless. In this arrangement half of the total pressure on the combustion-chamber crown is carried by the hanging stay, which should be proportioned according to the rules already given.

In accordance with the principle referred to in the concluding paragraph of Article III., in order to make the hanging stay effective, we must provide stays at the combustion-chamber bottom of a sectional area equal to it. This may be done by means of plate stays, as shown.

In some positions, where the available points of support are differently distributed, it may be necessary to forge girder stays with two, three, or even four feet, called respectively dog, tripod, and cross stay. In such a case the section of such stay, where the feet spring from the boss, may be found by the following formula—

$$\frac{\text{Pressure upon centre stay} \times \text{Length of foot (inches)}}{\text{Number of feet} \times 1{,}500} = \text{Thickness} \times \text{Depth}^2 \ldots\ldots \text{(xvii.)}$$

By assuming the thickness, the depths may be found, and *vice versâ*

The only point not yet discussed in connection with the combustion chamber is the staying of the tube-plate, and inasmuch as the weakness induced by the tube-holes and the strength given by the tubes when expanded in them are unascertained quantities, we have no mathematical treatment for this problem. The proportionate number of screwed stay tubes necessary in any particular case must be left to the judgment of the designer and to the results of experience of boilers under similar conditions. They should be distributed as equally as possible, and the aggregate area of their section should be sufficient to support the pressure in the tube-plate after deducting the space occupied by the tubes themselves. The stay-tubes may be made from ¼in. to ⅜in. thick, and the threads may be either *minus* or *plus*. The outer end is usually slightly larger than the inner end, in order to allow of their being easily placed in position.

THE SWELL IN THE ORGAN.—II.*

For many years after the construction of the Liverpool Organ, English instruments continued to be schemed with only one expressive department, called the Swell Organ.

I may pass over all the other organs made in this country prior to the year 1873: but in that year a notable instrument was erected in the Albert Hall, at Sheffield, which deserves very special notice in this hasty survey. Whilst I naturally regret that this noble instrument is not the work of a countryman, I am glad it stands a monument to the genius of my esteemed friend, M. Cavaillé-Coll, of Paris. In this organ decided steps are made towards rendering the instrument fully expressive; and, up to the present hour, I am not aware of any large organ having been constructed in Europe which goes beyond it in this direction. Certainly the comparatively small organ, by the same builder, in the Carmelite Church, Kensington, may, from a certain point of view, be considered more expressive.

In the manual departments of the Sheffield Organ there are 52 stops; and of this number no fewer than 33 are rendered expressive by being enclosed in three swell-boxes. The disposition is as follows:—The Grand Orgue, of 16 stops, is exposed and unexpressive; the Positif, of 12 stops, is enclosed in a special swell-box, and is entirely expressive; the Récit, of 12 stops, is enclosed in a second swell-box, and is also entirely expressive; and the Solo, of 12 stops, is mainly expressive by having 9 of its stops enclosed in a third swell-box. From this it can be seen that the flexibility and expressive powers of this organ are considerable.

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* Paper read before the College of Organists by George Ashdown Audsley, F.R.I.B.A.

In the year 1877 another noteworthy organ was erected in the concert hall of one of our enterprising provincial towns—this time by an English firm of organ builders—from the specification of two distinguished organists, the late Mr. Henry Smart, and Mr. W. T. Best, of Liverpool. I allude to the organ in the Public Halls, Glasgow. In the four manual departments there are 52 speaking stops; and of these 26 are rendered expressive by being inclosed in swell-boxes. The disposition of the musical forces in this organ is as follows:—The Great Organ, of 18 speaking stops, is entirely exposed and accordingly unexpressive; the Swell Organ, of 17 stops, is enclosed and, of course, entirely expressive; the Choir Organ, of 10 stops, has two of the number—the Vox Humana and the Clarionet—enclosed in a special small box and rendered expressive; and the Solo Organ, of 7 stops, is enclosed in an independent swell-box, and is entirely expressive.

With reference to the great advantages, from the true musician's point of view, derived from even the limited powers of expression provided in the Glasgow Organ, let me give you the opinion of a master, whose right to speak in matters of musical expression no one present will venture to question.

Dr. Hans von Bülow says, in the *Glasgow Herald* of November 23rd, 1877:—"I never met with an Organ so good in Germany, the instruments there not having the same amount of expression and flexibility—most delicate and exquisite *nuances*—that hearing the diminuendi and crescendi was to me a new sensation. If I would longer listen to an Organ like this, and a player like Mr. Best, I would, were I not grown too old, jeopardise my pianistical career, and begin to study the Organ, where certainly I would be able to display much more eloquence as Beethoven's and Chopin's speaker. In short, despite having been exceptionally fatigued by your consecutive concerts and numerous rehearsals, I listened with the most eager attention from the first to the last note of Mr. Best's recital."

Surely no higher testimony than this can be required as to the great value of increased powers of expression by the only mechanical means available in the pipe organ.

I feel, at this point, that I may have laid myself open to an accusation of injustice in not having mentioned the Concert Organ in the Town Hall of Leeds; in which, so early as the year 1859, two expressive departments were introduced; namely, the Swell Organ, of 20 stops, and the Solo Organ of 8 stops, the ninth stop, the Ophicleide, being outside the swell-box. In this instrument there are accordingly 28 stops under control and expressive out of a total of 77 manual stops. This organ was designed by the late Henry Smart, and Dr. Spark, of Leeds.

With such notaable examples in our midst, how comes it that England is making no real progress in the art of organ building, at least so far as imparting increased powers of control, expression, and flexibility are concerned?

The largest organ ever constructed in this country has recently left our shores for the other side of the world. In it absolutely no advance in this important direction has been attempted by its designers. In flexibility and powers of expression it is practically inferior to the Leeds Organ, designed so early as 1858; and is only slightly in advance of the organ in St. George's Hall, Liverpool, designed about the year 1854; and it is greatly inferior to both the Sheffield and Glasgow Organs. The Sydney Town Hall Organ contains in its five manual departments the immense number of 100 speaking stops, out of which only 29 are expressive. In addition to the Swell proper, the five reeds of the Choir are enclosed in an independent box. The vast difference between the scheme as carried out and the scheme of another competing firm for the same organ you will have the opportunity of judging presently. I cannot tell you how sorry I am that England has not "scored one" in connection with the Sydney instrument.

It is now my duty to attract your attention to what has been done on the other side of the Atlantic, where organ building has not gone to sleep. Two executed examples—one a Church and the other a Concert-room Organ, must suffice for my present purpose.

In the year 1883, there was erected in the First Congregational Church, at Great Barrington, Mass., U.S.A., an Organ containing in its three manual departments (exclusive of an electric Echo Organ of 5 stops) 48 speaking stops, of which no fewer than 38 stops are expressive and under control. The disposition of the stops is as follows: —The Great Organ, of 17 speaking stops, has 7 of them enclosed, and, accordingly, is partly expressive; the Swell Organ, of 18 stops, is enclosed and entirely expressive; and the Choir Organ, of 13 stops, is enclosed in a separate swell-box, and is also entirely expressive.

Turning now to one of the largest and latest Organs by the same builder—the Concert-room instrument in the Auditorium at Chicago, we find the highest development yet achieved in the direction of expressive powers. This grand instrument has distributed throughout its five manual divisions (exclusive of the Stage Organ) 86 sounding stops, of which the large number of 79 are enclosed in five separate swell-boxes, and rendered expressive and under control. The disposition of the tonal forces is instructive and highly interesting. The Great Organ, of 20 stops, has 13 of them enclosed in a special swell-box, and is accordingly about two-thirds expressive; the Swell Organ, of 23 stops, is enclosed in a separate box, and is entirely expressive; the Choir Organ, of 17 stops, is enclosed in a separate swell box, and is entirely expressive; the Solo Organ, of 15 stops, is enclosed in a special swell-box, and is entirely expressive; and the Echo Organ, of 11 stops, is also enclosed in a separate swell-box, and is entirely expressive. Three foot levers control these five swells; one controls the Swell Organ, one the Great and Choir swells, and the third the Solo and Echo swells.

The limited time at my disposal only permits me to glance at one other example of Mr. Roosevelt's advanced system of compound expression; I allude to the fine scheme submitted by him for the Sydney Town Hall Organ, which I feel sure no one here save myself is acquainted with. Such being the case, and seeing that the scheme so fully supports my plea for greatly improved powers of expression in the Organ, I may profitably devote a few minutes to its consideration. In the matter of expressive resources, it would be impossible to bring forward a more decided contrast to the scheme of the executed instrument.

Firstly, as a brief summary, I may tell you that the Organ was designed to contain 130 speaking stops, distributed over six independent departments —five manual and the Pedal. In the manual departments are 104 stops, of which no fewer than 93 are rendered expressive and placed under control, by being enclosed in four immense and independent swell-boxes. Further, to establish complete command over the vast tonal forces—comprising 5 stops of 32ft. pitch; 21 of 16ft.; 56 of 8ft.; 25 of 4ft.; 6 of 2ft.; 7 mutation stops; and 44 ranks of Mixture-work—there are 17 Couplers, 4 Tremolants, 3 balanced expression levers, a lever producing a stop *crescendo* and *diminuendo* on the entire Organ, and the complete system of Roosevelt Patent Adjustable Combination Action, controlled by 37 thumb-pistons and 8 foot levers. No organ ever schemed can for one instant be compared with this one in matters of expression, flexibility, control, and mechanical appliances.

The general disposition of the stops is as follows: The Great Organ contains 28 stops, 17 of which are placed in swell-box No. 1, which also holds the Choir stops. The Choir Organ contains 19 stops, and is entirely expressive. The Swell Organ contains 30 stops enclosed in swell-box No. 2, and is entirely expressive. The Solo Organ contains 17 stops enclosed in swell-box No. 3, and is entirely expressive. The Echo Organ, occupying a distant position, contains 10 stops enclosed in swell-box No. 4, and is also entirely expressive. The Pedal Organ contains 26 stops, none of which are expressive or under control: and here I take serious exception to the scheme for reasons shortly to be given.

As the consideration of the obvious musical possibilities of such an organ as this would occupy several papers of the length of this, I must leave to your imaginations the task of working out the sum of what an accomplished musician could achieve upon it.

I also leave it to all interested in organ matters to compare Mr. Roosevelt's unique scheme with the scheme of the organ now in Sydney Town Hall. Consider all from a purely art point of view, and with a mind free from all personal and narrow prejudices. Remember that truth cannot be reached so long as such prejudices clog the intellect and fetter the tongue. Too often have prejudices, born of ignorance and self-interest, stayed the footsteps of progress and artistic development.

I now enter upon what may be called the practical section of my Paper; and here I venture to ask your earnest consideration.

There seems to have been a very decided, and to my mind an unreasonable and unthoughtful opposition to the extension of the swell-box in English organs of all types: and I propose discussing in the briefest manner the cause of this opposition, and the one-sided arguments by which organ-builders and others have sought to sustain it.

Firstly, there has been and still is in certain quarters a firm belief that the swell-box is destructive to the sounds of the enclosed pipe-work; and I am free to admit that this belief has had in too many cases a good foundation; but a foundation that is anything but creditable to our organ-builders on the one hand, and to the reasoning powers of those outside the organ-building trade on the other. Whilst the former, in these days of competitive organ-building, very rarely show the spirit of artists and pioneers in the direction of improvements, the latter seem to overlook the fact that there are swell-boxes and swell-boxes, and supinely accept just what economically-disposed builders think proper to give them. I often wonder if it has ever struck interested purchasers of organs that a good and properly designed and proportioned swell-box costs considerably more than one of the cribbed, cabined, and confined things which are, as a rule, introduced in our English organs.

Perhaps it is unreasonable to condemn those who, although admirable performers on the imperfect instruments served out to them, have a very superficial knowledge of the internal economy (economy is a good word in relation to the usual style of swell-box construction) and the essential requirements of the Organ; whilst even some, who claim to be considered authorities in organ construction, hold that *small* swell-boxes—just sufficient to hold the pipe-work and no more, and with sloping roofs to do away with all *useless space* inside, not to speak of the desirable *economy of wood*—are the most efficient and satisfactory. Heaven only knows upon what these worthies base such a belief, except it be on pounds, shillings, and pence; for it is entirely unsupported by scientific teaching and common sense.

There is, of course, no question that stops enclosed in swell-boxes undergo a certain modification in their tones; but it is also a fact (and here I speak of what I know) that when the swell-boxes are properly proportioned and constructed, and the stops are skilfully voiced for their position, the slight modification is rather an improvement than a disadvantage, giving a further refinement to their tones. Of course, to organists who love noise in organ music in preference to every other quality, and who are never so happy as when they have every available stop of the instrument drawn, every coupler on, and the swell fixed open to its full extent, such refinement is simply so much power lost, so much possibility for noisy and ear-splitting effects done away with. Such players hold up their hands as if to ward off some shocking idea when the enclosing of the Tubas and other heavy-pressure stops is advocated. "What!" say they, "spoil our most effective stops by putting them in a swell-box? The powers forbid! Where would our grand climaxes, our immense crashing effects be?"

Well, I for one (not as an organist be it understood) have no delight in such robust playing, to use a mild expression; and I simply do not believe that it is musicianly or artistic; accordingly I am resolved to advocate and support any legitimate means of discouraging such torture to the musical ear—that is, if it can be discouraged. I much regret to say that even the fullest possible introduction of swell-boxes can only counteract such ear-splitting effects to a very limited degree, so long as the taste for stops voiced on excessive pressures of wind are favoured by both organ-builders and organists—I use the word organists, for I can hardly think the true and refined musician can favour such things, especially in their usual uncontrollable condition. Surely anything and everything conducive to refinement and flexibility of tone in our monster modern Organs should be hailed with delight both by players and listeners.

This is, however, a very conservative and groove-loving country; and even the most obvious improvements, except they are of the fashionable tubular-pneumatic type, will take a long time to establish. I know there are some of you present who are already in arms, in your own minds, against the very idea of having to play upon and control an organ with three or four expressive departments; but, if you will pardon me for saying it, your objection mainly springs from your limited knowledge of artistic organ construction, and your misconception of the full scope of the utility of many swells. Yet I dare bet a large sum of money, if I were to conduct you forthwith to a first-class Roosevelt Organ, and let you listen to the marvellous effects produced therefrom by such men as Eddy and Woodman, or your old friend Frederick Archer, all of whom know what such an organ is capable of, you would one and all perspire your prejudices and objections out at the points of your fingers. But this cannot be, so I must go on with my verbal argument.

In approaching the practical aspect of matters connected with the formation of swell-boxes, it is desirable that, as musicians, we should arrive at some sort of logical conclusion on two points. Firstly, what should the tone of the enclosed stops be when the box is fully opened; and, secondly, what should the tone be, relatively, when the box is completely shut. Or, in fewer words, what degree of *diminuendo* is necessary or desirable in any expressive department of the Organ.

To settle this question from a purely musical standpoint, I think we would do well to put the influence of any organs we are familiar with out of our minds, and look elsewhere for inspiration and direction.

In considering this important question respecting the desirable degree of the reduction in tone, or *diminuendo*, in an Organ Swell, we must suppose the full contents of the Swell drawn; for the reduction of tonal power by the manipulation of the stops is altogether another matter, and need not enter into the proposed question at all.

It is quite clear to me that we shall be best helped by turning our attention to the Orchestra. Let us imagine a selection of the different orchestral instruments made, say ten or fifteen of varied tones and pitches, and sounded together in unison or harmony, at what may be considered their *fortissimo*, or at the fullest strength possible without endangering their pure normal qualities of tone; and let us accept the volume of sound so produced to represent the tonal effect of all the stops forming an expressive department with the swell-box open to its full extent. Now let us request the instrumentalists to perform a gradual *diminuendo*, until they reach the *pianissimo*, or the softest tone possible while still retaining the true tonal character of their respective instruments, and let us carefully record the result in our musical consciousness. When this point is reached we shall hear a comparatively soft effect in relation to the previous loud one; but we shall still hear a rich, full, and perfect volume of pure tone; without any indication of that smothered, bee-in-a-bottle, mile-away, emasculated kind of tone which is generally accepted as the acme of the organ-builder's skill, in this country at least, in swell-box construction.

Now, for a moment direct your minds to those swell departments in Organs you are most familiar with, and which have always been praised for their charming effects of "*distance*," and just recall what those charming effects are. Let me ask you if the *pianissimo* of those swells in any way resembles the *pianissimo* of the orchestra, such as I have just shadowed forth—do the tones of the enclosed organ stops seem to be with you, round you, real present sounds which you can lay hold of, so to speak—do you seem to be producing those sounds at will on the instruments you are seated at, or do you feel as if you were playing at them—do they not rather seem to be in the next room, the next house, or in an adjoining street, or half a mile away, according to the *skill* displayed by the organ-builder, and, heaven save the mark, the *perfection* of the swell-box? Such questions may, at first thought, savour of exaggeration; but really they are sober and serious questions which you can best answer for yourselves. For my part, I have listened to closed swells which entirely destroyed the true and characteristic musical tone of the enclosed pipe-work; and I unhesitatingly condemn such swell-boxes as a gross libel upon the scientific art of organ-building — the work of bunglers, and the natural mistakes of men who have blindly followed precedent, or who have, from first to last, misconceived the true use and beauty of the Swell in the Organ.

The swell is a legitimate means for securing two most desirable ends; namely, *flexibility* and *musical expression*, within reasonable and artistic limits. To exceed those reasonable and artistic limits, is to make a great mistake, and to call down a deserved condemnation from every true musician. I speak strongly for I feel strongly, and no man who loves the Organ as I do, and who knows what it is capable of becoming in thoughtful and intelligent hands, can help regretting and lamenting whilst he sees thousands of pounds thoughtlessly expended every year, and organ after organ going up without a single serious attempt to make them more truly *musical*, *flexible*, and *expressive* instruments.

It will be seen by what I have said that I advocate so constructing a swell-box that when it is closed it shall to no serious extent cripple the tone of the pipe-work, and that it shall convey to the listener a clear idea of the tonal character of the stops which are speaking. Further than this, I hold that the effect of the closed swell should not be a "*distant*" one; but merely a *soft* and *pure* one—one which can be prolonged through an entire movement, if necessary, without producing any unsatisfactory feeling in the player's or listener's mind.

I know it is the common impression amongst English organ-builders and organists, that unless the closed swell has a very "*distant*," or what I should call a *bottled-up* effect, no satisfactory *crescendo* can be obtained; but I have practically tested this matter, and have satisfied myself that a perfectly satisfactory *crescendo* and *diminuendo* can be secured from a swell-box constructed on the lines I advocate. Apart foom its proper construction, two conditions are essential to its success—firstly, ample size for the enclosed pipe work; and, secondly, a proper position.

Before I proceed further, we may with advantage consider what are the proper and desirable uses of the Swell, especially in Organs, such as Roosevelt builds, with two, three, or more swell-boxes.

There has been considerable objection raised in this country against the swell through the unskilful and unmusicianly way too many organists have used and still do use it.

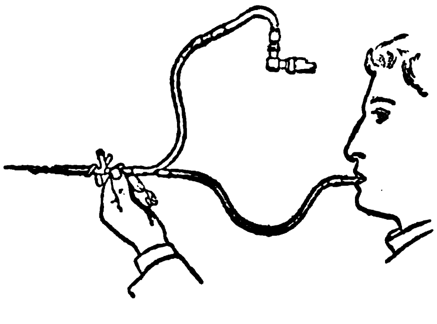
What is commonly called "pumping the swell-pedal," or what, in polite language, may be termed the restless, sentimental method of using the swell, is most objectionable from every point of view, and young organists are specially fond of it. It never, or at least very rarely occurs to them to use the swell in a restful way, or entirely at rest; as a means of imparting flexibility and staid variety to the tonal forces of the instrument, the swell is hardly ever resorted to in Europe. I am of opinion that the form of swell-pedal, or *expression-lever*, as I prefer to call it, commonly introduced in English organs, has greatly tended to foster the everlasting pumping or sentimental style of swelling. I allude to the ordinary recovering, or so-called "hitch-down pedal," which is, I think, so undeservedly popular with our organists. I know the College of Organists advocates this form; but I venture to disagree with its advocacy, a very presumptuous thing for me to do, doubtless; but as my personal study of the art of organ-building extends over twenty-five years, and has been prosecuted in England, France, Germany, Holland, Italy, Switzerland, and America, I have learnt the bad habit of thinking out things for myself, and the equally bad habit of saying what I think. The College will pardon my differing from it in the present matter.

I may just state here that our old-fashioned form of pedal cannot be used in an organ where the swell is fully developed and its proper functions are provided for. It will be wise to bear this simple fact in view. It would be wrong for me even to imply that nothing has been done by our organ-builders to overcome the radical imperfections of the hitch-down pedal. I am aware of several appliances which have been introduced in English organs simply for the purpose of enabling the player to leave the pedal, at any point of its downward or upward movement, fixed or stationary for the time. Such appliances clearly point to the inherent imperfection of the said form of pedal, and which they only partly remove. The correct, rational, and convenient form of the expression-lever is that known as the "French," or "balanced lever." And this is the form which will alone be introduced in organs constructed in the near future. It is already used, almost exclusively, by the greatest Continental and American organ-builders, and is advocated by all the leading organists in France and the United States—facts which, to my mind at least, are far more eloquent and convincing than the sluggish conservatism of our organ-builders and the generality of English organists.

(*To be continued.*)

MOOR'S IMPROVED BLOWPIPE.

THE time-honoured Black's blowpipe, as usually supplied to chemical students, and generally employed in the chemical laboratory for the purpose of light work, and performing the various dry tests for detecting and confirming the metals, proved itself long since anything but convenient. In the first place, owing to its rigidity, it is impossible for the operator to move his head without altering the flame, and, moreover, owing to the shortness of the stem, it often necessitates a stooping position. The blowpipe by Mr. C. G. Moor has been specially designed for the purpose of overcoming some of these difficulties.

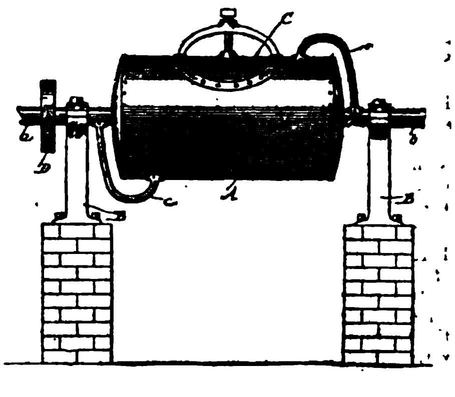


For dentists, jewellers, and opticians, for hard soldering and brazing, this blowpipe will be found very useful; also for soft soldering as generally practised. One of the chief advantages which this blowpipe possesses is the facility with which it can be brought to bear upon any point at any angle. The control of the direction and the size of the flame can be regulated simultaneously, with the same hand. It is very simple in construction, well made, and, therefore, does not readily get out of order. The regulation of the flame is simplicity itself; while the indiarubber tubes which connect the blowpipe with the mouthpiece (which is made of glass) and with the gas supply give great freedom in use, and can readily be attached to an ordinary gas-bracket. On this account the blowpipe is very handy for teachers and the like, who have to travel, and have to take part of their apparatus with them.

As an adjunct to the laboratory, this blow-pipe is most convenient. The inner and outer flame is very well defined, and, although a small blowpipe, it is, nevertheless, a powerful one for its size, the heat being sufficient to melt copper and silver; or, if hydrogen be employed instead of coal-gas, even fine platinum wire can be melted. For glass-blowing purposes, and in all cases where flames of varying size are required, the flame can be regulated to a nicety, while, although a good and reliable blowpipe, the price is sufficiently low to bring it within the reach of all.

RECOVERING TIN FROM WASTE TIN-PLATE.

FOR recovering tin from tin-plate, M. Bonnet, of Paris, uses a cylinder, A, mounted upon trunnions *a* and *b*, supported in suitable bearings upon the framework B. The cylinder is provided with a charging or loading orifice, C, which is closed by means of a man-head. The trunnions *a* and *b* are tubular. The trunnion *a* is connected with the cylinder A by a pipe, *c*, and the trunnion *b* is connected with the cylinder A by a pipe *e*. The scrap or waste tin-plate is placed in the cylinder A, and the orifice C is closed. An alkaline solution, preferably caustic soda, is then run into the cylinder A at a temperature of about 250° F. through one of the trunnion *a* or *b*. Air previously heated to the temperature of about 250° F. is then forced into the solution in the cylinder A. Agitate the mass for a short time by rotating the cylinder by means of the pulley D on one of the trunnions. During this time the alkaline solution and the oxygen from the air will act upon the tin, forming stannate of soda, which remains in solution, while the iron of the tin-plate remains free of tin in the bottom of the cylinder. Then draw the solution from the cylinder A, and separate the tin by introducing into the solution sulphurous acid, which precipitates the tin in the form of stannic acid, leaving sulphite of soda in solution. When the scraps of tin-plate are varnished, the varnish may be cleaned off by the use of sodium carbonate. The same process is applicable in recovering lead from plate metal, the lead forming plumbates, which can be treated in a similar manner. The chief feature of the process is the use of hot air in the presence of an alkali to act upon tin, forming stannates. Other alkalies may be used, such as potassium hydrate; but caustic soda is preferable.



What is "Cognac"?—A Berlin journal quoted in the *Board of Trade Journal* inquires what the French themselves understand by "cognac." The district of Charente is the place of origin of real "cognac," and has during the last seven years produced an annual average of 20,000 hectolitres, while the annual export by France of liquor known as "cognac" has exceeded seven times this quantity. In trade, "cognac" is usually understood to be a brandy obtained by the distillation of wine, and which was formerly known as French brandy; but it has been shown by analysts, and in a bulky volume issued by the State Department of Hygiene, that there is no reliable method of distinguishing real brandy distilled from wine from the spurious. So it is interesting to have a decision of a French court of law as to what is understood by the word "cognac." A merchant of Angoulême, who bought brandy in Valenciennes and labelled it "cognac," was prosecuted for so doing, but was acquitted on the ground that the word "cognac" is not to be exclusively understood as descriptive of the place of production, but often, as in the present instance, as descriptive of the nature of the product.

SCIENTIFIC NEWS.

THE position of Wolf's Comet on Nov. 11, Berlin midnight, will be R.A. 4h. 36m. 56s., S. Dec. 7° 16·7′; brightness 10·55, as compared with unity at time of rediscovery.

M. Bigourdan, of the National Observatory, Paris, describes the Tempel-Swift periodical comet as "une nébulosité excessivement faible, à l'extrême limite de visibilité; elle est ronde, de 1·5′ à 2′ de diamètre, légèrement plus brillante vers la région centrale, où l'on soupçonne par instants un petit point stellaire." As already stated the comet will be in perihelion about the middle of next month, but necessarily is of little interest except to those who have powerful instruments. M. Bigourdan's observations were made with the West Tower equatoreal, while at about the same time Mdlle. Klumpke was using the instrument in the East Tower.

The essay by Mr. F. H. Very, of the Allegheny Observatory, on the moon's heat, has been recently published, and will be found of much interest by students of the moon. The essay was awarded the prize of the Utrecht Society of Arts and Sciences, and the results recorded give support to those obtained at Lord Rosse's Observatory, viz.: that the lunar rocks store heat. Mr. Very's experiments were made with one of Prof. Langley's bolometers, combined with a sensitive galvanometer, and show that the temperature of the east limb after full moon is greater than that of the west limb.

The successor of Dr. John Russell Hind, F.R.S., as superintendent of the *Nautical Almanac* is Mr. Arthur M. W. Downing, M.A., F.R.A.S., one of the chief assistants at Greenwich, who will assume the responsible office at the beginning of next year, when Dr. Hind will retire, though not, it may be hoped, from the astronomical world.

The death is announced of Dr. Philip Herbert Carpenter, M.A., D.Sc., F.R.S., fourth son of the late Dr. W. B. Carpenter. Although so comparatively young for a scientific man (he was born in 1852) he had made his mark, and at the time of his death was one of the science masters at Eton College. Dr. P. H. Carpenter went on some deep-sea exploring expeditions, and in 1875 was appointed naturalist to the *Valorous*, which accompanied Sir G. Nares's Arctic expedition as far as Disco Island. His chief work was done in connection with biology and morphology, and he has left many important reports and papers as a memorial of his scientific labours. In 1883 he was awarded the Lyell fund by the Geological Society in recognition of the value of his work, and in 1885 was elected a Fellow of the Royal Society.

The Rev. Percy W. Myles, who died recently at Ealing, was the editor of *Nature Notes*, the journal of the Selborne Society; but his name will be chiefly remembered in the future as the author of the pronouncing dictionary of botanical names appended to Nicholson's "Dictionary of Gardening." A memorial fund is being raised for the benefit of his widow, and Prof. Henslow, of Ealing, will receive subscriptions.

At the Royal College of Physicians last week, on the delivery of the Harveian Oration by Dr. W. H. Dickinson, the Baly medal was given to Prof. Michael Foster for distinction in physiology, and the Morgan medal to Sir Alfred Garrod for distinction in clinical medicine.

The arrangements of the Sunday Lecture Society for November, besides those already mentioned, include a lecture on Nov. 8 by Mr. W. E. Church on the "Personal Life of Shakespeare," on Nov. 15 Prof. H. Marshall Ward, F.R.S., on "Our English Trees"; Nov. 22, Mr. A. W. Clayden, M.A., "On Thunderstorms"; and Nov. 29, Sir R. Stawell Ball, F.R.S., Astronomer-Royal for Ireland, on "How came the Great Ice Age." It should have been mentioned that the lecture last Sunday was written by the late Mr. Arthur Nicols, formerly organising secretary of the society.

The lectures on "The Differential and Integral Calculus," by Prof. John Perry, F.R.S., are delivered at the Finsbury Technical College, Leonard-street, E.C., not, as stated on p. 174, at the People's Palace.

The winter course of lectures by Mr. W. Peck, the City astronomer, are to be delivered in the Synod Hall, Edinburgh.

A rather influentially-signed letter has been published, complaining of oscillation on the London and South-Western Railway, between Basingstoke and Salisbury, especially between Porton and Salisbury. Oscillation is almost inevitable on S curves; but there is reason to think that not a few broken crank-axles owe their origin to the sometimes violent oscillation caused by badly-laid permanent way.

At the recent meeting of German naturalists and medical men, Prof. von Pettenkofer read a paper on the self-purification of rivers. Munich has 280,000 inhabitants, and 20,440 kilos. of refuse are carried into the river every day. But each day 3,456,000 cubic centimètres of fresh water flow down the stream, so that the proportion of refuse or dirt to the water is only 6 to 1,000,000 or 6 milligrammes to the litre, a pollution which, if artificially produced in a glass of water, is unrecognisable to the naked eye. Careful examination has shown that even this pollution disappears seven kilos. below the city. This self-purification of rivers had hitherto been attributed to sedimentary deposits, but Pettenkofer is convinced that it is the effect of oxygen, partly freely dissolved in, or absorbed by, the water, and partly produced by water-plants. He considers that the quantity of low vegetable organisms in water plays a great part in the purifying process. The vegetable growth in river beds should, according to Pettenkofer, be protected, and refuse water from mills, chemical works, &c., which is destructive to vegetable growth, should not be allowed to flow into rivers unpurified. It is doubtful whether Prof. von Pettenkofer will find many sanitarians agreeing with him.

M. Godard, the French aëronaut, made a balloon ascent last week from Prague, accompanied by two gentlemen and a lady. The balloon, after a ten hours' journey, landed safely near the Baltic Sea, not far from Stettin.

The obstinate nature of some skin-diseases is well known; but Sig. Semmola, of Naples, in a paper recently communicated to the Paris Academy of Medicine, says that certain forms of eczema and psoriasis, which become troublesome during the warm season, are determined by the irritant action of products eliminated by the skin. He recommends the use of prolonged baths at a temperature of from 86° to 100° Fahr. for two to three hours daily for a few weeks, and then douches on alternate days instead of the baths. Where there is any scrofulous taint, iodide of sodium should be given in liberal doses, or if there is gout or rheumatism, bicarbonate and phosphate of sodium are his selected remedies.

Dr. Calderwood, of Edinburgh, Professor of Moral Philosophy, lecturing the other day on hypnotism, said that it was merely a new name for mesmerism. The condition is one of artificially-induced sleep, which is, however, a lucid sleep. As regards the mode of producing the sleep, it is nothing in the nature of electricity or magnetism, and no influence emanated from the body of the operator. The result, he contended, was brought about by the wearying of a single organ or line of nerve. Many people—he thought probably all people—were liable to it, but not against their will. The condition during the mesmeric sleep was torpor, the cataleptic state, or the state of the sonnambulist. He warned his audience against being mesmerised at all.

It is now stated from Australia that strychnine has been found an antidote to snake-bites, but it is not stated what kind of snakes, except that they are called venomous. We suspect that it is impossible to avoid death when a cobra has injected the poison from his fangs.

False Bitter Almonds.—One of the last new products of the inventive genius of the adulteration-monger is the artificial bitter almond. The false seeds are composed chiefly of grape sugar, with an extremely small quantity of nitro-benzole, which gives them the flavour of oil of bitter almonds. They are pressed in a mould, which causes their external appearance to resemble natural almonds so well that when a number of the false seeds are mixed with the true ones the deception is exceedingly difficult to detect by mere inspection. Of course the former can be obtained at a ridiculously low price, and consequently the adulteration must be very profitable.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> "I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
> —*Montaigne's Essays.*

COPERNICUS—LUNAR RADIANT HEAT—MR. S. W. BURNHAM'S LATEST DOUBLE-STAR CATALOGUE—THE NEW SUPERINTENDENT OF THE "NAUTICAL ALMANAC"—HELIOMETER—TELESCOPES: AND TWADDLE—RING MICROMETER—SIDEREAL WATCH—THE TWELVE BRIGHTEST STARS—TELESCOPIC FIELD—ASTRONOMICAL EYEPIECES—THE ZODIACAL LIGHT—PRECESSION—DR. COMMON AND MYSELF—DIAMETERS OF JUPITER'S SATELLITES—NEW LUNAR CRATER—PROF. VINCE—VOLCANOES IN THE MOON—MEAN DISTANCE OF THE MOON—URANUS AND NEPTUNE—"FLARE" IN TELESCOPE—SHRUBS AND TELESCOPIC DEFINITION.

[32846.]—To everyone who can read and appreciate the purest and most expressive French, I would commend the perusal of a delightful little book by M. Flammarion, which has just appeared, entitled "Copernic; et la découverte du Système du Monde." No small part of the value of this latest work of our eminent French *confrère* is derived from the amount of astronomical information which is interwoven with the biography proper of the immortal Pole. For, commencing with a succinct historical review of the Astronomy of the Ancients, and, of course, explaining and emphasising the discoveries of Copernicus himself in connection with the details of his life, it concludes with a chapter on his successors, and on the progress of modern astronomy generally. To all who are familiar with M. Flammarion's almost unrivalled power of popularising astronomical facts and theories, it will scarcely be necessary to add more than that this small work is worthy of his reputation. I don't know well how I could praise it more highly.

Dr. Boeddicker, of the Birr Castle Observatory, has recently reprinted his researches on lunar radiant heat from "The Scientific Transactions of the Royal Dublin Society," and issued it, with an introduction by Lord Rosse, in a separate form. Now although it is not pretended that the results obtained are absolutely conclusive, or that they render further observation and investigation needless, yet some of them are at once sufficiently well established and remarkable to merit notice. They are mainly founded on the effects observed during the very favourable total eclipses of the moon of October 4th, 1884, and January 28th, 1888, especially on those noted during the latter one. The first striking thing was that the radiant heat began perceptibly to degrade for some considerable time (from 1h. 15m. probably, to 15m. certainly) before the first contact with the penumbra of the earth's shadow; the obvious conclusion being that the earth's atmosphere, which intercepts the heat of the moon, must be very much more extensive than has hitherto been supposed. In fact the result of one calculation performed by Dr. Boeddicker gives this height as 725 miles; but this being, of course, wholly inadmissible, only shows how much the observations were affected by disturbing influences. A more trustworthy estimate placed the height of our absorbent atmosphere at 190 miles; but even this cannot be regarded as definitive. Another very curious circumstance is by no means easily explicable. As the moon plunged into the penumbra, the decrease of heat was decidedly more rapid than that of light until less than half an hour before totality, when the heat and light curves (as plotted in the diagrams illustrating Dr. Boeddicker's essay) intersect. At this time the total amount of heat was about 7·3 per cent. of that radiated by the uneclipsed full moon. This amount continued to diminish until (in 1888) about two minutes before the end of totality it had fallen to some 0·4 per cent., without, however, so far as could be observed, at any time being reduced to absolute zero. A strongly-marked deficiency of lunar heat after the end of the eclipse is admitted to be inexplicable. All who are interested in the physical condition of our satellite should study Lord Rosse and Dr. Boeddicker's very curious and instructive volume.

Our greatest living double-star observer, Mr. S. W. Burnham, F.R.A.S., has just reprinted from the *Astronomische Nachrichten* his seventeenth catalogue of new double stars, together with measurements of others, nearly all made with the 36in. refractor of the Lick Observatory, which are too close or difficult for treatment with smaller instruments. Any detailed criticism of such a list would obviously be impossible. It must be studied by all interested in the structure of the stellar universe. I would only make one quasi-personal remark, and that is, that it seems curious to me to find Mr. Burnham speaking of γ^2 Andromedæ, as seen in the mammoth telescope on Mount Hamilton, in these words:—"Tried with all powers; and the elongation, if any, is so slight, that any measure would have no value;" when I remember the time at which I could certainly elongate this star with an instrument of a little more than 4in. in aperture and a power of 400.

The announcement of the appointment of Mr. A. M. W. Downing, one of the present excellent secretaries of the Royal Astronomical Society, to be superintendent of the *Nautical Almanac*, will be hailed with unalloyed gratification by every British astronomer. In the most sober and serious earnest, I may express my conviction that no more competent man for the post could have been selected; and now, after a forty years' interval, we may at last look forward to the much-needed improvements in our national ephemeris, and to being no longer driven to the American *Nautical Almanac*, or either of the Continental ones, for ephemerides and data which we have a right to demand in our own. But irrespective of his undeniable ability and fitness for the office, Mr. Downing possesses the merit of being a most thoroughly independent man, and may be relied on to resist illegitimate pressure from whatsoever quarter it may be brought to bear. It may be remembered that, in that remarkable "ballon d'essai" in one of your daily contemporaries, on which I commented (in letter 32582) on p. 526 of your last volume, a suggestion was made to place the *Nautical Almanac* Office (*inter alia*) under the control of the Science and Art Department. I confess that I should like to see any attempt on the part of that Department to coerce, or bring pressure to bear upon, Mr. Downing. I have an abiding conviction that they would speedily drop him like a hot potato. His predecessor, Dr. Hind, will carry with him, in his retirement into private life, the sincere esteem and regard of all who ever knew him personally. I am a little afraid that the regret for him in his official one will not be of a very poignant description.

M. Jourdain, in Molière's comedy, discovered to his surprise that he had been talking prose all his life without knowing it. Upon a cognate principle "Zed." (letter 32815, p. 177) would appear to have become possessed of, and actually to have been employing, a heliometer, in sublime unconsciousness of the kind of instrument he was handling. Your correspondent will find drawings and description of this instrument on p. 177 of Vol. II. of Chambers's "Handbook of Astronomy"; in Vol. I. of Arago's "Popular Astronomy" (Smyth and Grant's translation), pp. 386 *et seq.*; in Smyth's "Ædes Hartwellianæ"; in Lardner's "Handbook of Astronomy"; in Main's "Astronomy" in Weale's Series; and in any of the larger works on practical astronomy, such as Chauvenet's.

My first impulse was to treat letter 32817 (p. 177) with the silent contempt it alone deserves; but inasmuch as some of my brother-readers may imagine from "Wega's" mere abuse that I have been misleading them in my replies, I will deal with its paragraphs seriatim. Beginning with the first, your contributor can only be referring to letter 32456 on p. 382 of your last volume, in which I spoke of a previous statement by Mr. Fridy that he could not divide ε Lyræ, nor even γ Leonis, with 200 on a 2⅜in. achromatic, in these words: "Mr. F. certainly ought to see ε^1 Lyræ double without any difficulty with a power of 200 on a really good 2⅜ achromatic, and ε^2 also, by the aid of a little sustained attention; while γ Leonis he should separate at once." Nowhere does the word "glimpse" occur at all. I never recommended a power of 200. Mr. Fridy stated that he had failed to see something with such a one, and asked whether it should not have exhibited that object? So much for the honesty of "Wega's" quotation. Will any possessors of telescopes of 2⅜in. aperture who may read these lines, kindly try how far they can fairly separate ε^2 Lyræ with a power of 60—I do not mean show it as a distorted star or one merely obviously not single, but fairly to split the components—and report the result in these columns. Now we come to paragraph two, in connection with which I would simply reiterate that the focussing of lines in a negative eyepiece is imperfect, and the deeper the curves of the eye-lens the more glaring such imperfection is. I happen to know this experimentally, for when I determined the angular subtense of the field of each of the eyepieces in the battery belonging to my equatoreal, I stretched a spider-line diametrically across the diaphragm of every one of them for the stars I employed to run along, and I emphasise the fact that the ends and the middle of such line were never exactly in the same focus. "Wega" believes—or pretends to believe—that I spoke of the wires as *outside* of the eyepiece, as they are in the case of the Ramsden one. I undertake to say that he is the solitary individual who so interpreted my words. I am, though, of course, under no obligation to find him common intelligence. Now we come to paragraph three, in connection with which I can only repeat that the third lens in a triple object-glass *was* intended to correct, as far as might be, the secondary spectrum, and my reply to Mr. Strother was simply intended to caution him against any attempt to remove *either* of the lenses of his objective. Every reader of the ENGLISH MECHANIC has heard all about Prof. Abbe and his "special glass" over and over again. What "Wega" says about that is the most utter surplusage. Why does not he—omniscient as he is—answer Mr. Strother himself? Fourthly, I deny absolutely that my reply to "Tyro" is "utterly meaningless." Microscope objectives could give magnifying powers of "21, 41, and 81 respectively" *at absolutely definite distances* only, so that the length of the tube is presupposed in the question. Finally, I will even condescend to notice the concluding portion of the valuable communication of your correspondent, and explain (though assuredly not for his benefit) that, in my original MS., the sentence which so severely exercises him, stood thus:—"No optician, as a rule, takes the pains with the objective of one of these hand telescopes that he does with one constructed for astronomical purposes," &c. Now, I did not much like this sentence, so altered it to:—"No optician, as a rule, takes as much pains with the objective of one of these hand telescopes as he does with one constructed for astronomical purposes." The compositor did the rest. As you, Sir, doubtless still possess the MS. of letter 32762, you will be able to corroborate this statement as to what I really did write. I no more require "Wega" to teach me grammar than I do to teach me manners!

As one who has used the ring micrometer, I can tell "Phi" (query 75555, p. 184) that the observations with it are monotonous, and their reduction operose and tedious. Mine has a single ring (though, of course, observations are made at both edges). I am unfamiliar with the double-ring form of this instrument. Possessing as I do a filar position micrometer, I never dream of using my ring one save for a comet or star too faint to bear any illumination whatever.

If "Georgos" (query 75556, p. 184) can get hold of a watch having 24 hours marked round the dial plate (or, what is now more common, having XIII. under the I, XIV. under the II., and so on, the question of making a sidereal time one of it resolves itself into pushing the regulator over to the proper distance on the "*fast*" side of the arc. A deck-watch, whose rate is known, ought to suffice to enable the possessor of an equatoreal to find objects with it.

Without knowing specifically of what stars Mr. Ranyard was speaking, I may give "Thomay" (query 75559, p. 184) the following list of the twelve brightest stars in the heavens, as nearly as may be in their order of brilliancy: Sirius, Canopus, α Centauri, Arcturus, Rigel, Capella, Vega, Procyon, α Orionis, α Eridani, Aldebaran, and β Centauri. Of these eight only are visible in this country.

I cannot answer query 75561 (p. 184) for the simple reason that the angular subtense of the field of any eyepiece depends (*inter alia*) upon the linear diameter of the diaphragm.

If "E. R. S." (query 75565, p. 185) does not mind hiding his ornamental queen-post roof, he may effectually stop the echoes in his schoolroom by means of a canvas screen or velarinm.

It really is less troublesome to answer query 75574 (p. 185) for the *n*th time in these columns than to hunt up references to previous replies. "Tyro," then, will find that the focus of a Huyghenian eyepiece is obtained by dividing twice the focal lengths of its component lenses by their sum. Thus, suppose that the field-lens has a focus of 3in., and the eye-lens a focus of 1in. $\frac{2 \times 3 \times 1}{4} = 1\frac{1}{2}$. If his lenses be not of very short focus, he had better fix them on the edge of a graduated rule at right angles to its length, and then, turning the lens towards the sun, slide a card along the rule until the sun's image is sharply defined on the card. The focal length of the lens may then be read off by inspection. If this be very short, a different method must be adopted; but this would require a diagram to illustrate the simple apparatus employed. Years ago I gave this in one of your earlier volumes.

Mr. Dowsett (query 75585, p. 185) should look for the zodiacal light a little to the south of east before sunrise. Its shape is somewhat like that of half of a thick convex lens seen edgeways, with the base next the sun, and the point slanting upwards. It is best seen by averted vision, or, as is popularly said, "out of the corner of your eye." One hour before sunrise is not too late to look for it. It might be mistaken for twilight but for its brightness and fairly defined shape. I have never been able to trace it much more than 90° from the sun, myself. It extends up through Virgo just now. It should still be visible on November 1. The axis coincides roughly, though by no means accurately, with the Ecliptic.

I am sorry to be obliged to inform "J. D. H." (query 75595, p. 185) that astronomers do not pay any attention whatever to the wild hypotheses advanced by General Drayson. The motion of the pole of the earth is actually round the pole itself of the Ecliptic, and *not* "round a point which is 6° from" it. The fluctuations in the obliquity of the Ecliptic can never exceed 2° 37′ 23″—i.e., the limits of such obliquity are 21° 58′ 36″, and 24° 35′ 58″. "J. D. H.'s" last suggested explanation of the reason for the non-acceptance of the Draysonian system is the correct one.

The reasons, I may tell "Orion" (query 75600, p. 185), why Sir William Herschel often used a single convex lens instead of a Huyghenian eyepiece were twofold. First, he was thus enabled to obtain an actually greater linear magnifying power; and next, there was less loss of light in its passage through one glass only. My querist must, however, note that it is only the very middle of such a lens at which you get the best definition, and that there is no well-defined field of view. For all ordinary purposes of astronomical observation the Huyghenian eyepiece, with its sharply-bounded field and definition (good practically up to the edge) is in every way to be preferred.

I have just heard, but in so roundabout a way that I repeat it with all reserve, that when Dr. Common wrote letter 32784, on p. 187, he did so under the impression that I had made, or intended to make, some charge against him affecting his personal honour and character. Had this really been so, his language would not have been one whit too strong, and would have been more than justified; but in reality it is absurdly at variance with the fact. Should this meet his eye, and he will turn back to my original letter on p. 89, he will find my reference to the R.A.S. "Report" commencing, "Nor is this wretched system, I grieve to say, wholly confined to the miserably cadging crew to whom I have referred," thus, in express terms, dissociating and excluding him from the category of those who advertise for mercenary or personal objects. It is alike due to him and to myself to say this. I thought, and still think, he showed a great want of judgment in inserting the sentence to which I referred, in his report; but that is a vastly different thing to charging him with any unworthy or improper motive. I am about the last man in the world who would dream of such a thing, and should earnestly regret to hurt his feelings in any way; notably as he and I have never had the very smallest difference in our lives. Of course my information may have been erroneous, and Dr. Common (with whom I have had no communication direct, or indirect, on the subject) may not have so entirely mistaken what I intended to convey, in which case this is all surplusage; but should he have done so, I would only repeat my most emphatic disclaimer of any such imputation as, has been alleged, he fancied I meant to make. [It is perhaps needless to say that the above paragraph was written before the appearance of Mr. Freeman's letter (32845) on p. 201. I am quite at one with him as to the "pardonable pride" which Dr. Common may well feel, not only in the telescopes he has turned out of his workshop; but even more in the work he has done with them. I have yet to learn that it is derogatory to a man's dignity or character to make a profit out of a mirror (or anything else); but what I say is that it was quite needless, and a decided mistake that the sentence he quotes ever appeared; and I will tell him why. Now that we have once admitted an announcement into our publications that a private gentleman has made a telescope for sale, I quite fail to see on what equitable principle we can refuse to allow one of our professional opticians (being a Fellow of the Society) the right to insert a similar notice of any instrument of exceptional size and power that he may make for a customer. Would Mr. Freeman regard this as desirable? With this reservation, however, I endorse every word that he says.]

There is a noteworthy paper on "A Novel Method of Measuring the Diameters of Jupiter's Satellites by Interference," by Prof. A. A. Michelson, in No. 17 of Vol. III. of the *Publications* of the Astronomical Society of the Pacific. Every user of a telescope is familiar with the diffraction rings which surround the image of a luminous point, such as a star. Now Prof. Michelson provides the cap of his object-glass with two slits, adjustable both in width and distance apart, and when this arrangement is focussed on a star, then, instead of the concentric rings of which I have just spoken, there will be a series of equidistant bands whose length is parallel with the slits, the central one being the brightest. By observations of the disappearances of these fringes at recurring intervals, and the measurement of the distance between the slits, the values of the diameters of Jupiter's satellites were found to be, at the planet's mean distance—

I.	II.	III.	IV.
1·02″ ..	0·94″ ..	1·37″ ..	1·31″

The same number, among other papers of interest, contains an account of the discovery of the "New Lunar Crater in the Lick Observatory Moon Negatives," by Professor Weinek, of Prague.

In reply to Mr. Lynn (letter 32830, p. 197), I regret that I cannot give him my authority for the story about Prof. Vince. It is years since I heard it, and I only repeated it from recollection, as nearly verbally as my memory permitted. I am willing to concede, as an elementary geographical fact, that Devonshire and Suffolk are not conterminous.

"J. C. S." (query 75621, p. 206) will find, on reference to any recent work on the Moon, that the active volcanic craters which Herschel imagined he saw, are now believed to have been nothing but the brighter spots reflecting sunshine. With "the Old Moon in the New Moon's arms," the crater Aristarchus may be seen as a bright spot on the dark limb with a comparatively small telescope.

If "Gamma Draconis" (query 75640, p. 207) will for a moment reflect on the extraordinarily complicated and fluctuating character of the moon's path, which is not even a re-entering curve, he will see for himself that to take the greatest possible distance that she can under any circumstances depart from the earth, add it to the least distance and divide by 2, must give an erroneous result for the *mean* distance. The orbits of the planets are—for all practical purposes—ellipses.

I would answer your correspondent's next query (75641) on the same page, by saying that the values I gave for the distances of Uranus and Neptune in the table to which he refers are those of Newcomb, and are for 1850. There is a disagreement between the observed and tabular places of Neptune, not much exceeding 0·1″ in R.A., nor 3″ in Dec.; but I can find no evidence, with the data at my command, that it follows any law, either of increase or decrease. It is oddly irregular, as far as I can make out.

The "flare" of which "Object-glass" speaks (in query 75662 on p. 207), points to a defect in the object-glass itself. Had it been merely that the diffraction rings, seen round every star, were all on one side of it, then this would have arisen from the tilting of the objective in the tube, and "Object-glass" would then only have needed to loosen the screws of its cell, and, while looking at the star, very gently tapped that part of the periphery of the cell towards which the projecting rings pointed, inwards, or towards the eyepiece, until he got the star and rings concentric. If, though, it be really what he describes, a regular flare or wing of light, I would, were I he, cut out a variety of diaphragms, circular, semicircular, and sectors of circles, and place them on the object-glass. Ultimately, in this way, when the faulty part of the glass was covered up, the flare would disappear. By a series of trials, it could be ascertained what part of the glass was thus covered, and then a piece of black sticking-plaster, or something of the sort, could be put on it permanently. The loss of light would be very small.

I cannot think that it can be the shrubs in the neighbourhood of "H. A.'s" observatory (query 75663, p. 207) which prevent him from getting a good view of Jupiter. My own observatory is in a paddock, and I have an acre of kitchen-garden crowded with shrubs and fruit-trees, and a belt of plantation beyond that again between me and the meridian, and I never find it affect definition in the smallest degree. Jupiter is now low down, and it is very much more likely that the perfectly abominable atmospheric conditions which have so long prevailed have been the cause of "H. A.'s" difficulty, than that his shrubs have anything to do with it.

A Fellow of the Royal Astronomical Society.

THE LUNAR ECLIPSE NEXT MONTH.

[32847.]—In the English Mechanic for May 30th, June 13th and 20th, I worked out very fully the circumstances of the partial eclipse of the sun for June 17, 1890, and followed this up (in your issue of April 17, 1891) by giving a simple method of ascertaining the times of the Transit of Mercury on May 9th of this year. I now send a detailed description of the coming lunar eclipse, with two beautifully-executed diagrams by Mr. Sang, of Liverpool.

Elements Taken from "Nautical Almanac," page 404.

		h.	m.	s.
Greenwich Mean Time of ☍ in R.A. Nov. 15, 1891		12	8	45·2
Moon's Right Ascension		3	23	55
		°	′	″
Moon's Declination	N.	18	21	5·7
Sun's Declination..................	S.	18	37	41·2
Moon's hourly motion in R.A.			36	16·5
Sun's ditto ditto			2	34·4
Moon's hourly motion in Declination,	N		12	23·6
Sun's ditto ditto	S.			37·9
Moon's Equatorial horizontal Parallax			60	3·2
Sun's ditto ditto				8·9
Moon's true semi-diameter			16	23·5
Sun's ditto ditto			16	12·9

Referring to No. 1 diagram let S, E, M represent the centres of the sun, earth, and moon respectively at the G.M.T. of ☍ in R.A. Then F is the apex of the earth's shadow, and E F C or E F D half the angle of the cone of the shadow. Now, by Euclid the exterior angle S E B of the triangle B E F is equal to the two interior and opposite angles—i.e., S E B = E B F + B F E, therefore, B F E = S E B – E B F, or *half the angle of the cone of the earth's shadow is equal to the sun's semi diameter minus his horizontal parallax.*

To find the breadth of the earth's shadow at the distance of the moon, let M′ M M″ represent that portion of the moon's orbit traversed during the eclipse. Then M E H will be half the angle required.

Now, by Euclid, E H D = H F E + F E H, therefore, F E H = E H D – H F E. But E H D is the moon's horizontal parallax, and B F E or H F E the sun's semi-diameter minus his horizontal parallax. Accordingly, F E H or M E H = E H D minus the sun's semi-diameter plus the sun's horizontal parallax—i.e., *half the angle subtended by the section of the shadow at the moon's distance is equal to the sum of the parallaxes of the moon and sun minus the sun's semi-diameter.*

And since the angle F C K′ or F D K is equal to the sun's diameter, we must add this angle to M E H to obtain the semi-diameter of the penumbra.

The figure of the earth being spheroidal, that of the shadow will deviate a little from a circle, so that to have a mean radius the horizontal parallax of the moon should be reduced to a mean latitude of 45°. This reduction, by Raper's Table No. 41, is 6″, so that the moon's reduced parallax is 60′ 3·2″ – 6″ = 59′ 57·2″. Then to obtain the semi-diameter of the earth's shadow at the moon, we have 59′ 57·2″ + 8·9 – 16′ 12·9″ = 43′ 53·2″, and increasing this by $\frac{1}{60}$th for the earth's atmosphere, gives 44′ 37·1″ or 2677·1″. Adding the sun's diameter—viz., 32′ 25·8″ or 1945·8″, we obtain 4622·9″ as the semi-diameter of the penumbra.

To construct No. 2 diagram, take C as a centre, and with radius C B (2677·1″) and C β (4622·9″) describe circles representing respectively the umbra and penumbra of the earth's shadow at the distance of the moon, and let C β be parallel to the equator. Make C G perpendicular to it equal to the difference of declination of the centre of the earth's shadow and that of the moon. Thus C G = 18° 37′ 41·2″ N. minus 18° 21′ 5·7″ N. = 16′ 35·5″ = 995·5″, and this is to be set off to the south of C, as the moon is south of the shadow. The hourly motion of the moon from the shadow in R.A. is 36′ 16·5″ – 2′ 34·4″ = 33′ 42·1″ = 2022·1, and this must be reduced to the arc of a great circle by multiplying it by the cosine of the moon's declination, or by ·94915, the natural cosine of 18° 21′. This gives, say, 1919·25 as the reduced hourly motion of the moon from the shadow in R.A. Make C O equal to this, and C P perpendicular to it, equal to 705·7″, which is the moon's hourly motion northwards from the shadow in declination. Then the relative hourly motion of the moon in her orbit from the shadow, or O P = $\sqrt{1919{\cdot}25^2 + 705{\cdot}7^2} = 2044{\cdot}9''$. Ruling a line parallel to O P through G, the moon's centre at Greenwich Mean Time of ☍ in R.A. we have her apparent path through the earth's shadow, and a perpendicular from C upon her orbit, and meeting it at K, will give the moon's centre at the middle of the eclipse. We now take a slip of paper, and applying its edge to the line O P, mark off O P upon it, and after dividing it into 60 equal spaces, transfer these to the moon's orbit, causing the point G to read 12 hours 8¾ spaces (or minutes). Then with the compasses and the moon's radius 983·5″, we describe circles, touching the penumbra and umbra at tangents. The centres of these circles on the moon's divided orbit will obviously indicate the times of the several phenomena which may be read off by inspection.

If considerable accuracy be required we must make the following calculation:—

In triangle O P C tan. O $= \dfrac{CP}{CO} = \dfrac{705{\cdot}7''}{1919{\cdot}25} = \begin{cases} 2{\cdot}848620 \\ 3{\cdot}283131 \end{cases}$

$= 20^\circ\ 11'\ 18''$ $\qquad 9{\cdot}565489$

And by construction angle P O C = angle G C K

In triangle K C G right angled at K, sine C $= \dfrac{GK}{CG}$ or

$$GK = CG \text{ sine } C = 995{\cdot}5'' \text{ sine } 20^\circ\ 11'\ 18'' = \begin{cases} 2{\cdot}998041 \\ 9{\cdot}537954 \end{cases}$$

$$= 343{\cdot}55'' \qquad = 2{\cdot}535995$$

$$CK = GK - \tan. C = 343{\cdot}55 - \tan. 20^\circ\ 11'\ 18'' = \begin{cases} 2{\cdot}535995 \\ 9{\cdot}565489 \end{cases}$$

$$= 934{\cdot}34'' \qquad = 2{\cdot}970506$$

In triangle K C ε sine ε $= \dfrac{CK}{C\varepsilon} = \dfrac{934{\cdot}34''}{5606{\cdot}4} = \begin{cases} 2{\cdot}970506 \\ 3{\cdot}748684 \end{cases}$

(And C ε = C β + ☽ semi-diameter)

$$= 9^\circ\ 35'\ 36'' \qquad 9{\cdot}221822$$

$$K\varepsilon = \frac{CK}{\tan. \varepsilon} = \frac{934{\cdot}34''}{\tan. 9^\circ\ 35'\ 36''} = \begin{cases} 2{\cdot}970506 \\ 9{\cdot}227932 \end{cases}$$

$$= 5528{\cdot}1 \qquad = 3{\cdot}742574$$

In triangle K C E sine E $= \dfrac{CK}{CE} = \dfrac{934{\cdot}34''}{3660{\cdot}6} = \begin{cases} 2{\cdot}970506 \\ 3{\cdot}563552 \end{cases}$

(And C E = C B + ☽ semi-diameter)

$$= 14^\circ\ 47'\ 17'' \qquad 9{\cdot}406954$$

$$KE = \frac{CK}{\tan. E} = \frac{934{\cdot}34''}{\tan. 14^\circ\ 47'\ 17''} = \begin{cases} 2{\cdot}970506 \\ 9{\cdot}421585 \end{cases}$$

$$= 3539{\cdot}3'' \qquad 3{\cdot}548921$$

In triangle K C S sine S $= \dfrac{CK}{CS} = \dfrac{934{\cdot}34''}{1693{\cdot}6} = \begin{cases} 2{\cdot}970506 \\ 3{\cdot}228811 \end{cases}$

(And C S = C B – ☽ semi-diameter)

$$= 33^\circ\ 28'\ 59'' \qquad = 9{\cdot}741695$$

$$KS = \frac{CK}{\tan. S} = \frac{934{\cdot}34''}{\tan. 33^\circ\ 28'\ 59''} = \begin{cases} 2{\cdot}970506 \\ 9{\cdot}820504 \end{cases}$$

$$= 1412{\cdot}6'' \qquad 3{\cdot}150002$$

Moon's relative hourly motion in orbit = 2044·9″. Then as—

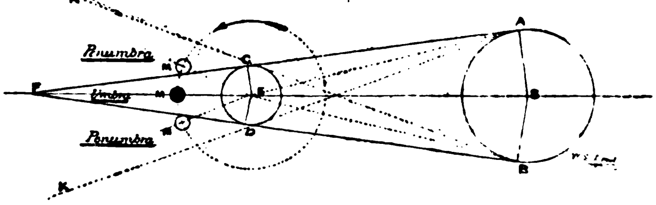
2044·9 : 60min. : : 343·55″ : 10min. 5sec.
2044·9 : 60min. : : 5528·1″ : 162min. 13sec.

2044·9 : 60min. : : 3539·3″ : 103min. 50sec.
2044·9 : 60min. ; : 1412·6″ : 41min. 27sec.

And

h.	min.	sec.		h.	min.	sec.		h.	min.	sec.	
12	8	45	+	0	10	5	=	12	18	50	.... Middle of eclipse
12	18	50	–	2	42	13	=	9	36	37	.... First contact with penumbra
12	18	50	+	2	42	13	=	15	1	3	.... Last contact with penumbra
12	18	50	–	1	43	50	=	10	35	0	.... First contact with shadow
12	18	50	+	1	43	50	=	14	2	40	.... Last contact with shadow
12	18	50	–	0	41	27	=	11	37	23	.... Beginning of total phase
12	18	50	+	0	41	27	=	13	0	17	.... End of total phase.

Diagram No. 1.



Then C R = 26771·1″ and C K + ☽ semi-diam. = 934·34″ + 983·5″ = 1917·84″. And 2677·1″ − 1917·84″ = 759·26″, and moon's diam. being reckoned as unity, we have for the magnitude of the eclipse $1 + \frac{759{\cdot}26}{983{\cdot}5'' \times 2} = 1{\cdot}386$.

To find position angle on moon's limb for first and last contact with the shadow, and for direct image we have—

[90° − (20° 11′ 18″ + 14° 47′ 17″)]
= 55° 1′ 25″ from N. towards East for beginning.

[90° + (20° 11′ 18″ − 14° 47′ 17″)]
= 95° 24′ 1″ from N. towards West for ending.

As there is an absolute loss of light in a lunar eclipse, the times of phenomena will take place at the same instant at all parts of the earth where the eclipse is visible. Could the times of contact be accurately observed, they would be most useful, in simply and readily determining differences in longitude; but the earth's shadow being an ill-defined line, makes this impossible, and for the same reason the above calculations would be accurate enough if carried to four places of decimals instead of six.

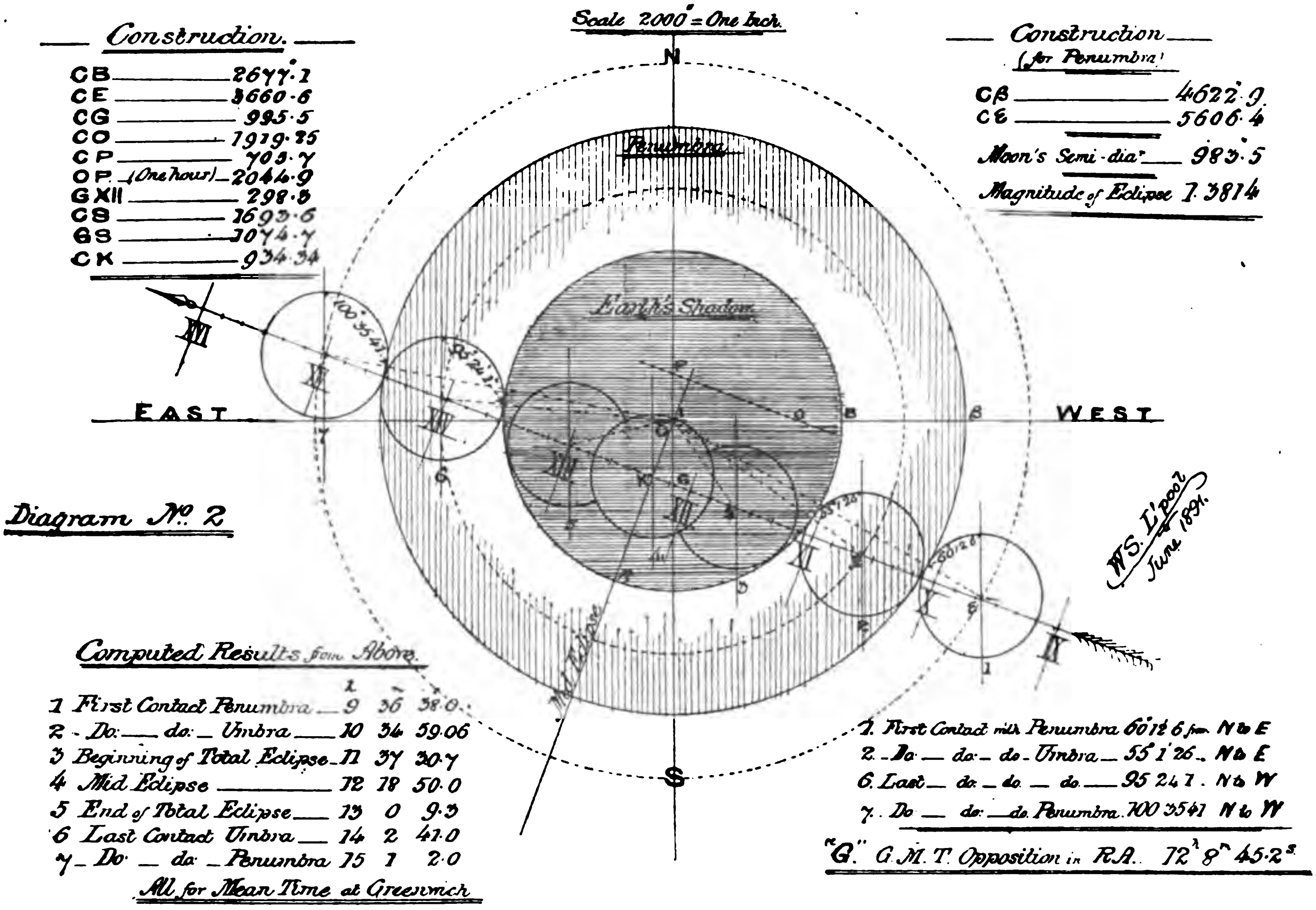
Harry Pool Slade, F.R.A.S.

16, Westcote-street, Hull, October 13.

P.S.—The second diagram by Mr. Sang is from an independent calculation.

Eclipse of Moon. Novr 15 1891.

Scale 2000″ = One Inch.



Construction.

CB	2677·1
CE	3660·6
CG	995·5
CO	1919·25
CP	703·7
OP (One hour)	2044·9
GXII	298·3
CS	1693·6
GS	1074·7
CK	934·34

Construction (for Penumbra)

Cβ	4622·9
Cε	5606·4
Moon's Semi-diar	983·5
Magnitude of Eclipse	1·3814

Diagram No. 2

Computed Results from Above.

	h	m	s
1 First Contact Penumbra	9	36	38·0
2 Do: do: Umbra	10	34	59·06
3 Beginning of Total Eclipse	11	37	30·7
4 Mid Eclipse	12	18	50·0
5 End of Total Eclipse	13	0	9·3
6 Last Contact Umbra	14	2	41·0
7 Do do Penumbra	15	1	2·0

All for Mean Time at Greenwich

1. First Contact with Penumbra	60°12′6″ from	N to E
2. Do do do Umbra	55°1′26″	N to E
6. Last do do do	95°24′1″	N to W
7. Do do do Penumbra	100°35′41″	N to W

"G." G.M.T. Opposition in R.A. 12h 8m 45·2s

RAYS, AND A VOLCANIC SURFACING INCONSISTENT WITH LUNAR TIDES.

[32848.]—Many thanks to "F.R.A.S." for drawing my attention to the paper in *Knowledge*, August 1st. I have forwarded a few lines on the subject to the editor. Might I say here that the writer of the articles in *Knowledge*, who is a geologist, conclusively shows that the rays cannot be what we call "faults." He inclines to look on them as "trap-dykes," which Mr. Ranyard shows they certainly cannot be. I have supported this view in my letter above referred to by quoting Canon Webb's well-known objection to their being trap-dykes, p. 74 of the "Celestial Objects," where he so truly says: "The chances against so general and exact a restoration of level, all along such multiplied and most irregular lines of exposure would be incalculable."

It seems to me that the proof that the rays cannot well be due to any form of *fissure* is that the terminations are, as a rule, so branchless. On our earth we generally find that dykes and such like fissures, or ruptures of the crust, meander about and fork repeatedly, especially near their terminations, like the map of a river and its tributaries. I think "F.R.A.S." will agree with me that this feature distinctly differentiates the lunar rays from all terrestrial fissures, due to rupture of the crust. In "The Theory of Lunar Surfacing by Glaciation," pp. 10 and 11, I gave the ray characters as—1st, brilliancy; 2nd, superficiality; and 3rd, radiality. I would now like to add a 4th—i.e., terminal branchlessness.

Might I ask "F.R.A.S." if astronomers generally consider that the moon formerly rotated more rapidly on its axis, and has been slowed down by tidal friction? An era of tides seems to me (necessarily) to imply a prolonged and moderate, to low, secular temperature, possibly with polar caps, and certainly with a scouring of the surface for ages, sufficient to remove all the scoria and "cinder rings" of the preceding lava-lake and volcano stage. Or do they consider that after tidal friction had slowed down the rotation to its present speed, the so-called ellipsoidal figure arose, and secular temperature (in some way) increased sufficiently to cover the entire surface with lava lakes and "cinder rings," poles included? I cannot make out what astronomers consider as the sequence. Is it A (1) ellipsoidal figure, then (2) volcanic era, and (3) tidal era; or B (1) lava surfacing, (2) tidal era, (3) ellipsoidal figure; or C (1) tidal era, (2) ellipsoidal figure, (3) lava surfacing? Proctor, in his "Moon," pages 132-3, insists on the ellipsoidal figure, and is mute over tidal retardation. Neison is particularly obscure on all points, and I can find nothing in Webb on the subject.

As far as I understand this question, our tides are due to lunar attraction, deforming—or heaping up—the liquid shell covering our earth, which itself is too rigid to yield quickly to lunar attraction. The tidal friction which results again is steadily slowing down the speed of our earth's rotation, and eventually will stop it altogether, as the earth has the moon's rotation. The non-rotation of the moon (in its relation to our earth) is, I take it, the admitted proof that formerly there were tides on our satellite. But tides, again, are a proof that the outer shell was liquid *when* the nucleus or solid body of the globe was too rigid to yield to terrestrial attraction, and too cold to be called a molten mass. Now where does this ellipsoidal figure come in? This is the puzzle which I have attempted to solve by assuming that the present real libration is due, not to an ellipsoidal figure (a meniscus on our side of a homogeneous globe), but to extra density of the crust on our side, of a spheroidal figure, and hence one compatible with tides. On this matter see letter 32140, p. 51, "E. M." for March. What I there put forward was that the present centre of the disc is the *densest* portion of the lunar crust, which was drawn to the geocentric position, after rotation had been slowed down by tidal friction, and libration thence set in. The former "tidal equator" being now indicated by the series of circular *maria* Imbrium, Serenitatis, Crisium, and M. Smythii, the remains of the old equatorial belt of solar influence, which for ages retarded the junction of the "polar caps," see the right-hand diagram on p. 51.

Sibsagar, Asam, Sept. 14. **S. E. Peal.**

THE TWO NEW PROBABLY VARIABLE STARS—THE STRUCTURE OF THE MILKY WAY.

[32849.]—Kindly allow me to correct an error in your "Scientific News," p. 196, where a quotation is made from my communication to the *Astronomische Nachrichten*. The second of the two variable stars is stated to be D.M. + 49·3239°, whereas the red star is distinctly stated by me to be not only not identical with this star, but not even in the D.M. at all. The red star, indeed, lies 7 seconds preceding and 1·5′ north of D.M. + 49·3239°. Since my communication to the *A. N.* both stars have diminished in brightness. Should any of your readers care to look them up, their places are:

(1) α = XXh. 0m. 23s. δ + 36° 30 5
(2) α = XXh. 12m. 55s. δ + 49° 36·0

Through pressure of other work, I have not been able to pay much attention to them; but on Sept. 29 the first was found to be only 9·0, and on Oct. 12 the second was estimated as only 10.

Mr. Ranyard's paper, to which "F.R.A.S." refers (letter 32810, p. 175), is indeed a most interesting one. Dr. Wolf has kindly sent me his latest photographs of the new Cygnus nebula. This one, using ξ Cygni as the guide star, shows a definite structure. There is a circular lane, which can be traced all round the great cluster. The centre is apparently void of stars, and four rifts stretch from it roughly in the form of a cross. These divide the structure into four parts, and the nebula occupies the preceding edge of the four. The star streams, which are well marked, seem to be projected from 68 Cygni in the direction of α Cygni, and another towards 59 Cygni. These photographs seem to prove conclusively: (1) That the nebula and stars are distinctly connected; (2) That the tendency of stars to form into streams is *not* accidental.

Tow Law, Oct. 26. **T. E. Espin.**

NU² SCORPIONIS—LAMBDA OPHIUCHI—TEST-STARS WANTED.

[32850.]—Since last writing I have succeeded several times in dividing ν^2 Scorpionis with a power of 80 (on 3¾in.)

I looked at λ Ophiuchi the other night, and found it pretty divisible with 250. I should say it was a very good test object for a 3in. refractor at its present opening. Would anyone kindly say if there is a late measure of the components? Webb, in "Celestial Objects," gives 1·6″ in 1877. It is decidedly more open now, and the position-angle changed somewhat.

I should be much obliged if some contributor to the "E.M." would give me a few double stars whose present measures are from 1·4″ to 1·6″, as I am anxious to test my telescope thoroughly for definition. It is by a maker whose name I have never seen mentioned in the "E.M.," Messrs. Aronbergs and Co., of Liverpool, and seems to me to be of high excellence. Light-grasping tests I do not want, as the object-glass is, as I before mentioned, somewhat obscured by a fungoid growth. I have seen the *comes* to Vega pretty steadily on some nights, but generally only by averted vision.

As Barbados is in N. lat. 13° there will be a good choice of stars in either hemisphere. Stars below 6th magnitude will not be much use. What I should like would be a 5th magnitude star, with equal components, about 1·4″ apart.

T. P. Battersby, Capt. R A., F.R.A.S.
Barbados, October 5.

BRILLIANT METEOR, 11th OCTOBER.

[32851.]—This large and brilliant meteor was observed here at about 6.5 p.m., local time. To one observer, Mr. J. Coghlan, it appeared almost due east, at an altitude of about 45°. It tailed off to the south-west, passing below Jupiter, and leaving a long, continuous streak of light, until it almost reached the horizon. He informs me he was looking at that part of the sky when it appeared, and describes it to have been "as large as the head of a drum." Estimated duration of course four seconds; angle from appearance to disappearance 90° to 100°, long path.

Mr. W. E. L'Estrange Duffin, county surveyor, Waterford, kindly writes:—"I saw it at about 6 p.m. It travelled slowly, and I computed it to be in sight between eight and ten seconds. It left a bright trail, which varied between blue and red in colour. The nucleus of the meteor before and when it disappeared was a bright blue, and appeared to travel in a plane almost parallel to that of the horizon from north to south towards Jupiter, which was visible at the time. The altitude was nearly that of Jupiter, close to which it was when it disappeared."

I should like to see the radiant, height, path, &c., of this meteor computed, and should be very pleased if some of our English observers could give further particulars. Was it an arietid?

Dublin, Oct. 24. **W. H. Milligan.**

SOLAR LIGHT.

[32852.]—At a meeting of the Royal Academy of Science of Belgium, held on the 16th of December last, the President, J. S. Stas, read a paper entitled "De la Nature de la Lumière solaire," in which occurs the following paragraph:—

"Avant de continuer, je dois dire que dans son magnifique mémoire sur l'éclipse solaire totale du 29 août, 1886, le Dr. Schuster se demande toutefois san conclure, si des décharges électriques sont la cause de la luminosité coronal. Dupuis onze années l'expérience m'a convaincu que la lumière solaire peut être attribuée à des décharges électriques disruptives. Les détails dans lesquels je viens d'entrer et les faits que me restent à exposer n'ont qu'on seul but, celui d'essayer de démontrer que toutes les raies solaires proprement dites sont *exclusivement* celles qu'on observe avec ses décharges électriques disruptives, saturées de corps terrestres, et nullement celles qu'on constate dans l'espace spectral des spectres calorifiques, en un mot, *que nous sommes éclairés par de la lumière électrique disruptive.*"

May I ask whether this paper has been commented on in any of the English science papers, and if so, which? or, further, for the opinion of "F.R.A.S." or some of your astronomical readers?

Neville Holden.

RADIATED AND REFLECTED DARK RAYS OF HEAT. — TERRESTRIAL CRATER-RINGS. — JOVIAN LATITUDES.

[32853.]—May I once more—I hope for the last time—trespass on your space? I am afraid "F.R.A.S.," in letter 32582, has mistaken the point of the question I asked. I knew that a plate of glass was used to cut off the dark heat rays from those of shorter wave-lengths, but I did not quite understand how a distinction was made between dark rays of radiant heat and those of the same wave-lengths *reflected* to us by the moon. The latter body of course receives rays of all wave-lengths from the sun; and I imagine there is no reason to suppose it incapable of reflecting the longer waves, seeing that it possesses no atmospheric covering. Consequently, even if it does radiate a measurable amount of heat, it also *reflects* dark heat rays to us, and the latter, being of the same wave-lengths as the former, would be stopped, equally with them, by the glass plate. How, then, can the two kinds be distinguished from one another? In the notice of Prof. Langley's work, given in the *Observatory* for September 1890, he is said to find two distinct heat maxima, one due to radiant and one to reflected heat; so that *he* evidently distinguishes between them in some way. Again, from the account given on page 205 of Proctor's "Moon," it would seem that Lord Rosse regarded the *high percentage* stopped by the glass as a proof that a portion of the moon's heat is radiant and is not all of it reflected. But then it is very evident, from Mr. Peal's letter 32383 (p. 314), that Prof. Boys does not agree with Lord Rosse in this respect, and attaches no importance to the great preponderance of dark rays in the total quantity we receive from the moon.

I was glad to see letter 32584 from "Hammer," and I hope to be able before long to read the book he refers to. I find it stated in Webb's "Celestial Objects" that craters in Java and the Sandwich Islands afford some analogy to those on the moon.

In connection with the diagram of Jovian latitude and longitude lines given by Mr. Freeman on p. 549, perhaps the following little table may be found useful. It gives the Jovian latitude (ϕ), corresponding to distance (y), the latter being measured from the centre of the disc towards either pole and expressed in terms of the polar radius, the compression being taken as $\frac{1}{17}$.

$y = \cdot 1$, $\phi = 5{\cdot}4°$; $y = \cdot 2$, $\phi = 10{\cdot}9°$;
$y = \cdot 3$, $\phi = 16{\cdot}5°$; $y = \cdot 4$, $\phi = 22{\cdot}3°$; $y = \cdot 5$, $\phi = 28{\cdot}5°$;
$y = \cdot 6$, $\phi = 35{\cdot}2°$; $y = \cdot 7$, $\phi = 42{\cdot}6°$; $y = \cdot 8$, $\phi = 51{\cdot}4°$.

From the above table the approximate latitudes of belts shown on drawings of Jupiter may easily be ascertained. A correction should be applied to allow for the elevation of the earth above the plane of Jupiter's equator; but this is never very large, and at present is about 1·6°. Latitudes answering to intermediate values of y can easily be found from the following formula:—

$$\text{Log} \tan \phi = \log y - (0.0263289 + \tfrac{1}{2} [\log (1+y) + \log (1-y)])$$

Adelaide, S.A., Sept. 22nd, 1891. **E. P. S.**

POWER OF EYEPIECES.

[32854.]—Regarding Captain Battersby's interesting letter, No. 32812, p. 176. He remarks at being able to use a power of 250 on his 3¾in. o.g. I should like him to state whether if this is his own estimate of the power of the eyepiece or an optician's. I have no doubt he is aware that opticians over-state the power of eyepieces. As Mr. Denning puts it, in "Telescopic Work for Starlight Evenings":—"It seems to be a fashionable imposition on the part of opticians to over-state magnifying powers. Eyepieces are usually advertised at double their true strength."

My own experience, which is not very extensive, is that eyepieces' powers are stated to be about ¼ too great.

I find that 90, 120, and 150 are the usual powers I can use to good purpose on Jupiter on my 5in. o.g. of the finest definition. The above powers were advertised as being 120, 170, and 225 respectively.

I hope Captain Battersby will write some more of his interesting letters; am sure that telescopic performances in a foreign land will be greedily read by the astronomical readers of the "E.M."

Arcturus.

INCUBATORS.

[32855.]—Following up the letter of Oct. 16 (p. 178), I reproduce a device which appeared in the number for October 30th, 1885, from the pen of "Backwoodsman, B. C.," a signature which implies that the writer has not too many opportunities of obtaining those little (sometimes necessary) things which can be so readily procured in any of our towns. The illustration shows a "regulator," and perhaps when our friend sees that, he will give some account of his experience, and state what success he has had in his climate. "Backwoodsman, B. C.," wrote: "Get a tinsmith to make a cylindrical heater and circulating coil, as shown at Figs. 1 and 2. The heater is 14in. high and 10in. in diameter, and should be made out of galvanised sheet iron or extra heavy tin plates, seams well riveted and soldered, ends stayed with angle-irons or stay-rods of $\frac{3}{16}$in. iron running through each head and from top to bottom, ends of rods being reduced so as to form a shoulder against which the heads are placed and riveted smoothly, and head of rivet buried in solder to insure its being airtight. Eight rods arranged in a circle of 6in. diameter concentric with heads. The flue stays the centre. The coil may be made of charcoal tin plate. The small tubes are ¾in. inside diameter, and the large ones 1¼in. diameter inside. The coil, or rather gridiron, will be 32in. long from A to B, and 26in. wide from front to back, outside measurements. The return pipe, carrying the cooled water, must be made with two elbows, so as to enter heater at bottom, or nearly so. The mode of circulation will readily be seen. Twelve or fourteen ¾in. tubes with 1¼in. spaces between will radiate sufficient heat to keep the eggs warm, and the temperature can be regulated by utilising the expansion of water contained in heater and gridiron, if these are made strong and watertight. See they are tested before boxing them in. The regulator shown at C (Fig. 1) is a piece of ¾in. iron gaspipe, screwed into a flange at one end, which is riveted and soldered to the top of heater; at the other end is soldered an inverted tin cone, the base of which is 5in. in diameter. As the heater and coil are filled through the regulator pipe, a ¾in. hole must be cut in base of cone, and over this solder a brass flange, into which is screwed (to close the hole after filling up with water) a brass plug, pointed at shown at *d* (Fig. 1). The standard, *s* (Fig. 1), is a ⅜ bolt, slotted to receive lever *g* at its upper end, and screwed into a flange, which is in turn secured by wood screws to frame as shown. By boring a hole through woodwork, the standard can be turned up or down to a height suitable to height of regulator. Through a *slot* in the free end of lever *g* is passed a wire rod (threaded), *r*, having a nut that, being screwed up or down, lengthens or shortens the distance between the two levers *g* and *h*, the latter one having attached a segment of a toothed wheel, the radius of which is equal to the distance between fulcrum or point of suspension and the outer edge of the teeth. A small weight of 5oz. or 6oz. may require to be attached to the lever *h* at the end receiving connecting-rod *r* to overcome any stiffness of the apparatus that turns up or down the lamp-wick. The rod *r* is inclosed in a tin tube, where it passes through the sawdust packing (see Fig. 1). The bibcock, shown at *b*, is for the purpose of drawing off the water when incubator is no longer required. At *w w* water is poured down tubes into dishes resting on gridiron radiator for the purpose of supplying moisture to air in egg-chamber. v^1 v^2 are ventilating tubes, fresh air being admitted over the top of gridiron, as shown, and the vitiated air is withdrawn in the direction shown by arrows up v^1. There will be required two sets of these ventilating tubes at each end. They are not all shown in sketch, so as to avoid confusion. At *t* is shown the thermometer, which is arranged to enable the operator to examine the temperature of the egg-drawer without opening it, and so chilling the eggs if opened too often. A tin tube turned over a little at the ends, when in position to secure it, and prevent the sawdust getting into egg-chamber, holds the thermometer in place at its upper end, and a similar tube, but much shorter in the cross-piece *p*, which is a piece of 1in. timber 4in. wide, extending (but not so shown in Fig. 1) to and let in flush with the top of drawer slides. The thermometer itself must be inclosed in a tube just small

FIG. 1. SECTIONAL VIEW.

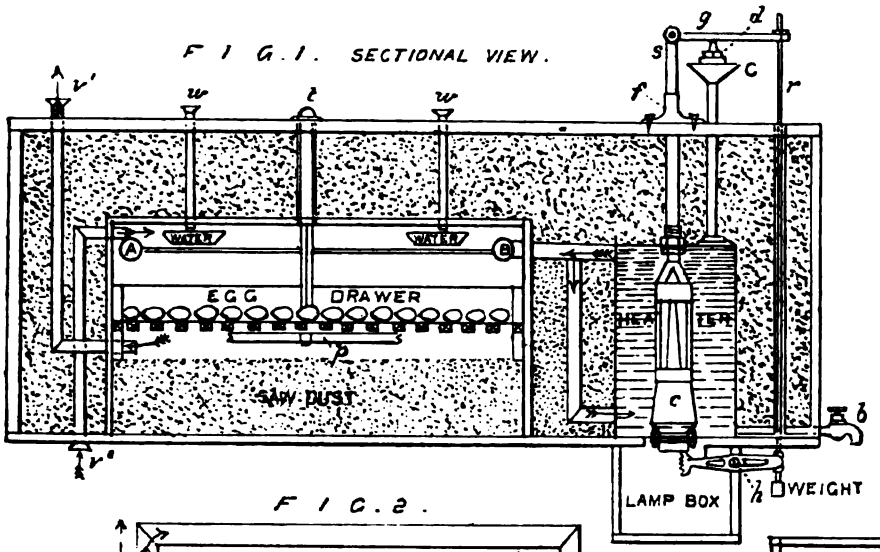


FIG. 5.
LAMP WICK ROLLERS

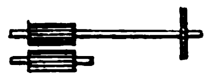


FIG. 6.
SUGGESTED REGULATOR

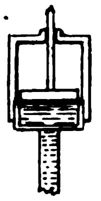
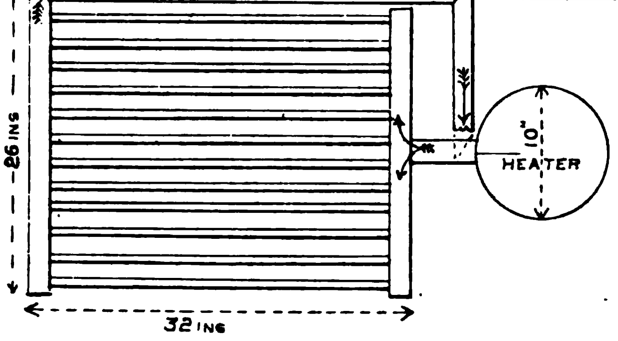
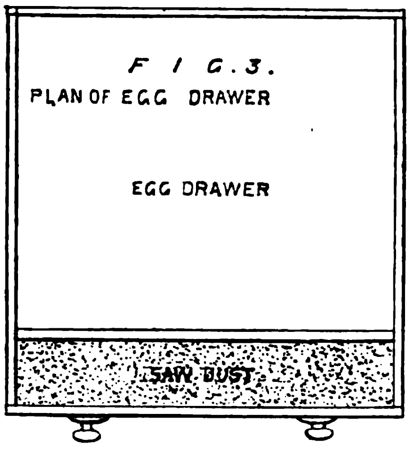


FIG. 2.



PLAN OF GRIDIRON & HEATER



enough to slide easily and fit snugly, the tube passing through sawdust packing, and the smaller one in cross-piece. Where the mercury is, the tube is cut away so as to show the temperature recorded, and as low as the bulb.

Where the tube passes through the egg-drawer, it is surrounded and inclosed by a funnel-shaped tube; the lower and straight part is same size as that in cross-piece, and *must not project* below the level of slats in egg-drawer; the flange is to tack it to the slats of the egg-drawer, and the conical part is to keep the eggs from rolling under the thermometer tube when the thermometer is withdrawn, and is made thus to allow of the bulb being exposed to air in egg-drawer. The bulb must just be level with *top* of eggs, and the upper end fitted with a flat cover and finger-piece, by which it can be removed. The thermometer thus arranged can be examined at any hour, day or night, without the necessity of opening the egg-drawer, and it locks the egg-drawer when in position, only takes up the space of one egg, and cannot be broken by opening or closing drawer if it is removed fully before trying to open the drawer. I broke quite a number of eggs before I devised the cross-piece tube. The egg (Fig. 3) drawer is 32in. wide and 26in. long, inside measure, by 3in. deep, excluding the supporting slats; it ought to be dovetailed at the corners. Over this is stretched very tightly a piece of 8oz. ducking or strong sail-cloth, and over this again are nailed the slats, 1in. square, to keep the cloth from bellying when the eggs are placed upon it—one slat at each end working on the drawer slides, as shown in Fig. 1. The measurements above given, give the size of that part containing the eggs only. The sides are 32in., plus the thickness of ends, and the ends are 26in., plus thickness of sides, and 6in. or 8in. of packing space, (See Fig. 3.) The egg-chamber containing the gridiron, radiator, and egg-drawer, &c., is made to inclose only the part of egg-drawer holding the eggs, the sawdust packing being left out as it were. This chamber will be about 15in. or 16in. high, a trifle larger inside than the outside of egg-drawer, excluding the packing space. In the front of the chamber an opening 4in. deep and the width of egg-drawer outside is cut about 3in. from the top to admit egg-drawer; between this opening in chamber and the outside casing inclosing sawdust packing, a box must be made, through which the egg-drawer can be easily slid; this is to keep the sawdust from falling among the eggs, when opening or shutting drawer. Make all the necessary holes for hot and return water tubes, ventilating tubes, water and thermometer tubes, &c., in egg-chamber, before proceeding to inclose the packing space, which ought to be at least 6in.; 8in. would be better all around egg-chamber and heater.

The gridiron is hung at its free end by wires passing through top of chamber. In putting on this top use jointed lumber, or else cover it over with paper, to stop the sawdust working into chamber, and use screws instead of nails: they are easier to get out if you require to get at the water dishes, or to repair a leak in gridiron, &c. This will also apply to the outer casing. The legs (if not set on a bench), if continued as corner posts to top of outer casing, would add greatly to its strength; make them about as long as ordinary table legs: you will have less stooping to do in trimming lamp, which must be attended to daily. To get the largest amount of heat and economise oil, I make a tin chimney like that shown at *c*, Fig. 1; this fits the lamp exactly the same as a glass one, and is surrounded, excepting at the bottom, which projects into the lamp box, with water. The lamp is pushed up this projecting collar, and is held or supported by blocks of wood. To the disc of the spindle, to which is attached the wheel or wheels for raising or lowering the wick, solder a brass wheel about ⅞in. in diameter, having *teeth same size* as toothed segment on lever *h*, with which they engage. The spindle is very apt to give a little when the movement of lever *h* is reversed by the regulator, instead of turning the wick up or down at once. To remedy this fix the lamp in a block of wood securely, and let the spindle project through the brass wheel, and fit into a bearing in a standard inserted in block. The lamp box must not be shut up tight; it is better to leave the front open. As shown in Fig. 1, the flue is removable. An opening in bottom of heater is left large enough to insert the flue or chimney. To this opening is soldered *inside* heater, a brass or iron flat ring with opening same size as hole in heater. Four or five holes must be drilled or punched through both to admit bolts being placed with the *heads inside* heater, putting a rubber gasket under each bolt-head to prevent leakage. A tin or brass flange is soldered to base of chimney, and is of such a size that it will not allow the chimney to be pushed through the ring.

Between this flange and bottom of heater is a rubber gasket pierced with holes to allow passage of bolts, as is also the flange. If the bolts are square-shanked, and the holes in inside ring are also square, they will come apart more easily—at least, they won't turn in the holes, as rusty bolts sometimes do. Put on the nuts and screw up tight. A little blacklead on both, or only one side of gasket, will facilitate removal. The top of flue, which should be about 1¼in. diameter, is soldered inside a brass flange (see Fig. 3), threaded on its vertical part outside. The flange being larger than the hole in top of heater, prevents flue from going too far through. Slip a rubber gasket over flange before inserting up through bottom of heater, and when in position screw down the nut over vertical part of flange, and it should be watertight removable at will. The upper flue *f* is then slipped in snug, and need not be soldered.

The tubes in flue are seven in number. One in the centre is conical, the upper opening being not over ¼in. in diameter, and bottom ⅞in.; the other six are placed in a circle round it, and are ⅜in. in diameter. The upper flues, on leaving smoke-box, converge before entering brass flange. I think this is about as clear as I can make it without taking up too much of your valuable space.

Now for instruction to work it. Put in through regulator, after removing brass plug *d*, as much hot water *at* 150° Fahr. as will come to top of regulator cone, tilting the incubator once or twice by raising the lamp-box end to allow the air contained in gridiron radiator to escape, and insure the circulation of the water. Let it (the regulator) stand open until the temperature in egg-drawer rises to 98° Fahr. Place the lighted lamp, not fully turned up, in position, and allow it to remain five hours to heat the sawdust packing and woodwork, which, by the way, must be pretty well seasoned. Fill up the regulator tube and cone *level full* of water at the expiration of the five hours, and if the temperature of drawer does not exceed 100° Fahr., or fall below 99° Fahr., screw on the brass plug very tight, connect the two levers *g* and *h* by the rod *r*, and with the nut bring the weight of train of levers, rod, and small weight to bear on point of plug *d*, taking care not to turn down the lamp too much in doing so. See that tap *b* is tight, cover over the openings of tubes *w w* to water dishes, but leave ventilator tubes open. Put the thermometer in its tube, and run the incubator without eggs about 48 hours. Examine the thermometer hourly during the day, recording the temperature. If it keeps at a set temperature, put in 200 or 220 eggs from *selected fowls* if you desire a large out-turn of chicks. Fill up water dishes, of which there should be four, and attend to them daily, as insufficient moisture causes many eggs to fail to hatch. For the *first week* a temperature of 104° to 105° won't hurt the eggs, or, for a short time, 108° Fahr.: higher than that generally proves fatal. For the second or third week the heat must be *kept down to* 103 *or* 102, as anything causes the young chicks to become feverish and die in the shell. Turn your eggs daily, and when you take out the drawer put a piece of wood in opening to retain the heat in egg-drawer chamber. At the end of the fourth or fifth day examine the eggs and remove the transparent ones: this will give more room to turn the rest. Open the drawer as seldom as possible, particularly on the last two days of incubation.

With good, strong, healthy parent fowls the eggs will hatch out as well as under a hen, and need no assistance if due regard is paid to heat, moisture, and ventilation.

When the young chicks come forth, open the egg-drawer and close it very carefully, or you will kill some of them.

Let them remain until quite dry, and do not open the egg-drawer oftener than two or three times (if you desire success) on *the last day*. For the *first week* the young chicks require a temperature of at least 98° Fahr., or they will crowd over each other or, rather, under each other, and the strongest chicks thus get smothered. For an artificial mother, get a galvanised iron tank, 40in. square and about 6in. deep, place it in a box 6in. larger and deeper all around, first putting 5in. sawdust in bottom, so that the tank will come about 1in. below top, then fill all round with sawdust, cover it over with a board floor, tongued and grooved to prevent the dry earth which must be strewed over it, from working below. A pipe to draw off cool water from bottom, and one to replace it with hot water at the top must be provided. Make a shallow box, 40in. square inside and 6in. deep; but on two sides cut away one half the depth, nail on a bottom, and turn it upside down over tank box floor. This will leave an opening on each side 3in. high, which must be covered with a curtain slashed every inch. If two or three thicknesses of old blanket can be got, it will answer very well. Throw about 1¼in. deep of fine dry earth over the floor to absorb the moisture from their droppings before turning the box over the floor. To ventilate it an inch tin pipe is carried under the floor and over the tank, the ends both being left open and the pipe long enough to go across the tank and packing space to the outside of box communicating with the cool fresh air, which is soon warmed by heat from tank and ascends through ⅜in. vertical tubes, passing through floor and to nearly top of box. Six of these tubes will supply enough fresh air, and the vitiated air passes out under bottom of curtains. If you draw two or three bucketfuls of water from the tank every evening, and perhaps morning, when the day is cold or wet, and replace it after heating it to boiling point, that will radiate sufficient heat to maintain a temperature of 98° Fahr. 24 hours. As the chicks get older reduce the heat after second week gradually, until the 6th, when they will no longer require artificial heat, but may be allowed to remain under brooder until eight weeks old, when they should begin to perch. If the brooder can be placed on a closely-cut grass patch and the young chicks fenced in and well protected from vermin, supplied with good pure water and a little fine gravel or broken granite, they will do as well without a mother as with one; but they make infinitely more noise, and will drive a nervous person into a lunatic asylum. If they get diarrhœa, remove from brooder and give one drop Browne's chlorodyne in one teaspoonful warm water (one half of this is a dose for a week-old chick) every three hours, and keep warm and dry; two doses always and invariably cure the worst cases if taken in time. If very bad, give few drops of castor oil first, and in two hours give a small piece of dry chalk, and the chlorodyne one hour after. To raise them successfully they must be kept warm, dry, and clean.

To overcome an extra amount of friction at certain points of the revolution of wheel turning up lamp-wick, I substituted a pair of small brass rollers, slightly fluted for the star-shaped wheels usually employed, and find them a great improvement. The roller with short journals (see Fig. 5) fits in slotted bearings, and is pressed slightly towards the other one by a thin spring at each end. A small piece of watchspring, one end soldered to lamp, and the free end pressing against journal I used for springs.

If I could have procured *pure sheet rubber* I would have made a regulator thus. In place of the cone C on regulator-pipe, screw or solder a shallow brass cup having a screw-thread cut on the outside; on the top of the cup place a rubber disc over this screw, a cap having a shoulder inside to fit over the edge of lower cup, to secure a tight joint with rubber disc. Inside the cup, and resting on the rubber is a piston, the rod of which passes through a hole in the centre of cup, and engages the underside of lever *g*. I fancy the rubber disc, being more elastic than the tin base of cone C, it would act quicker, and the strain on heater and pipes is much less. A sketch of this is given at Fig. 6. If any of your readers act on this suggestion, I hope they will say how it answers. When you trim the lamp, always let it stand a few minutes before replacing, or it will blaze up too high. Turn it down to as near the same height as it was when you removed it. If you have occasion to remove the lamp for more than an hour, you must open plug *d* to allow the air to enter as the water cools, or something will collapse, and the heater will no longer act as a regulator. About a gallon and a half of oil will run the incubator three weeks if kept in a moderately warm room. The temperature of room affects the consumption of oil."

Here, then, you have two designs which are within the capacity of any intelligent mechanic to construct, while at the same time he may see points at which these incubators could be improved. If that should be the case, I hope he (or they) will send the suggestions on as promptly as possible. If I find any more designs worth reproducing, I will continue the subject. **Incubans.**

INCUBATORS.

[32856.]—Now that the incubator discussion is going on I should like to ask one or two questions.

1st. Could the hot-water pipes in a greenhouse be made to supply the heat to an incubator; if so, would someone kindly say if there are any such in actual work? I fancy many an amateur with a small greenhouse hot-water apparatus would like to know how to hatch chicks with the same.

2nd. The hot-water tank incubator described on page 179—could this be made on a smaller scale, say one-third size, would it still maintain the heat the same as the larger one, or would it require hot water oftener? **X. Y. Z.**

SCIENTIFIC ADVERTISING.

[32857.]—It is a pleasure to me to read and reply to the straightforward letter of Mr. Freeman (32845, p. 201). The point, however, is hardly whether I make a profit out of the manufacture of mirrors, or not; that I do not can be very well seen from what follows.

The charge made against me by "F.R.A.S." is that, as an official of the Royal Astronomical Society, I advertised myself as a tradesman to South Kensington, a charge as offensive as it is untrue. I regret now that I ever took notice of the matter: cowardly attacks by anonymous writers are best left unnoticed. It was more on behalf of the Council that I wrote than on my own. I see that this part of the untruth is apologised for to the Council, but the rest persisted in. Having noticed him, I must go further, much against my inclination.

As Mr. Freeman says, I do not say for whom the mirrors I mention are intended. I could not very well do so; nor can I do so now, without asking those friends to whom I must allude to forgive me for dragging them in. For Mr. Freeman's information, or the information of anyone else who takes an interest in the matter, I will briefly explain all about these mirrors. When the first 5ft. mirror was made, the machine stood idle; this opportunity enabled me to offer to make a 30in. mirror for a friend, a spectroscopic worker, who badly wanted a larger instrument. I told him if he would provide the disc of glass and pay for a pair of tools, I would then do the rest. He did so, and he now has a telescope which has not cost him more than he would have paid in the ordinary way for the mirror. I mention the making of this in my report for 1889. About this time, thinking it only fair, I offered to another friend, our most eminent spectroscopist (on the other side of the House, if I may be pardoned the expression) a similar mirror on similar terms. It was not convenient for him to mount it at this time, but it has been put in hand so that it shall be available when called for. This is one of the 30in. mirrors mentioned. The other has been made to fulfil a promise to the Astronomer Royal to make a mirror for his observatory if he will provide the glass disc (see his annual report for 1891).

The 30in. spherical mirror is for my own use in making plane mirrors. As regards the 20in. mirrors, the two mentioned in my report for 1890 were, on their return from the eclipse expedition, presented to the Royal Society. Of the two mentioned in my report for 1891, one I had mounted for my own use, the other was made as an extra one. Prof. Pickering desiring one exactly like those used in the eclipse expedition, I sold him the one I had mounted for my own use, and I have since mounted the other mirror in its place. Whether I made a profit on the sale, or not, I could not say; nor does it concern anyone as to the 36in. mirror for South Kensington. They had already in their possession a very fine disc of glass, which they wished to have made into a mirror. I undertook to do this if I were paid my out-of-pocket expenses. This amount they desired me to fix a limit to, and I named the exact sum I charged Prof. Pickering for the 20in. mirror of his telescope. It is hardly necessary to say that I would not undertake to make such a mirror again under such conditions. However, it is done, and is, I think, as fine a mirror as I have ever seen. I say nothing of the personal worry involved in making a mirror. This can only be appreciated by those who have made mirrors; nor does this touch the question at all. The almost perfect state of working that our machinery has been brought into (including in the word machinery two assistants and myself) has tempted me to make as much use of it as I could whilst such a condition of things lasted.

As to the identity of "F.R.A.S.," to which Mr. Freeman alludes, if he is the person indicated, and, viewed by recent events, his implied denials rather confirm this opinion, his case is, indeed, a bad one. It is hardly credible that any man would write as he has done of a colleague whom he has known for many years. If he is this person, then, in the interest of common decency, it is quite time that this Jekyll and Hyde business should be put a stop to. Whoever he may be, "F.R.A.S.," judged by the sentence that Iago gave utterance to,

> "Who steals my purse, &c.,"

is a person who would suffer by comparison with a pickpocket. **A. A. Common.**

63, Eaton-rise, Ealing, W., Oct. 24.

A CURE FOR DIPHTHERIA.

[32858.]—The following is recommended, and said to be unfailing, for the cure of this terrible disease:—Salammoniac, saltpetre, of each 124 grains Troy; water, 3,080 grains; watery tincture of rhubarb, 308 grains; ext. succi liquerit, 232 grains. Taken at first one tablespoonful every hour, but on improvement setting in every two or three hours, in sugar-water. For children under ten years of age one-half the quantity, and for very young children one teaspoonful or less, according to age, at like intervals. If stool sets in, take one spoonful every two hours, and later one every three hours.

Gargle, previously to taking, with the following solution:—Chlorate of potash, powdered borax, tannin, of each 150 grains; water, 4,620 grains; at least twice every hour.

Packing around neck with a towel wrung out in a solution consisting of—Arnica tincture, 1,540 grains; lead-vinegar, 154 grains; one quart of hot water; and kept damp by repeated additions in a cold state.

Recovery in from 16 to 20 hours.

I shall be glad to know what our friends think of this recipe, and shall be ready, if thought well of, to supply the further particulars recommended and necessary to be observed.

N.B.—The chemist—a Mr. Rud. Simpson, of Mohrangen, Prussia—desires the publication of the recipe in the interests of humanity at large.

Marienberg.

GAS-ENGINE AND ELECTRIC LIGHTING.

[32859.]—On October 2nd and 9th letters appeared in the English Mechanic on "Gas-Engines for Electric Lighting." Can anyone tell me what having a gas-engine and dynamo in the house will involve:—1st, as to cost, and 2nd, as to time spent in managing them? As I feel sure that my case must be like that of hundreds of other readers, I will give particulars.

I wish to have the house partially lighted by electricity—say, to the extent of 70 or 80 candles—by means of a gas-engine and dynamo. No one in the house will understand these except me, so that an accumulator will be needed in order to make the light available when I am away on business for two or three days. I am anxious to know:—

1. What voltage will be best for the lamps and for the dynamo? A low voltage means fewer cells in the accumulator; but, on the other hand, thicker leads.

2. Will a regulator be needed in order to prevent the engine from racing when only one or two lamps are lighted, or will it be sufficient to connect the dynamo and accumulator in parallel circuit, so that the latter will absorb the spare current?

3. Can a satisfactory accumulator of this size be made by an amateur? If so, when the plates are being formed by alternate charging and discharging, must the discharging be done on short circuit, or may the accumulator be made to light lamps at this time.

4. What switches, cut-out, &c., will be needed in the same room as the dynamo?

5. Must the dynamo have a flywheel to prevent pulsations in the light, or will the accumulator (when connected in parallel circuit) regulate the strength of the current sufficiently?

In the above I have purposely confined myself to the apparatus necessary for the generation of the current. Can anyone tell me what such a gas-engine, dynamo, accumulator, with switches, &c., will cost? also whether a gas-engine and dynamo can safely be left running for five or six hours without attention, whether they are charging the accumulator in the morning, or lighting the lamps in the evening? **X.**

A NEW GAS STOVE.

[32860.]—My attention has been called to the letter of Thos. Fletcher (32775) on the merits of a new gas stove which claims to increase the heat of a gas flame 300 per cent. Without having seen the stove in action, Mr. Fletcher concludes on *a priori* grounds that it is "worse than useless" for warming rooms, because "it is a law of nature" or scientific theory that "the heat of a gas flame is always in exact proportion to the amount of gas consumed, whatever burner may be used." An ounce of fact, however, is worth a ton of theory, and I inclose for your inspection a copy of the opinions of competent experts who have examined and tested the "Fire Globe," as this new stove is called, and who once held this old theory so commonly taught in our schools. Prof. Barrett, F.R.S.E., of the Royal College of Science, Dublin, found the temperature of his room 10° higher at the floor-level after using the fire globe on a bracket burner for an hour. But when burning the same amount of gas as a flame without the fire globe, the temperature did not rise one degree. Mr. L. A. Scott, gas engineer, of Woodbridge, affirms that the fire globe "will warm a room three times more than the same burner if used for lighting"; and Mr. Geo. Livesey, of London, certifies that his room was kept for three days at a temperature of 20° above that of the outside atmosphere by simply burning 5ft. of gas per hour in the fire globe.

These are authorities that I am sure Mr. Fletcher will respect, and facts which he will find it hard to reconcile to his theory. Everyone knows that the amount of light from a gas flame may be more than doubled by using the most suitable burner, and it is quite time the old scientific theory should be abandoned, that in whatever way you consume gas, and whatever burner you use, you are sure to get the same amount of heat from it.

I have sent a fire globe to Mr. Fletcher (whose splendid gas appliances I very much admire) for examination, and he has undertaken to test its claims. I hope he will favour your readers with a report of his own experiments.

Thos. Batty
(Patentee of Portway's New Gas Stove).

ETHER.—VACUUM.

[32861.]—It is pleasant to me to give pleasure to others; so that I am glad to hear that I have been able to amuse "F.W.H.," p. 198. But I cannot accept his philosophy or science as altogether authoritative. Why are we to attach importance to a dictum of Immanuel Kant, who wrote more nonsense about things he knew nothing about, in common with all other men, than anyone else except, possibly, Hegel? After all, his dictum was nothing more than a re-statement of feelings expressed by every scientific man from Newton till now.

But as "F.W.H." wants the opinion "of 'Sigma' or other non-ethereal gentlemen," I should like to know on what ground he classes us "non-ethereal." How many more times shall I have to repeat that I have never said a word against the idea of space-pervading ether as a light-transmitting agent? In other pages I have spoken of the ether as "hypothetical substance probably existent, but of whose real nature we know nothing and can never know anything." I have protested at the unscientific practice of inventing properties of a substance wholly beyond our knowledge, merely to enable it to fulfil certain functions, and more especially to enable it to do work which there is no scrap of evidence to show that it takes any part in.

I have no objection to the conception of the ether as an unknown but probable "something" which in some way transmits light across space. But I do say that, as far as we know, that something has none of the properties which we recognise as those of matter; and that, therefore, we cannot argue from the properties of matter to those of ether, and that still less can we use the properties of ether, of which we know absolutely nothing, to explain the actions of matter. What I have specially repudiated is the bringing in the artificial, imaginary properties of ether to explain actions of electricity which we see manifested only by matter.

"F.W.H." is funny over the "empty" accumulators, and yet the railways are right. It is only the filled cells that are useful, so that it is really the "charge" which is the thing transmitted, not the lead or liquids. These may form the weight carried, but so do the crates, or packages, and bottles very often weigh many times their contents; yet, as a business matter, these are carried back for a nominal price in order to bring business to the company when refilled. But, further, the idea that "energy is apart from matter, and can be taken in and out like a horse from a cart," is the simple truth. Energy is not known apart from matter, nor is it an entity, so far as we can understand; but it is apart from any particular matter, because it is transferable: the energy goes from the arm to the cricket-bat and then to the ball, which carries it to a distance where it can do work; the stroke on a bell is energy which is distributed far and wide as sound.

But Mr. Wheeley (p. 200) will never see what he desires. No perfect vacuum will ever be made on earth, certainly not by mercury, because mercury gives off a vapour, very slight but still not to be got rid of, and it is probable that even glass would do so; nor is there any reason to suppose that a vacuum, if existing, would not transmit light. That is where true science differs from the make-believe, the hypotheses of philosophy; it deals with, and builds on, proved facts; space is our best conception of pure vacuum as far as matter is concerned, and space transmits light. But the "ether jelly" is already dead; it has gone the way of all other preceding conceptions of the nature of ether itself. Its creator, Sir W. Thomson, found it would not work, so killed it off and invented another notion, which will in due time follow the others for the same reason.

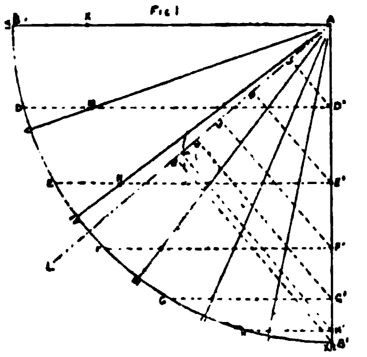
Sigma.

DIALLING, AND THE ELLIPSE.

[32862.]—As no one more familiar with the subject has answered the request for rules for making a sun dial, and as I can speak from experience of the usefulness of a dial in African wilds, I send the following, and hope it may be of interest to "C. H. T."

In Fig. 1, A B' and A B, drawn at right angles to each other, are the XII. and VI. hour-lines. With centre A, and any convenient radius, describe the quadrant B' B, and divide it into six equal parts, B D, D E, &c. Draw D D', E E', &c., parallel to A B. Make the angle L A B equal to latitude of the place where dial is to be fixed.

Fig 1

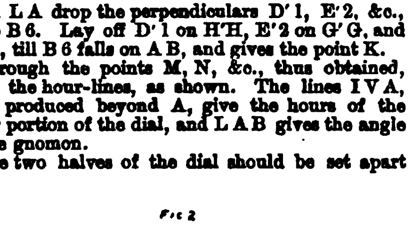


On L A drop the perpendiculars D' 1, E' 2, &c., up to B 6. Lay off D' 1 on H'H, E' 2 on G' G, and so on, till B 6 falls on A B, and gives the point K.

Through the points M, N, &c., thus obtained, draw the hour-lines, as shown. The lines I V A, V A, produced beyond A, give the hours of the other portion of the dial, and L A B gives the angle of the gnomon.

The two halves of the dial should be set apart along the XII. o'clock line, according to the thickness of the gnomon, and I am not sure "E. L. G." would not also make a correction for the time of the sun's passage, corresponding to its own diameter; but that is a matter I must leave to the mathematicians.

Fig 2



I take the above rule from my note-book; but whence I originally got it I cannot now remember—possibly from a quaint old book by Ozanam.

On examining Fig. 1 it will be noticed that the points K, M, N, &c., lie in an elliptical curve, and this suggested to me another and simpler method of working by using one of the ordinary rules for drawing an ellipse, hence the "compound" heading to this letter. Whether the method is original or not I cannot say; but probably *not*, as so much attention was in former days devoted to this subject. It is, I think, correct.

Proceed first to draw the quadrant of Fig. 1, and lay off the latitude angle; also drop the perpendicular B 6. Then with these data construct Fig. 2 as follows:—B B' is the quadrant, as in Fig. 1; A K is, as in Fig. 1, made to equal B 6; the quadrant is also similarly divided into six equal arcs, B D, D E, &c. Radial lines are then drawn from these division points, D, E, F, &c., towards the cente A, cutting a circle described with radius A K in the points D' E', F', &c. From each of these points D and D', E and E', F and F' lines are drawn, as shown, parallel to A B and A B', and through the intersections M, N, &c., the hour lines are drawn, and the other part of the dial completed, as described in Fig. 1.

"C. H. T." probably knows the method of getting the hour lines from an ordinary globe with its axis properly inclined.

A. S. L.

CHIMING CLOCK.

[32863.]—I cannot quite agree with "G." (letter 32840, p. 200) when he says that a locking-plate is easier to make and more reliable than a rack striking mechanism.

With regard to the advantages of a rack, an absence of rubbing friction during striking is one, and, as "G." says, if the clock by any accident stops, it invariably strikes the correct hour when started. In a chiming clock this latter is a consideration, as striking it round, say, 10 hours and letting off all the quarters *en route* is no joke. The old English country-made striking clocks were by no means made in wholesale quantities, yet the rack was almost always used, and all the parts filed out by hand. I have had a large number of these old clocks under my notice, and have observed that those with rack striking, though over one hundred years old in many cases, always strike correctly, and the mechanism shows very little wear—in fact, the striking part outlasts the clock; while, on the other hand, those with a locking-plate arrangement at the same age become a perpetual nuisance. The wear of the striking parts makes their renewal a necessity if the clock is to go at all. For heavy chime-weights I myself prefer good gut line, as large as the barrel will allow.

F. J. G.

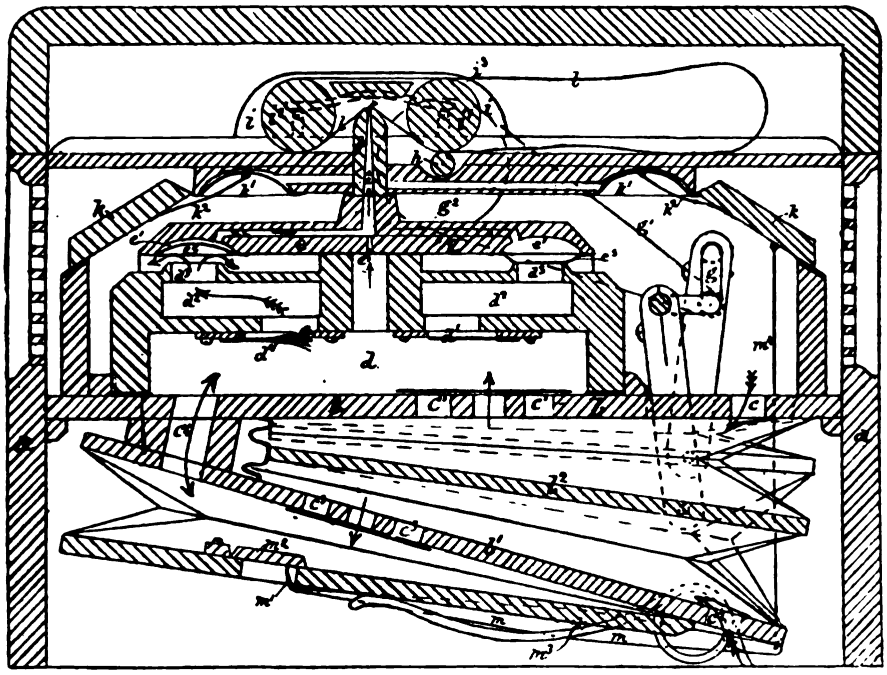
VIOLIN MAKING.

[32864.]—The excellent series of articles by Mr. Pickering will no doubt set many hands and minds to work on this rather interesting subject. Some may perhaps think that there is not much that is new to be said about fiddle making; but I am not of that opinion, and am glad to find that Mr. Pickering has treated the subject in a concise and intelligent manner. If I might venture to find fault, I should say that the instructions are too concise on one point, and that is on forming the curves of the back and belly. Comparatively few of those who are likely to utilise these instructions have access to a first-class old violin, and even if they have, it is scarcely to be expected that they can carry its curves in the eye. Some years ago, a correspondent of this paper kindly lent me a new work on the violin, by Heron-Allen. In it were two sheets of working drawings, full size, giving the outlines and curves of two first-class old violins, one a Strad, the other a Guarnerius. If the publishers of this work (Messrs. Ward, Lock, and Co.) could make arrangements to issue these sheets separately at about a shilling each, they would confer a boon on amateur violin makers, as nothing more useful could be devised.

The possession of a good model may not insure the making of a good violin; but the amateur may as well start on a good model as on an indifferent one, and with greater probability of success. I don't think it is possible to define what the curve of a violin back or belly is or should be. Mr. Haweis, I think, says it is in a Strad the natural curve of vibration; but even if so, I don't see how it is possible to trace this curve, except as a foundation, for, like Mr. Pickering, I believe the tone of the instrument was finished by retouching the back and belly after the instrument was put together. In no other way could a uniformly successful result be attained, and minute differences in height of arching and thickness of wood must have very great influence in retarding or reinforcing the vibrations. It would be impossible to find out the faulty places until the instrument was strung up; then, as Mr. Pickering says, the artist might commence the delicate retouching, and finish the tone to his liking. Does it not seem highly probable that the artists of old worked on some such method as this? To my mind it seems a certainty, and though I know very little, practically, of old fiddles, I have read much concerning them, and it seems generally agreed that each of the great makers had a quality of tone peculiar to himself. Now, how could this be attained uniformly except by final outward retouching until the tone satisfied the ear of the artist? The shape or build of the instrument cannot be responsible for the tone entirely, though it is a most important factor.

I think it would be valuable and interesting if those who have the curves of the backs and bellies of instruments by Da Salo, N. Amati, Stradivarius, and Guarnerius would measure them by the method of ordinates and abscissæ, and give the results in these pages. It would then enable anyone to plot

FIG. 19



out the curves at pleasure. Say we take a base-line 1in. below the lowest part of the curve, and for the curve lengthwise of back or belly, measure the ordinate in $\frac{1}{16}$in. at each ½in. in length of the base-line. For the cross curves the ordinates should be taken at every ¼in. of base, as the curve is sharper and less easy to trace; and these curves should be taken across the widest part of top and bottom boughts and narrowest part of middle.

The outline of the fiddle might be given in the same manner, and we should then have in a condensed form information from which anyone might trace his own curves; besides which, it would show the different and distinct arching adopted by these renowned artists.

As regards the sound bar, I find it stated in the "Violin Notes" attached to a Memoir of Ole Bull, that the bar should be made to have a slight upward spring to counteract the pressure from the strings on the bass side, and that the sound post should be fitted either tight or slack, according to the character of the instrument. In other books I have seen it stated that the belly should not give under the pressure of the strings. This seems to me to be scarcely correct.

And lastly, as regards the wood, are there no foreign woods which will answer as well as harewood and Swiss pines? If so, and I see no reason why it should not, they would most likely be cheaper, and easier to get in the special form cut for violin purposes—that is, on the quarter.

Orderic Vital.

ORGANETTES.—VIII.

(*Continued from page* 97, *Vol. LIII.*)

[32865.]—As stated at the time, I intended my last letter to conclude the series describing the organettes proper; but proposed in a subsequent letter or two to describe those instruments in which the mechanism for selecting the notes was separate from the piano, harmonium, or other instrument producing the actual sounds.

I have, however, since then come across a whole series of patents (fourteen in number) relating to these automatic instruments, which contain many very curious combinations of mechanism, and which are, I think, well worth reproducing (briefly) in our pages.

The "Ariston" organette, in which a perforated disc revolves and actuates the levers and pallets, is too common to need much description, but one of the patents provides for the reversal of this process, the disc being stationary, and the whole apparatus of levers, reeds, &c., carried round underneath it. I have only seen one of this particular pattern, and cannot tell what is supposed to be the advantage of it, so that I have not included a drawing of it.

If the rotating arrangement of the reeds, &c., just referred to is peculiar, a further development described in the specification is still more extraordinary—viz., the perforating the disc in all manner of patterns instead of in concentric circles. Thus we have three and four-sided figures, octagons, and even a shell pattern illustrated in the specification.

In order to bring the perforations into the proper position to actuate the pallet levers, the latter (with the box containing the reeds) are mounted in a traversing frame which is made to slide to and fro by means of a cam and a counteracting spring, the shape of the cam being made to correspond with the particular pattern of the perforations in the revolving disc.

This seems ingenuity misplaced, and it is hardly worth while to trouble the engraver to reproduce any of the arrangements shown. If, however, any reader cares to get the specification, it is 10291, of 1885. The same patentee, in other specifications, shows how strings may be struck, steel tongues vibrated, and so forth; but I defer these till I have finished with the wind instruments. In one form of the mechanism the perforated tune-bands are lapped round a roller, the length of the band being only about equal to its circumference. The roller is grooved to allow the points of the levers to pass through the perforations, and has a kind of clip to secure the two ends of the bands where they (slightly) overlap. In this case each revolution of the roller repeats the air, so that the effect is the same as with the endless bands of other organettes, but obviously the tune can only be a short one.

The organette shown in Fig. 19 is interesting in having an automatic arrangement for increasing or decreasing the loudness of the reeds as well as in the peculiarity of its pneumatic valves, which are much like those applied by Roosevelt to large pipe organs.

In one of my letters (No. VI. page 55, Vol. LIII.) I described a very simple flap-valve arrangement, shown also in the figure No. 16, but expressed my doubts (apparently confirmed by experiment) as to its successful working.

Since writing that letter I have been kindly furnished by Mr. Holt with a working model which answers perfectly, but with the condition that the escape channel shown at i^1 in Fig. 16 shall be a short one. If this channel is of too great length, the action fails, and this was the reason of the want of success in the instance I at the time referred to. It is necessary to make this explanation and correction, as in the organette shown in Fig. 19 the same principle is applied, though in a somewhat different way.

The bellows are made with a centre-board, b^2, working up and down between the fixed boards b and b^1, of which the former is the bottom of the wind-chest d, and the latter is the top of the reservoir. The reservoir is of the usual description, with its inlet valves c^3 and its relief valve m^2, and communicates with the wind-chest by the passage c^4. The wind from the upper part of the bellows passes direct to the wind-chest by the valves c^1, the inlet to this part being at o, and to the lower part at c^2. As the feeder arrangement is in duplicate, and each is double-acting, a good and steady wind supply would be kept up, while the whole forms a very compact arrangement.

The wind-chest contains two ranks of reeds marked d^1 d^1, set upon the channels d^2 d^2. The outlets of the channels (or "cells") have their edges slightly raised, as at d^3 d^3, in order that the elastic valves may work freely and bed securely. These elastic valves are shown one (on the left hand) open, and the other closed. The valves work each in a cupped recess on the underside of the board e e, the recesses above the valves communicating by the passages e^1 with the vertical channels e^1 in the bridge f, over which the tune is passed from roller to roller, as shown at l l and l^1 l^1. The reeds (and their cells) being arranged alternately, only the left-hand channel is fully shown, the other being dotted, I fear, too faintly to be reproduced in the figure. At the lower ends of the vertical channels, e^1, are small holes, marked e^3; but the action of the valves and the object of these holes will be best understood from Fig. 20. This

FIG 20

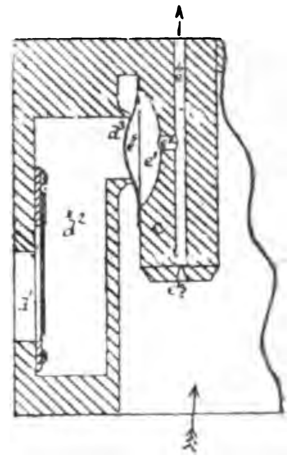


figure represents on an enlarged scale one of five different arrangements of this portion of the instrument. In this one the reeds and cells and valves are placed vertically; but in other respects it resembles that shown in Fig. 19, and that is my reason for selecting it in preference to either of the others.

As in the flap-valve, shown in Fig. 16, the valve is prevented from rising by the air confined in the part above or, in this instance, behind it, and on the escape of the air (by a perforation in the tune-band coinciding with the passage e^1) the valve opens and the reed sounds. The patentee claims that the movement of the valve is caused by the rush of air through the small hole e^3, which acts as an ejector (he says "injector") and carries the air from behind the valve, and so causes it to open. This part is of course made to vary according as the instrument is on the exhaust or pressure principle, but the general idea is the same in all. In one form the air is exhausted *through the tune-band* into an upper set of channels connected with the exhaust bellows. This, however, would subject the tune-bands to so much friction, that I doubt whether the paper of which these are ordinarily made could withstand it.

Returning to Fig. 19, we have next to notice the automatic action for "expression," if such a term can be applied. Above the reed chambers and their valves is a precisely similar pair (or more) of valves k' k', which also have their escape channels passing through the bridge f and controlled by special perforations in the tune-band. These valves k' k' act on the lids k k and produce the "swell," while a still further provision is made for varying the loudness of the reeds by the curious connection of the relief valve m^2 of the reservoir with the right-hand-lid k. This is done by means of a lever, m, pivoted at m^3, and carrying at one end a pin, m^1, to push open the relief-valve m^2, and at the other the link m^4, extending up to the lid k. Thus, when the lid k is shut the relief-valve is opened, while the spring underneath exerts but slight pressure; but when the lid k is open the relief-valve does not open until the reservoir is wide open and under full pressure.

I do not know whether any organettes have been constructed under this patent, which is not one of those taken out by the inventor of most of the organettes; but there seems no reason why it should not make a good instrument.

The patentee claims also an arrangement for traversing the reeds so as to change the key; but I am pretty sure that this is not a novelty—in fact, I believe I have a sketch of something similar, though where I saw it I cannot now remember.

A. S. L.

Messrs. George Philip and Son, of 32, Fleet-street, have published a "patent clock-face" having movable hands and revolving discs at the back, which, through a "window" at the top, states the time in print. It will be useful for teaching children to read the clock.

REPLIES TO QUERIES.

⁂ In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.

[74424.]—**Midland Loco., 1870.**—In this query which appeared May 15 last, "Loco." said that No. 1870, a new engine with 7ft. 10in. wheels, had been "turned out at Derby." Can he say what has become of that engine, or whether it was found defective? Mr. Stretton probably can give some information. T. L.

[75174.]—**Terebene Driers.**—Will Mr. Stanley (p. 180) kindly say of what those terebene driers to which he refers are made? B. J.

[75256.]—**River Punt.**—After fixing plug in, you come to the engine. Of course, if you follow my advice and have a "Kingdon Patent" engine, you will only have to fit it in your punt. In Fig. 1 I show the top of a "Kingdon" patent boiler. In front of the funnel is a steam whistle, to the left is the steam pipe from the boiler to the engines, and to the right is a steam tap. The funnel is of brass, polished; the boiler is covered outside with wood. Fig. 2 represents the punt when finished, showing the boiler funnel and part of the engines. I have made my sketch as small as I could, as there are other sketches to be considered in the "E. M." The shading goes down as far as the water-line. If you consider the scale you will find that from the extreme end to the beginning of the engines is nearly 6ft., and that from the end of the boiler to bow of the punt is nearly 5ft. I have made the short end in front because the weight of the shaft, screw, and rudder must be considered. The centre line cuts mid-way between the engines and the boiler, and is a little over 2ft. from the centre of the funnel. I chose a "Kingdon" engine because of its great economy in fuel, its absence of noise and vibration, and its wonderful workmanship. You will find its working very simple and very quick in raising steam. If you do not care for this engine, a "Priestman" oil-engine could be fitted in just as well; of course, you would have to use their launch oil-engine. C. G. M. Bennett.

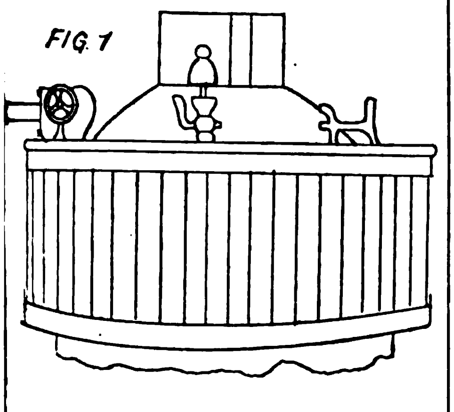


FIG. 1

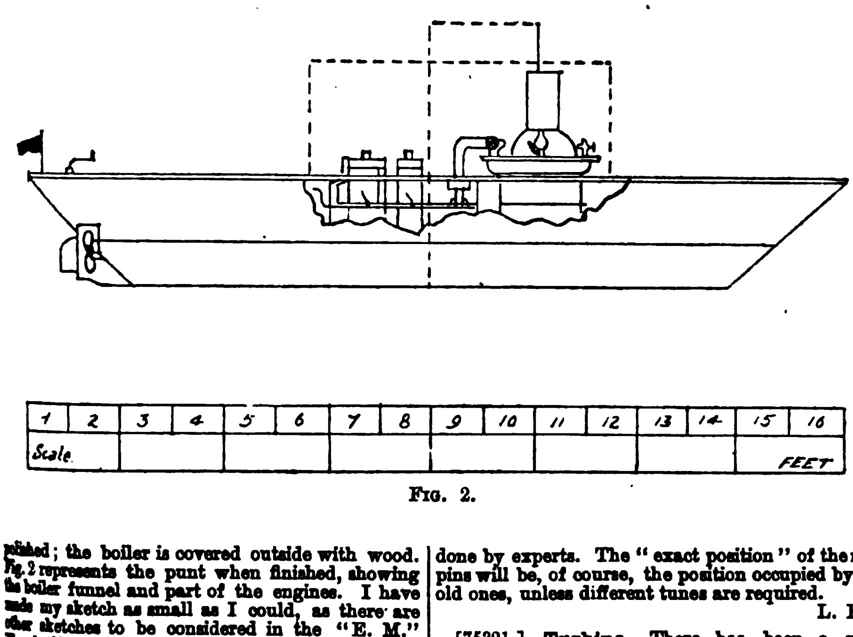


Fig. 2.

[75273.]—**American Organ.**—I must thank those readers who replied to this query, and endeavoured to help me out of the difficulty of being unable to make some of the 8ft. set of reeds speak in their proper cavities. After trying everything I could think of, I was obliged to give it up as an impossibility, and shift up the reeds an octave, making a 16ft. set which speak freely; and this is, I find, a great improvement to the instrument, as there are six sets in the treble. Since sending the query, I discovered that four of the 4ft. treble reeds were dumb in just the same manner, and in this case I discovered a cure—viz., the pallets, of course, to cover six rows are long, and I have fitted the springs to bear exactly over the plunger, so that pallet opens parallel, which, I presume, is right. Now I found, if I pressed the key down the slightest bit, the note would speak; but on being pressed down to its full depth it became dumb, so I concluded there must be something wrong with the pallet, and I found that, by putting a small leather button on one of the pallet pins of each of the four reeds, and thus letting the pallet open only one end, it put them all right; but I must confess I cannot understand why this should do so: it must affect the current of air under the pallet in some manner. My cavity-board was obtained direct from America, and all the reeds "voiced and tuned," so I did not try filing-down any of them. Perhaps our friends who are discussing the subject of "voicing" and tuning A.O. reeds would kindly enlighten us as to where the art of voicing lies beyond filing the reed to its proper pitch, and giving it a certain bend or twist. I cannot distinguish any great difference in any of the reeds of the different sets in the board referred to. Spring.

[75276.]—**Carbonising Wool.**—To carbonise, or, rather, to extract wool from mixed fabrics at a profit needs experience, whichever method is adopted. To describe either in brief in reply to "Fibre" would be misleading. It is a complicated trade, and seldom proves remunerative. Still, if "Fibre" is really intent upon extracting on a commercial scale, he can obtain all the information he desires from G. M. Swan, Arcade, Bradford, Yorkshire, No. 228, who is thoroughly competent to advise him. But he must not expect advice gratis. The writer knows all the intricacies and difficulties of the business, and would caution "Fibre" against entering upon it in haste. Seaside.

[75306.]—**Musical-Box.**—The broken pins must be drilled out and new ones put in. The cylinder is probably filled with some cement. If so, that can be melted out, and the broken pins punched through. It is always advisable to get such repairs done by experts. The "exact position" of the new pins will be, of course, the position occupied by the old ones, unless different tunes are required. L. B.

[75321.]—**Turbine.**—There has been a good deal about turbines in back volumes; but the querist's best plan would be to procure catalogues from makers, and obtain estimates by sending full particulars of the site and the power required. M. T.

[75324.]—**Camera.**—The method of making dark slides was described fully not long ago. The querist should procure the Nos. for April 5, 1889, and consult the index of Vol. XLVIII. S.

[75327.]—**Metal Patterns.**—It would seem that ordinary tinman's solder is what this querist requires, unless he wants something harder, when he should try pewter. L. T.

[75328.]—**Midland Locos.**—I have asked several times at St. Pancras about this wonderful locomotive No. 1870, but cannot hear anything definite about it. None of the drivers seem to know it. Perhaps "Loco," who was the first to mention it, will kindly explain where he found any notice of it. I do not think it has been illustrated in any of the engineering papers. R. S.

[75331.]—**Wall Diagrams.**—The querist seems to have used the regular materials—lamp-black and size—but perhaps he did not use the mixture thick enough. X. M.

[75342.]—**Phosphor Bronze.**—I think phosphor bronze is still protected by patent; but a description of it appeared some years ago. It is made by preparing a phosphor-tin or a phosphor-copper, and then adding a portion of that alloy to the molten mixture of copper and tin, stirring vigorously. S. R.

[75377.]—**Blower for Gas Generator.**—If "M.R.C.S." wants a blower worked by weights he cannot do better than write to the Incandescent Gas Light Co., Palmer-street, Westminster, who make gas apparatus for photographic and lighting purposes, which works with benzoline in conjunction with an air blower, and will run 8 or 10 hours at a stretch with once winding up. Gas-Engineer.

[75377.]—**Blower for Gas Generator.**—I would feel obliged to Mr. Fletcher for drawing of generator to raise gas from benzoline, as I fail to see how it is possible for "M.R.C.S." to make gas for nine hours with machine 3ft. by 2ft. by 6ft. diameter. The motive power used by me at present is the gas from plumber's lead-burning machine passed through benzoline, which gives a white light. But for cheapness I would prefer air.

Thos. Briggs, Plumber.

58, Rokeby-street, Stratford.

[75436.]—**Nasik Squares.**—It is an essential feature of a Nasik square that it should consist of consecutive numbers from 1 upwards. Consequently your correspondents have not yet helped me. Moreover, some of their squares are more defective than my own as regards summation. My query is still unanswered. Arithmetic.

[75436.]—**Nasik Squares.**—May I correct one or two slips of my pen on p. 203? Just under Fig. 3, the word "figures" twice occurs; I should have written the word "numbers" instead. In the sixth line from top of column, instead of "by a number *not less* than the greatest in the other," it would have been better to have written "by a number *greater* than the difference between the extremes in the other." Lastly, Fig. 3 does not add 264 in each of "its 24 diagonals"; I meant, of course, its "12 diagonals." Nevertheless, there are many magic summations besides the 24 in rows, columns, and diagonals—both in my square and in that of "E. L. G." (who has, curiously, given precisely the same square as one I indicated). For example, there are summations along 18 paths that are similar to the "knight's move" in chess. Six horizontally from left to right, as

$$1 + 30 + 40 + 7 + 34 + 38 = 150$$

in "E. L. G.'s" square, and as

$$11 + 52 + 65 + 17 + 56 + 63 = 264$$

in mine; six downwards from left to right, as

$$1 + 10 + 34 + 49 + 40 + 16 = 150,$$

and six upwards from left to right, as

$$35 + 19 + 30 + 15 + 31 + 20 = 150.$$

Before concluding, perhaps those readers who have been interested in this kind of magic square would like to have the rule extended from the square of 6 to other oddly-even squares, as those of 10, 14, 18, &c. In their case, instead of selecting numbers which may be arranged in columns adding alike, it is only necessary that the rows add alike. Thus for the square of 10, the smallest numbers available are 1 to 11, with the middle number 6 left out. For—

$$\begin{array}{l} 1 + 3 + 5 + 11 + 10 = 30 \\ 2 + 4 + 7 + 8 + 9 = 30 \end{array}$$

These may be arranged in the top rows of the skeleton squares in any order, provided that a number from each of the two rows above is put down alternately. This is called "single rectification," and is all that is necessary in oddly-even squares of 10 or upwards. "Double rectification" is essential only in the surface of 6. T. S. B.

[75451.]—**Eyepiece.**—I cannot suppose "F.R.A.S." would willingly discourage an amateur striving to obtain a serviceable telescope; but his remarks on my query had a depressing effect on me, and as he thinks my eyepiece an optical curiosity, I beg him to turn to p. 184, Vol. XXIX., where he will find described and illustrated what I have taken as my model; but as it does not answer my expectations, I wish to know if it is wrong in principle or faulty in construction? I have a plano-convex lens, ¾in. focus, ditto 1in. focus, and p.-concave, mounted in three separate tubes, so as to place them any required distance apart; but I cannot get clear vision in any position with the three lenses. But if I take out the p.-concave, I can then get a misty view of object. I should therefore feel greatly obliged to any of our contributors who would point out to me where the fault lies. C. S.

[75479.]—**Slide-valve Setting.**—I regret that, through oversight, I omitted to make allowance for increased length of boiler with engine in steam. Of course, under those conditions your back port does require to open rather wider than the front one, and if you find that the back port opening ⅛ wider than front one causes the engine to "beat" to your satisfaction, then by all means set your valve to that amount. A. Marriott.

[75507.]—**Locomotive Colours.**—In reply to the above query, I beg to submit the following particulars. The North London Railway Co. now paint all their engines black; the picking-out colours are bluish white and red lines; the buffer beams and connecting-rods are bright red; the numbers are in brass, and the number-plates are painted black. This company used to paint its outside-cylinder engines green, the picking-out colours being black and white, and the relieving colour red. The inside-cylinder engines have been painted black for many years, and the picking-out colours bright red. The relieving colours beneath the footplates of the other engines mentioned are as follows—viz., G.N.R., Vandyke brown; N.E.R., Vandyke brown; L. and S.W.R., black. Of the H.R., G.N.S.R., and Irish locos. I have no particulars.

James F. Vickery.

[75519.]—**Mnemonics.**—I have tried both the systems mentioned, and much prefer Stokes; but neither will do any good without thoroughly studying and applying the principles. I would recommend "T. S." to read a little book by Dr. Pick, called "Memory and its Doctors." Careful observation and attention are at the bottom of a good memory; but a good system of mnemonics is an immense help in getting up and keeping a quantity of miscellaneous facts. De B.

[75523.]—**Logarithms.**—I should be very glad if "A. D. I." would kindly, as he promised, give the rules in English for using the logarithmic tables of Anton Steinhauser. S.

[75523.]—**Logarithms.**—I give herewith the name of a work which seems to meet querist's wants exactly. I refer to Gray's "Tables for the Formation of Logarithms and Antilogarithms to Twelve Places," which can be obtained of Layton, Farringdon-street, close to Holborn Viaduct. It is a small and inexpensive work, and the results are obtained very simply and easily. The logarithms of the quantities he mentions are as follows:—

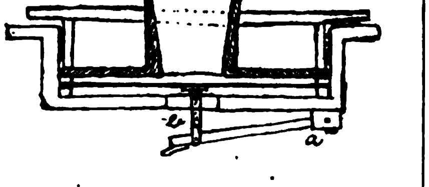
107	2·029383777685
374	2·572871602200
1824	3·261024833992

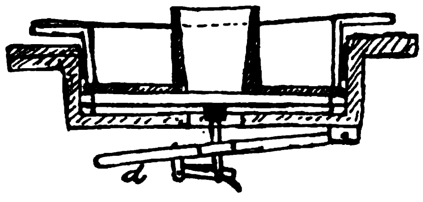
C. N. H.

[75524.]—**American Organ.**—I wish to inform "Organon," p. 204 and 205, that I do not intend to enter into any useless controversy on the subject of certain patented improvements which have been made in American organ construction since "Organon" wrote his vague instructions. If he is unacquainted with the improvements referred to by me, he can remain in ignorance as far as I am concerned. I am always ready and willing to help those of the readers of "Ours" who require to be taught on any subject which I know to be of general interest. I wish to advise purchasers of organ fittings not to buy the cheaper class of fittings. Pay a reasonable price, and have everything of the best quality. In my reply to this query last week I omitted prices for keys. Two good sets for a two-manual, cannot be had for less than £2 10s.; good plain walnut case, £4. In reply to "Etienne," p. 201, the springs I refer to (as I stated before) are used in the best American-made organs, and the springs are made where the organs are manufactured. I do not claim or wish to claim any acquaintance with the "rubbish" referred to by "Etienne," but good and first-class organs are made in England as well as in America. This ends my part in this controversy.

Practical Organ Builder.

[75552.]—**Phonograph.**—The two correspondents discussing the subject of the phonograph are not quite right in their information. "S. R." is correct in saying that he saw two diaphragms, one being the repeater carrying a round-pointed needle, the other the recorder. The latter, however, instead of carrying a chisel-pointed cutter, carries a gouge-shaped one. The original querist speaking of a ferrotype iron diaphragm is mistaken; the diaphragm is always glass. The recorder is a glass diaphragm about 1½in. diameter, which has a cutter attached with a little shellac. The cutter is also fixed at *a*, as shown, *b* being two links which give it the necessary freedom of motion to respond to the motion of the diaphragm in all directions. The repeating needle (sometimes made of sapphire) is usually fixed to another diaphragm in such a way that it drops into the impressions made by the recorder. *d* is a weighted lever which keeps the needle close to the wax cylinder. Edison has made a few of his latest phonographs with only one diaphragm, the recorder cutter and repeating needle being both fixed to it. Either is brought into action by the holder of the diaphragm being shifted round. I am afraid no good results can be obtained with a cylinder which is turned by hand, as even with an electric-motor working it the very slight difference of the battery current is sufficient to make the voice indistinct. Volt.





[75559.]—**The Stars.**—The twelve brightest stars in the heavens are (approximately) in order of brightness as follows:—1, Sirius; 2, Canopus; 3, *a* Centauri; 4, Arcturus; 5, Capella; 6, Vega; 7, Rigel; 8, Procyon; 9, *a* Eridani; 10, *a* Orionis; 11, Altair; 12, Aldebaran. There is, however, some little doubt with reference to the fainter stars of this list. For example, Dr. Gould makes the southern star β Centauri equal to Procyon, but Sir John Herschel places it below Aldebaran ("Cape Observations," p. 334). Numbers 4, 5, and 6 are nearly equal in brightness. J. E. Gore.

[75563.]—**Rain Gauges, Recording.**—Crossley's is a *registering* rain gauge, and the only difference between it and Yeates's is—the first shows the rainfall direct on a dial, whereas Yeates registers his by the aid of electricity, so that the gauge can be outside and the registering apparatus in a room. I am sorry I cannot give you a sketch of the mechanism. Curiously, in "British Rainfall," 1878 and 1879, Mr. Symons describes almost every other gauge but Crossley's. Perhaps, if this should meet his eye, he will oblige with the desired information. F.R.Met.Soc.

[75573.]—**Stable Fitting.**—In the volume on "Hunting?" (Badminton Library), page 92, "H." will find the following passage, which seems a perfect answer to this query. "The floors of the Badminton loose-boxes are therefore laid perfectly level, and paved with large flat flagstones, much after the fashion of the London foot-pavement. There are no drains of any sort in the stables, and, as a consequence, none of those noxious exhalations which are practically inseparable from the best system of drainage. A plentiful supply of clean straw is, of course, spread in every box, and replaced as necessity demands; but it has been found that no more straw is used now than was used formerly when the stables were drained." I need hardly point out that the stables referred to are those of the Duke of Beaufort, Master of Hounds, and President of the Four-in-Hand Club, and perhaps as great an authority on such points as one can refer to; but at the same time, I must add that my own ideas on the question differ *in toto* from what I have quoted; and having to build some new stables only this year, I had them drained and ventilated in the most thorough manner, with the result that the air in the stables is as pure as the air on the lawn, and I would defy anyone to discover any noxious exhalations at any time. I cannot but think that it is against the laws of sanitary and all other science that the atmosphere can be pure when the urine is left on a level floor, to soak into the bedding and to evaporate into the air.

Ashfield.

[75582.]—**Electrical Cylinder Machine.**—Take care that you have no point or other sharp edge wrongly exposed on your conductor. Substitute a ¾in. solid glass rod in place of your 1in. tube, as insulator. Glass tubes should not be used for this purpose, as moisture collects inside them. No need to insulate the rubber, unless you wish to collect negative electricity, nor yet the cylinder. Cover the ends of the latter with shellac varnish.

L. T. G.

[75592.]—**Condenser.**—Make your condenser of about 50 sheets of tinfoil, 7in. by 3in., placed between sheets of good thin paper 8in. by 4in. Carefully examine every sheet of the paper (by holding it between your eye and the light) and choose only those that are quite free from holes. Soak for a few minutes in hot paraffin wax before using.

Brighton. T. C. Smith.

[75584.]—**How to Calculate H.P. of Cylinder.**—Presume you mean the indicated H.P., as nominal is quite out of date, and is the power calculated supposing there is a mean pressure of 7lb. per square inch in cylinder. The actual or indicated H.P. of cylinder of an engine cannot be got till you know the mean pressure in it per square inch. You will require to take an indicator diagram from it, and calculate the mean pressure from heights of ordinates, usually done by adding heights of ordinates (corresponding to pounds pressure), the number of which is generally 10, and taking average pressure by dividing by 10.

Then— $\text{I.H.P.} = \frac{Plan}{33{,}000}$.

Where P = the mean pressure in pounds per square inch in cylinder.
l = length of stroke in feet.
a = area of cylinder in square inches, less ½ area of piston-rod.
n = number of strokes per minute = revolutions × 2.

This is supposing piston-rod comes out at crank end of cylinder only. Inertia.

[75602.]—**Gramme Dynamo.**—Your dynamo probably gives about 55 volts and 10 to 12 ampères. It would probably light 12 or 14 incandescent lamps of 48 volts in parallel, and might run two arc lamps, provided they did not take more than six ampères each. S. Bottone.

[75605.]—**Incandescent Lamps.**—Yes, a 16c.p. 48-volt lamp, taking 1·1 ampère, can be run by hand off an appropriate dynamo. S. Bottone.

[75606.]—**Mounting Microscopic Objects.**—Potash will suit the moths' antennæ (if not used too strong) without hurting the nervules, or they may be taken quite fresh, well cleaned from dust, and mounted in glycerine. As regards mounting whole insects, &c., it would take a long explanation; but you will find it fully described and illustrated in a pamphlet published on the subject by Mr. R. Mason, of 69, Clapham Park-road, Clapham, S.W., for 6d. I have obtained many useful hints from this little book. It seems thoroughly practical.

Poplar, London, E. T. A. Lugger.

[75606.]—**Mounting Microscopic Objects.**—(1) As for the feathered antennæ of moths, I would suggest that as the soaking in potash does away with the nervules, you should omit this, and mount, say, one-half of them direct in balsam. (2) What "animalcules" have you found it difficult to mount? Rotifers are "animalcules," and you have apparently succeeded with them. (3) I think the insect should be put in position on the slide you intend mounting it on, putting on first a drop or two of Canada balsam, then with the needles arrange the insect. Put on cover-glass in the usual manner, and keep all in position with the little spring clips made of piano-wire. Lay out your slides slightly sloping to the sun (to get quit of air-bubbles and solidify the balsam), and in a month or so they will be ready for use.

Plymouth. B.Sc.

[75606.]—**Mounting Microscopic Objects.**—You will not find mounting the moth antennæ dry a very satisfactory way. It can be done in a shallow cell; but if you clean it of dust, and soak it in spirits of turpentine for say 24 hours, you will find this will not hurt it, and you can then mount in Balsam and benzole, or you may take it fresh from the insect and mount it in glycerine in a cell, seal the cell with Miller's cement: no difficulty then in keeping it air-tight. There is no way, I believe, to show the wheel of animalcula, excepting when they are living. Arrange your insects on a glass slip, put paper or card to about the thickness, place another slip on, put indiarubber band round, soak in alcohol 24 hours, then in clove oil, then mount in balsam and benzole. Only patience and perseverance wi overcome the legs, &c., moving; try again—it wi come right by practice.

R. G. Mason, Manufacturing Optician.
69, Park-road, Clapham, S.W.

[75606.]—**Mounting Microscopic Object &c.**—Mr. Bellringer need have no difficulty i mounting his feathered antennæ. Let him arrang his specimen on a piece of cork with entomologic pins in such a manner as to display the par required, and place in an ordinary chemical, or hot air desiccator, until free of all moisture. Then c off the head, and mount dry in a suitable cel *secundem artem*; or, better still, fix the head on small disc of cork, cardboard, or leather, an having a short pin to be held in the stage forcep so that the specimen may be examined on all side as an opaque object by the Lieberkühn, side reflector, or common bull's-eye. These discs ar most convenient for opaque specimens, and ar described in Quekett's "Practical Treatise." Animalcules, i.e., infusoria, which rotifers emphatically are not, cannot be satisfactorily mounted, so far as I know, and whole insects in balsam ar usually worthless for study of the individual part unless small, and mounted without pressure. Now a query of my own. I was lately asked if I knew that Jupiter's moons, though invisible to the nake eye by direct vision, could be seen distinctly b observing the image given in any looking-glass. On pointing out the improbability, I was met with ocular demonstration, the night being fine, and, sure enough, there was the planet with a moon on each side. I hinted that he had four satellites, and then somebody said he thought he could see three. All my efforts at explanation, that the extra images were merely reflections from the front and back surfaces of the glass, and so on, were scouted, and I would like to ask some of our competent correspondents if this is a new notion got up in the interest of the after-dinner scientists, or merely an old fallacy revived. A DEMONSTRATOR.

[75607.]—**Accumulator-charging Dynamo.**—To MR. BOTTONE OR MR. ASKEW.—Ten cells will need 25. 10 ampères give a fair charging current. Hence, the dynamo should give 10 ampères at 25 volts. A drum armature dynamo, with upright field-magnets, about 6in. high, 6in. long, 1in. thick, with tunnel for armature 3⅛in. diameter; wound with 10lb. No. 16, armature being 6in. long and 3in. diameter, when wound with 3lb. No. 14, will, if shunt-connected, do all you require. Your calculation is about right. S. BOTTONE.

[75609.]—**Force-Pump.**—An air-chamber is all that is required to effect this. The principle of this, with sketch, may be found in any textbook on hydraulics. WALTER HERBERT.

[75611.]—**Black Magic Mirrors.**—*Muntra wallah* (or "magic dealer") is an ancient profession imported into India from Egypt, where the wise man always professed to reveal coming events in a mirror. The subtle Brahmins of modern times, at Muttra and elsewhere, make a nice livelihood by these consultations and the sale of amulets, love-charms, and life-protectors. They secretly obtain many leading facts from menial servants and elsewhere. Having strung these together, they frequently make a good hit in futurity. I never allowed them to enter my gates, nor have I ever looked into their prophetic instruments, so cannot declare their value. EOS.

[75612.]—**Interest.**—If he gave back £200 for £150, he virtually pays £50 for the loan of £150, that is, £33 6s. 8d. for £100. In other words, he pays 33⅓ per cent., which is rather low rate for a money-lender. FRANK.

[75612.]—**Interest.**—This is very nearly at the money lender's easily-calculated rate—viz., 1s. in the pound per month. Let us work it at 5 per cent., then the interest on £150 for 15 months is £9 7s. 6d. Interest at the same rate upon repayment is £5, leaving a balance of £4 7s. 6d. But the amount repaid is £50 more than the amount borrowed; therefore, as £4 7s. 6d. is to £50, so is 5 per cent to the rate charged, the answer to which I make 57⅓ per cent. R. GILL.

[75612.]—**Interest.**—The rate of interest is as near as possible 45 per cent. per annum, and the quickest method of obtaining it is by trial. Suppose the £150 is borrowed on 1st January, then as he repays quarterly of debt alone £30, he owes on—

	Debt.	Repaid.	Interest at 45 per cent.
1st April....	£	£	£ s. d.
July	150	30	16 17 6
Oct.	120	30	13 10 0
Jan.	90	30	10 2 6
April....	60	30	6 15 0
	30	30	3 7 6
		150	50 12 6

On 1st April, then (a suitable day for such a foolish transaction), your friend will have repaid his loan of £150 with interest at 45 per cent. less 12s. 6d., in all, £200.

Plymouth. B.Sc.

[75612.]—**Interest.**—The question, as I read it, supposes that £30 plus the interest of the sum which remained in hand of the £150, after the last payment, makes up the £40 which is paid off at the end of each quarter. At the end of the first quarter, the interest is £10 on £150. During the first quarter, therefore, the rate of interest is about 27 per cent. per annum. At the end of the second quarter, £10 is the interest on £120, the rate per annum being then 33⅓ per cent. In a similar way, it can be shown that the rates of interest per cent. per annum during the third, fourth, and fifth quarters are 44½ on £90, 66⅔ on £60, and 133 on £30 respectively. It seems, however, not unnatural to work out the question in a different way. Suppose the money-lender not over-particular with regard to the exact payments of £30 on each occasion, so long as he receives £150, together with the interest, within 15 months. Now, let r denote the constant quarterly interest on £1. Then we may say that the whole amount of interest paid during these 15 months is—

$$(150 + 120 + 90 + 60 + 30)\,r,$$

and as this equals £50, it follows that $r = \frac{1}{9}$, and $4r = {\cdot}445$. Hence, on this assumption the annual rate of interest is 44½ per cent. But the above value of r makes the interest at the end of the first quarter greater than £10.

Charing. J. R. C.

[75614.]—**Electric Lighting.**—Procure a small drum, or Manchester-type dynamo, giving 3 or 4 ampères at 50 volts. Let it be furnished with a good heavy balance-wheel, to steady any irregularity in your engine. This will enable you to light direct off your engine three or four lamps of 48 volts 16c.p.—quite sufficient to light brilliantly your room. S. BOTTONE.

[75616.]—**Dynamo.**—Put 2lb. No. 22 on the armature, and 10lb. of the same gauge wire on the field. Connect up in shunt with the brushes. For full details as to method of fitting up and winding, I must refer you to my book, price 2s. 6d., "The Dynamo: How Made and How Used."

S. BOTTONE.

[75617.]—**Stannic Ware.**—This is probably tin ware; *Stannum* being the Latin name for tin.

ALLTFAB.

[75621.]—**Volcanoes on the Moon.**—It is most probable that the evidences of volcanic eruption which Herschal thought he saw going on in the moon were high mountains, which possess a greater reflective power than other portions of the lunar surface. The crater known as Aristarchus is an example of this property, and if "J. C. S." will examine the full moon with a telescope, he will find others for himself. ETA ARGUS.

[75622.]—**Hot-Water Boilers.**—The best and simplest form is a coil of wrought-iron steam-pipe. The proper size for the house would be made from four coils on a taper mandrel, 7½in. diam. at the top, and 9in. at the bottom. 1in. pipe will do; but 1¼in. would be better, and the fire-bars must be set 4in. below the bottom coil, and arranged to draw out so as to drop the clinkers and dust. The coils should be fully 1in. apart, and this would make the total depth from top of coil to fire-bars about 13in. The flue should leave horizontally on a level with the top coil. If a reserve of fuel is needed, the brickwork must be continued above the coil, and the opening must be gradually narrowed towards the top to prevent the coke sticking instead of falling down. If the water circulates into a large tank, this will do better than pipes, and the larger the tank the steadier the heat. If made to hold 150 gallons to 200 gallons, no night-firing will be necessary.

THOS. FLETCHER.

[75624.]—**Condy's Fluid Stain on Linen.**—The above can be removed by immersion in a moderately strong solution of oxalic acid, and thoroughly washing with water. VENDITOR.

[75625.]—**Winding for Manchester Dynamo.**—Put 3oz. No. 24 on the armature, and 2lb. No. 22 on the fields. Connect up in shunt.

S. BOTTONE.

[75627.]—**Magnetised Steel Wire.**—The two pieces would be precisely alike, each having its own N. and S. pole, and of the same power, if the steel were all of similar texture. S. BOTTONE.

[75627.]—**Magnetised Steel Wire.**—If this is broken into a hundred lengths, each of these will be a perfect magnet having a north and south pole. Why did you not try before writing?

THOS. FLETCHER.

[75628.]—**Arctic Moonlight.**—(1) Yes; it arises from a similar cause. (2) I don't really know what is the greatest length of time the moon could be below the horizon in latitude 70°, and I have not access to a globe just at present; but, by a rough calculation, I make out that it would be about five days. This would be when the moon's orbit was at its greatest inclination to the Equator. When its orbit was least inclined, the moon would not remain below the horizon much more than 22 hours together, even when at the extreme south of its orbit, as its rays would make a tangent with a point about 40′ north of 70° when it was on the meridian. It, would, therefore, appear (partly on account of refraction) more than a full diameter clear of the horizon. These values must be taken with some reservation, as I have not the proper data by me just now. H. WAKE.

[65629.]—**Battery for Small Motor.**—Chromic-acid battery, with a little chlorate of potash added. You cannot prevent the consumption of zinc. You can moderate it by keeping the zincs well amalgamated. S. BOTTONE.

[75630.]—**American Organ.**—It is not at all likely that "Organist" can improve his A. organ in the way suggested. He speaks of it as having "four sets of reeds and fourteen stops." It must be admitted that it has enough stops, even if "four sets" means four rows of 61 reeds in each row; but I suppose it is only a two-row board with four "sets" of reeds. "Organist" says "there are false stops in the organ." I should think so, and I admire the ingenuity of the builder who made fourteen stops out of four rows, assuming them to be rows; but if only sets (meaning half-rows), that builder must be a genius indeed. I wonder what our old friends Matthews and "Elève" would have thought of that? We know how to put seven stops on a harmonium with one row of reeds; but fourteen on two rows is a caution—to the buyer. The best advice I can give the querist is to sell the instrument as it is, and build another, for even if he could add the extra rows of reeds, he would find much trouble in arranging the action, and would no doubt have to enlarge the bellows, which would be rather difficult. In sending such queries it would always be as well to say how many reeds there are, as some confusion is apt to arise between "rows" and "sets." ORGANON.

[75630.]—**American Organ.**—If you are sure that the bellows is large enough to supply wind sufficient for four rows of reeds, the best plan would be to replace the one you have with an ordinary four-row cavity board. You can get one of these (with reeds) for 30s., voicing (not bending) 6s. per row extra. If you do not care to go to this trouble, state what room you have to spare at the back of the soundboard, and I will advise you. Another suggestion (and probably the best of all) is to sell the present instrument at a reasonable cost, and with a little extra outlay, to purchase an organ containing the required number of sets of reeds. This is the least trouble, and probably the most satisfactory way to go about it. A patched-up organ is seldom or ever of much account, and seldom proves satisfactory. Is the organ in quession a Karn organ? If so, do not interfere with it, or any other organ that is made by a good maker. It is a pity to spoil a Karn organ by such treatment, for I know that it is impossible to improve any organ made by a first-class maker by such means. Messrs. Willis and W. H. Duffield, of London, also Cass and Co., Boothstown, and J. Schofield, supply fittings that can be relied upon.

PRACTICAL ORGAN BUILDER.

[75634.]—**Dynamo.**—To MR. BOTTONE.—Your dynamo cores will do, though, as you say, they are rather light. You must have a laminated armature if for continuous running; not necessary if only hand-driven. As you speak of putting eight coils on your armature, I presume it is either a drum or a ring. Put 3lb. No. 14 on the armature, and 10lb. No. 16 on the fields. Connect up in shunt.

S. BOTTONE.

[75636.]—**Magnetic Insulation.**—Suspend either the magnet or the iron article inside an iron case. WALTER HERBERT.

[75636.]—**Magnetic Insulation.**—No; but a screen of soft iron placed between the two will, to a certain extent, shield the piece of iron or steel.

S. BOTTONE.

[75637.]—**Electrical Problem.**—The main point of the problem is to find the joint resistance of the 4 wire in multiple arc. Now, the conductivity of a wire is the reciprocal of its resistance, and the total conductivity of two or more wires in parallell equals the sum of the conductivity of each wire. Therefore, the conductivity of the four wires in parallel equals $\left(\frac{1}{27} + \frac{1}{49} + \frac{1}{53} + \frac{1}{75}\right)$ and the reciprocal of this equals the total resistance. Therefore, $R = \dfrac{1}{\frac{1}{27} + \frac{1}{49} + \frac{1}{53} + \frac{1}{75}}$ which expression, worked out, gives 11·15; that is, the joint resistance of the four wires is 11·15 ohms. Now to find the total current $= C = \frac{E}{R} = C = \frac{15}{11{\cdot}15 + 10}$, which gives $C = {\cdot}709$. The total current in the circuit is, therefore, ·709 ampère. Now, to find the current in each wire, as the current varies inversely as the resistance, the following proportion will hold:—

$$\begin{array}{ccc} 27,\ \&c. & : & 11{\cdot}15 \\ \left.\begin{array}{c}\text{As } r \text{ of any}\\ \text{one wire}\end{array}\right\} & \text{is to} & \left\{\begin{array}{c}\text{R of all the wires}\\ \text{in parallel}\end{array}\right\} \\ ::\quad {\cdot}709 & : & x \\ \text{so is}\left\{\begin{array}{c}\text{the total}\\ \text{current}\end{array}\right\} & \text{to the} & \left\{\begin{array}{c}\text{current in that}\\ \text{particular wire}\end{array}\right. \end{array}$$

This gives, calling the four wires A, B, C, D,

A	·293 ampères	=	41·3	Percentage of total current in each wire.
B	·161 ,,	=	22·7	
C	·149 ,,	=	21·0	
D	·106 ,,	=	15·0	
Total	·709 ampères		100·0	

We have thus found the total current in the circuit ·709 ampère, and the actual current carried by each wire, together with the proportion of the whole current taken by each wire. There is nothing really difficult in the question; it is a matter of careful arithmetic. Work out the problem, and check my figures. STUDENT.

[75638.]—**Path of Neptune.**—The *Durchmusterung* place of + 19° 716 is 4h. 16m. 28·5s. + 19° 42·6′. Bringing this up to 1892·0 by applying the precessions given in my letter, we have

4h. 18m. 35·0s. + 19° 47·7′. Of course these places are not absolutely accurate, as the precessions I gave were for the centre of the map, and the star in question is close to the edge. Not being able to find the star in any meridian catalogue, I wrote a month or two ago to Berlin for its place, and Prof. Auwers kindly sent me the following unpublished places for 1875·0: 4h. 17m. 38·70s. + 19° 45′ 59·0″. Reducing these to February 15th, 1892, we have for the place of D.M. + 19° 716 at that date, 4h. 18m. 35·20s. + 19° 47′ 30·0″. The place of Neptune from the *Nautical Almanac* for the same date is 4h. 18m. 39 89s. + 19° 48′ 4·6″. I think Mr. W. L. Walter will find that the distance of the star from Neptune is nearer 80″ than 30′. Seeing that there would be no very close appulse of the planet to the star, I merely gave the distance roughly. Of course the path of Neptune in my map is reduced to 1855·0. On the evening of October 28th, Neptune will make a very close approach to the 10th magnitude (D.M. 9 3 magnitude) star, D.M. + 20° 777. Prof. Auwers, however, writes to me that as it is 9·3 magnitude in the D.M., "it is not a star of the Catalogue programme, and does not occur in my zones." I have been unable to find it in any catalogue. [Errata.—Letter 32811, p. 176, for "plans" read "places"; for "near opposition" read "mean opposition."] H. Sadler.

[75644.]—**Moon from Equator.**—The moon will be longest above the horizon at the Equator when her motion in Right Ascension is most rapid—that is when she is at her greatest declination north or south, and is at the same time near perigee. Under these circumstances her daily motion in Right Ascension is about 1h. 10m. This makes the interval between consecutive transits about 25h. 14m.; the time that the moon's centre is above the horizon (neglecting refraction and parallax) is half this, or 12h. 37m. Taking refraction and parallax into account, this is reduced to about 12h. 34m. This, then, is the longest interval that the moon's centre can be above the horizon at the Equator; but the interval from the first appearance to the last disappearance of any portion of the disc would be about 2m. longer, or 12h. 36m.

Andrew C. D. Crommelin.

Montpelier House, Blackheath, Oct. 25.

[75646.]—**Surfacing for Wood Engravers' Blocks.**—If "Engraver" will coat his boxwood blocks with a thin wash of Chinese white, he will obtain a smooth, white surface, that lead pencil will work well on when perfectly dry; colours or tints can then be washed over the sketch, when required. Luke Sharpe.

[75647.]—**To Mr. Bottone.**—(1) Please refer me to the reply containing description of voltmeter, as I do not know which you mean, so cannot reply. (2) It is possible to measure the E.M.F. of an induction coil. A half-inch spark coil has an E.M.F. considerably exceeding 50,000 volts. (3) Because the tension is not sufficient. S. Bottone.

[75648.]—**Impure Food.**—Is it true that the Jews are exempt from cancer? The danger in pork meat lies, not in its being an impure food, but in the likelihood of the presence of trichinæ, cysticerci, or other minute parasitic insects in the flesh. Salted bacon is less liable to contain these than the fresh meat. Thorough cooking entirely eliminates this danger. S. Bottone.

[75648.]—**Impure Food.**—Bacon is often considered a dangerous food in tropical climates owing to the decaying and putrid matter on which pigs feed in hot climates. This is supposed to be the reason why Moses classed the flesh of the pig as unclean, and it should always be avoided in hot climates; but the prohibition is not necessary in cold and temperate countries, where decomposition is not the chronic state of most dead animal and vegetable matter. 999.

[75648.]—**Impure Food.**—You ask, "is bacon injurious?" I would say rather the reverse, if properly cooked. I would like much to hear of any authority for your statement that "Jews never suffer from cancer because they do not eat bacon." My own experience in the hospitals at Vienna is against this. They certainly enjoy immunity to a great extent from tuberculous disease, because of the great care taken by their authorities to reject all butcher meat having the slightest suspicion of disease, and also immunity to a great extent from syphilis, because of circumcision and their better moral behaviour.

Plymouth. B.Sc.

[75648.]—**Impure Food.**—"Kit" says: "It is said that Jews never suffer from cancer, because they do not eat bacon." The answer is that Jews, like other people, do suffer from cancer. I believe they rarely have cholera or typhoid fever, being very careful as to the "cleanliness" of their food and drink. Bacon is a salted and smoked meat, and is not to be commended as a select healthy article of diet; but it serves its purpose, and has done so for centuries, and I fancy will continue to do so. I should think there are many people in this country who suffer more from the want of good bacon than from consuming it. There are several articles commonly used as food which do not agree with some people; but all that can be said from the scientific point of view is that the simplest food is the best. People who "eat much bacon" are, as a rule, those who live in the country, and presumably work, and work hard, in the open air. They do not suffer specially from cancer.

Porcus.

[75649.]—**Bath.**—The hot water will not rise higher than the level of the supply cistern. Put the cylinder against the wall in your bath-room, and case it round with wood to keep the heat in.

999.

[75650.]—**Leclanche Battery.**—Procure as many 2lb. plum-jars as you want cells. Procure an equal number of porous cells of the same height, but only half the diameter. Place a lead-capped plate of carbon, with terminal, in each porous pot; fill in tight with a mixture of equal parts of crushed graphite and black oxide of manganese. Put a zinc rod (with terminals) in each outer jar; fill up to about three-fourths their capacity with a solution of 1 part salammoniac to 10 parts of water. Connect up in series—that is to say, the carbon of the first cell to the zinc of the next, and so on, leaving the first zinc and last carbon free for attachment to the outer circuit. For more detailed instructions in making Leclanchés, see my "Electric Bells, and all about Them." S. Bottone.

[75653.]—**Clockmaking.**—For pinion and arbor turning, &c., a pair of clockmaker's "turns," or a clockmaker's "dead-centre lathe," as some would call it, is the best. Such a tool is described at length in "Lathework for Amateurs," p. 537, Vol. LIII. No. 1377, and illustrated on p. 419 of same vol. (No. 1372). For turning with this tool, use ordinary gravers from $\frac{1}{16}$in. to $\frac{3}{16}$in. wide, according to work. For barrels and other similar work, an ordinary lathe is used. For very small clockwork, a lathe such as that illustrated on p. 513, Vol. LIII. (No. 1376), is very useful, but must be used carefully, and no heavy cuts attempted. For ordinary clockwork, a useful size of lathe is about as follows: Centres 3in. to 4in., bed, flat and wide, about 2ft. long, a good face-plate, a slide-rest with screws of fine pitch. Boley's clockmaker's lathes, fitted with step chucks and split-wire chucks, are very handy, and may be obtained anywhere in Clerkenwell. The centres of a clockmaker's lathe must be fine and reversible, either male or female, at will, though female centres are almost always used. F. J. G.

[75654.]—**Forming Accumulator Plates.**—To Mr. Bottone.—Yes, your six cells will charge them fully and well. Proceed precisely as described in my book. The size of cell does not influence the principle. S. Bottone.

[75656.]—**Five-candle Lamp.**—Leclanché cells not adapted. Two, or at most three, chromic-acid cells, with lifting arrangement to draw plates out of acid when not in use, will be much more satisfactory. S. Bottone.

[75658.]—**Bichord Piano.**—The causes may be three. (1) The sounding-board is split. Examine by taking out action and lower board; glue strip of parchment over crack. (2) The lower bridge is unglued from the sounding-board at some place, or the wire that jars does not rest firmly on the bridge. (3) One or more of the wires below the second bridge answer in pitch to the jarring string. Get someone to strike the offending note while you press your hand against the lower half of the strings till you come to the one that vibrates. Place some pieces of flannel in and out between that string and its neighbours (below the bridge). Some part of the frame may clatter, or something in the room.

S. Bottone.

[75659.]—**Plating Solution.**—It does not matter how good the solution may be, if the articles are not properly cleaned before plating, you will find the work strip under the scratch brush or burnisher. There is one other cause—that is, being deposited too fast, having too much free cyanide in solution, or using too high battery power or too large anode surface; yet another cause, that is not being properly rinsed after cleansing in potash solution. Is the rinsing water after the potash dip clean and free from potash? Do you use a cyanide dip previous to placing the work in the plating bath? What metal is the work you are trying to plate? I have not seen this "gold cyanide," although I have heard of it before. We use the best black cyanide 98 per-cent. for all plating work, gold, silver, copper, brass, &c., and are well pleased with it. The price is no higher than that you mention. S. Robert Bonney, Electroplater, &c.

[75664.]—**Model Electric Motor.**—Please let me know the number of the reply to which you refer. I can then advise you. Or look in my book, "Electro-Motor: How Made and How Used," which gives descriptions of most forms.

S. Bottone.

[75665.]—**Skin Eruptions.**—I suspect that the friend of "Subscriber from the First Number" has not acted out my instructions. Let him read again my reply on page 44 of No. 1380. What is there stated I am prepared to stand by. The "thick" he mentions is the magnesia. This should be shaken up and taken with the salts; otherwise I have no doubt it will act as he states. Let him also read my reply on page 116 of No. 1383. I have just lately taken several doses of it, and have not had the slightest unpleasant disturbances. This medicine has been of so much benefit to me and others that I recommended it to, that I wished it to be known of far and wide, and after about 2[illegible] years' knowledge of it and its effects, I can speak of it as a splendid medicine for the blood.

Mallett.

[75665.]—**Skin Eruptions.**—Dr. Hughes, of Brighton, joint author of the "Cyclopædia of Drug Pathogenesy," in his "Pharmacodynamics," or *materia medica*, 1875, gives a short article on magnesia carbonate—i.e., "Magnesia, in its simple or carbonated form, is known (in the drug books) only as an anti-acid and mild laxative. Trousseau and Pidoux point out that the evacuations produced by it are *at first* simple liquid stools; but the continued action and use set up inflammation of the mucous intestinal membrane (i.e., the bowels or intestines), &c." If the "Subscriber" has a wife or heirs, then, provided they can but induce him to be a bit persevering in the use of his inestimable (for them) prescription, they may venture upon insuring his life in a number of offices, and for a good round sum, with a certainty of a handsome return for their money and their risk.

The Lydney Dispenser.

[75666.]—**Verbascum—The Great Mullein.**—"Who would believe that the medical school, as it has hitherto existed, in the place of earnestly endeavouring to ascertain experimentally what genuine peculiar dynamic powers this plant manifests on the health of human beings, was content to ascribe to it conjecturally (and falsely) a demulcent, resolvent, and laxative power, from the sickly odour of its flowers when crushed by the fingers, and from the slimy character of its juice, and to employ it blindly, in combination with other drugs whose medicinal qualities were equally unknown, for such conjectural objects, in the form of gargles, poultices, and clysters? The following pure symptoms and morbid states which have been produced by this plant on healthy persons will show how much mistaken the medical world was (and is) in its frivolous conjecture; and, on the other hand, for what true curative objects it may be employed with certain and sure effect in natural morbid states corresponding in similarity to the characteristic symptoms produced by it." Thus says Hahnemann, on Verbascum, in the concluding article of his immortal *Materia Medica Pura*, of about 18[illegible], translated by Dr. Dudgeon, and issued by the Hahnemann Publishing Society, 117, Grove-street, Liverpool, in 1881. Frequent extracts from this grand two-volume work *in re* one or other of its medicaments; also *in re* those other drugs in his five-volume "Chronic Diseases," and classed as Antipsorics, would be sent for insertion in "Ours" now and then, provided Mr. Editor desires such, as to which his inclination may possibly be influenced by the views of those readers who may express to him their wishes, the waste-paper basket being a holocaust much respected by

The Lydney Dispenser.

[75666.]—**Mullein.**—Verbascum is not akin to Hyoscyamus. It was formerly much used as a demulent in coughs. In Italy it is still extensively used as a tea. The bright yellow flowers are gathered, dried, and infused in boiling water, and make a very agreeable and palatable substitute for tea. As to any active properties, it has none. speak from ten years' experience of its daily use.

S. Bottone.

[75669.]—**Snakes.**—Prof. Krefft wrote a valuable book at Sydney fifteen years ago. The British Museum Library may have it; or write Agent General New South Wales, Victoria-street, for news about it. Colonist.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75140. Iron for Casting, p. 581.
75142. Working Model Figures, 581.
75146. Small Sucker, 581.
75151. Brass and Nickel Casting, 582.
75153. Steel Castings, 582.
75157. Textbooks in Mechanics, 582.
75161. Photographic, 582.

75316. S.E.R. Loco. "Onward," p. 97.
75332. Dyeing Glass, 98.
75335. Polishing Bosses of Wood Rollers, 98.
75336. Engine, 98.
75346. Engine for Lift, 98.
75347. Patent Resonating Gongs, 98.

QUERIES.

[75673.]—**Broken Electric Wire.**—Can any reader tell me how to calculate the distance at which broken part of an electric wire is to be found?—W. H. R.

[75674.]—**Gas Engine.**—Can anybody tell me whether there is any objection to the use of platinum as a material for the ignition tubes of gas-engines? Platinum can get white hot without melting, and the heat required to make it white hot is not beyond that which is generally used in the ignition chimneys of modern gas-engines having tube ignition. Platinum is of course an expensive metal, but the cost of a platinum ignition tube must, in the course of time, be exceeded by temporary ignition tubes which require replacing about every two days, whereas a platinum tube would never want replacing, and so would save trouble and expense.—R. L. M.

[75675.]—**Phonograph.**—Would Mr. Gillet kindly inform me if the cutting edge of the recording stylus is straight across or curved with the same radius as the bulb-shaped end of reproducing stylus, so as to make the bottom of the groove in the wax hollow, that the latter stylus may have a better bearing therein? Also, how many soft iron rings is the armature supposed to consist?—in other words, what thickness is each ring? Can the phonograph be made to record and reproduce even in a rough way, without the aid of a motor, by turning it with the hand? as I wish to exhibit it at Christmas to some friends, but will not be able to complete the motor by that time.—Leinster.

[75676.]—**Legal (United States).**—Wills and Probate.—A. dies in America, leaving money amounting to about 800 dollars, after paying all debts and expenses to B. in England, and, in the event of B. being dead, to A.'s children and widow. B. only survives A. by three days, and, according to the will, the widow and children are entitled to the money in equal shares. The trustee under the will gives very vague information, and the family are anxious to have some definite knowledge, as it is now 14 months since the death of A. Will some reader who knows the way kindly reply as to how to proceed to get a copy of the will and statement of affairs? I may say that A. was a naturalised American, and lived and died in Illinois, U.S.A.—Legatee.

[75677.]—**Jupiter's Satellites for Verifying Chronometer.**—Perhaps "F.R.A.S." would inform me what power would be necessary with a 2in. o.g to observe Jupiter's satellites for the purpose of verifying a chronometer at sea? Whether an occultation or a transit of a satellite, or its shadow, would be the best to observe, and if, with such an instrument, I might expect to get the time to half a minute?—Shipmaster.

[75678.]—**Pocket Aneroid.**—I have a pocket aneroid which has become somewhat sluggish in its movements, its indications being generally behind those of a larger instrument in my possession. Is it necessary that the working parts should be oiled from time to time? Would it be practicable to alter the lever arrangement so as to diminish the range, and render changes of altitude or pressure more apparent?—Shipmaster.

[75679.]—**Canoe Building.**—Would any reader help by giving desired information regarding planning? Or is there a cheap book in the market that would give me such? I want a good sea-going canoe, one that would carry a small lug-sail.—McDuff.

[75680.]—**Falling Bodies.**—Can any of our readers give the formulae for a falling body, where the force of gravity (g) is itself increased at a constant rate, as, for example, from moon's orbit to earth? This can be got by $P\sqrt{\frac{1}{32}}$; but formulae independent of the period are desired, such as—

$$t = \sqrt{\frac{2h \times k}{g_0}} \ldots\ldots (g_0 = \frac{32 \cdot 17}{60^2} \text{ in this case})$$

Where k is some constant, and g_0 represents the minimum value of g at starting point.—W. S.

[75681.]—"**Faust.**"—Would some reader who is familiar with "Faust" kindly say where I can find the following lines:—

> "See all things with each other blending,
> Each on each in turn depending," &c.

From Anstie's Translation of "Faust."—W. F. Harold, Warminster.

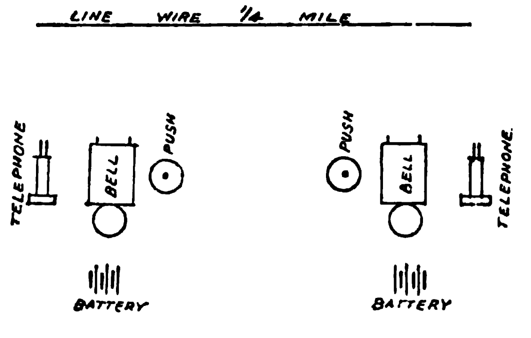
[75682.]—**Illuminated Fountain.**—Will some one kindly inform me how to make one suitable for shop window as Christmas attraction? I think they were used at the Paris Exhibition, and consist of an electric lamp with mirror and coloured glass so as to make the water form spray of different colours.—Old Subscriber.

[75683.]—**Astronomical Driving Clock.**—Would it be troubling "F.R.A.S." or some other astronomical reader to give a rough sketch or description of a continuous motion pendulum and escapement for the above, as I am unable to obtain access to any good library?—Regulus.

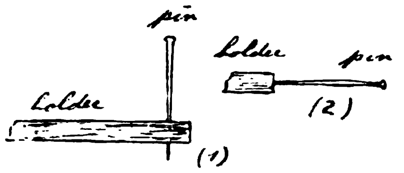
[75684.]—**Dynamo.**—To Mr. Bottone.—I have a set of castings, exactly like the motor described by you in "E.M.," March 15, 1889. They are the same size, excepting the cores, which are ¾in. thick. What weight of wire and gauge must I wind on field-magnets and armature to get the best possible result as a dynamo, shunt-wound, for lighting a small incandescent lamp or two? Should the punchings extend the whole length of the armature tunnel, or within a ¼in. off each end? Will the punchings go on a 3-16in. spindle, or what size is the hole in them?—Anxious.

[75685.]—**Limelight.**—Will Mr. Bottone, or any other fellow-reader, kindly put me right? I want to make my own oxygen gas. I have retort, gas-bag, and purifier, but do not know the ingredients and quantities to make 10ft. of gas (bag holds 10ft.)—Fifteen Years' Subscriber.

[75686.]—**Bell and Telephone Connections.**—Will some reader oblige me by giving me the proper method of connecting two bells and two telephones as per sketch? A, push to ring bell at B, and B, push to ring bell at A, with switch to put telephones in connection after call has been rung and answered; the whole to be worked by single-line wire and earth return.—R. R. B.



[75687.]—**Casting in Lead.**—To "Practical Caster."—I am much obliged to you for your reply to my query on the above, and should be glad if you will kindly answer the following:—1. What kind of paper would be the best to make the tubes of; and about what diameter should they be? 2. Should the pin be inserted in the holder, as shown in sketch (1), or project straight out in a line with the holder (2)? 3. What would be the best way of running the liquid into the mould? 4. Should 3in. hole be square or round?—Loco. No. 2.



[75688.]—**Colds.**—For the last two or three winters I have been troubled with cough and cold nearly the whole of the winter, generally attended with rather severe sore throat. Will any of our medical friends be kind enough to give me a good recipe for above? Only these qualified please reply.—Electric.

[75689.]—**Accumulators.**—I am thinking of making a set of about 8 or 10 accumulators, plates 4½in. by 6in., 3 negative and 2 positive plates in each cell. Will Mr. Bottone kindly say if I can charge these off a series dynamo giving about 55 volts and 12 ampères? Also, about what ampère hours I may expect from them. Also, will he say if he thinks the above size good, or what size would he suggest? Any suggestions would be thankfully received.—Electric.

[75690.]—**Indicators.**—Will Mr. Bottone kindly give me sketch of connections for a 6-hole indicator with electrical replacement? And oblige—C. W.

[75691.]—**Electrical.**—I am told there is a method of placing a cut-out to each accumulator in such a manner that, should a cell short-circuit, the fuse melts, and the cell is automatically cut out. Will someone explain, with diagram, how this is achieved, as I am sure it would be of great service to many besides—H. C. Braun.

[75692.]—**Artificial Stone.**—Would felspar rock make a good artificial stone? and if ground into an impalpable dust would it cement together with water only? And would it be necessary to dry it under a current of hot air—if so, what temperature? The felspar stone is of a whitish-grey colour, very like a limestone, hard and tough, scratches glass deeply. There are also veins of a pink colour. What would be about the cost per ton of breaking, grinding, and pulverising, without taking into account the motive power? When finely ground would it be of any, and what, value as a manure? I have observed the grass grows very luxuriant in the bottom of the old quarry. Any further information on the subject will greatly oblige.—Mitchell.

[75693.]—**Dynamo Casting.**—To Mr. Bottone.—Please tell me with what wire to wind one of your small dynamos, so as to light two 4-volt lamps?—T. F. B.

[75694.]—**Logarithms.**—In the examination for Associate of the Society of Actuaries, October, 1889, the second question in the first paper on arithmetic and algebra was as follows:—"Within what limits are the approximations obtained by the use of a table of proportional parts in a book of logarithms accurate?" I should be much obliged by the proper answer to this question; or by a reference to a textbook in which the information is given.—S.

[75695.]—**Sediment in Nickel-Plating Bath.**—What is the cause of the reddish-brown precipitate which I find in my nickel-bath after using? Does it show that the bath is out of order or not, and how must I get rid of it? I added some borax to a part of the bath, and found the same sediment after standing. Should the bath be decidedly alkaline, or should I just dissolve the crystals of the double sulphate in water, and use?—Ulpha.

[75696.]—**A Stopping for Electro-Silvering.**—I want to electroplate some articles with silver. Certain parts of the articles I wish to keep clear of silver. What must I use to prevent the silver taking on those parts? I have tried shellac-varnish, and find that the bath dissolves it off.—Ulpha.

[75697.]—**Heating Workshop.**—Can any reader of "Ours" give me a hint as to the best means of heating a large workshop, 78ft. by 34ft., walls 10ft. high, and roof rising about 18ft. in the middle—about 52,000c.ft.? About two-thirds of the roof are sky-light, and all outside walls. Have no steam boiler, so cannot use hot-water. Would a coke-stove in the middle of each half be sufficient? If so, what size stoves should I want, and what is the best make? I should like a stove in which, by filling up with coke and checking the draught, a fire could be kept all night without attention. I should want a temperature of about 60°. Perhaps Mr. Fletcher could tell me if gas-stoves would do, and what consumption of gas would be required.—Thermo.

[75698.]—**Poster Writing.**—Would any reader inform me of the best means of learning poster writing, kind of brushes used, inks, &c.—Geo. Ward.

[75699.]—"**Berliner**" **and** "**Fiddler**" **Violins.**—In Vol. XXXII. of "Ours" there was some correspondence respecting the above. I should be very much obliged if any one would kindly inform me if either of these was a success, and give any details as to the latest form of each instrument. Perhaps "Fiddler" or Mr. Berliner would oblige.—Fiddlestring.

[75700.]—**Hardening Potatoes.**—Is there any way of hardening potatoes like bone, so that they may be turned in a lathe?—G. W. G.

[75701.]—**Steel Polishing.**—Would any of "ours" give me some information about steel polishing, what bobs, mops, and powder, &c., to use?—H. Randall.

[75702.]—**To "Organon."**—It is proposed to add a second manual, with separate wind-chest connected to the present one, to an American organ containing eight sets of reeds. Would the addition of this second manual render the reeds slow of speech? The object of this addition is to be able to get a very soft accompaniment, as the second manual will be inclosed in a swell-box.—R. M.

[75703.]—**Enamel.**—How are bedsteads enamelled by stoving process? Give heat and time required; also say how the enamel is made, and what from.—Enamel.

[75704.]—**Balloon.**—I want to make a small balloon to carry a wire to a height of about a mile. Total weight of wire and hemp cord for securing balloon would probably be 30lb. to 40lb. Should be glad of information as to necessary size of balloon, what silk and net I should use, any hints as to making, or name of a book giving the information I require.—Meteorologist.

[75705.]—**Reed Voicing.**—1. Will "Practical Organ Builder" be kind enough to explain how reeds are properly voiced, and what methods are used besides bending and tuning? 2. Also, what is the smallest space required for an octave-coupler? 3. How are cavity-boards made; how much cubic space should be allowed in each tube? 4. Are mutes usually made of wood or brass? A letter on the interior of the American organ would be highly appreciated by many readers of the "E.M." if "P. O. B." could oblige.—Reeds.

[75706.]—**Thermopile.**—To Mr. Bottone.—With reference to the form of thermopile given at p. 140 of your book on "Electrical-Instrument Making," &c., will you kindly state what would be about the voltage, resistance, and current given (on the short circuit) by 12 pairs in series, each pair being 1ft. long, and made of No. 8 German-silver and copper wires, the one set of points being heated almost to redness, and the other set kept cool by cold water continually dropping on them?—Thermo.

[75707.]—**Organ.**—I am building a two-manual organ. I wish to know the dimensions and positions of keys and pedals as recommended by the College of Organists?—Diapason.

[75708.]—**Magnetic Iron Ore.**—Is this of any value other than for the manufacture of iron? The particular ore I refer to is being obtained as a sand, which will pass through a 30-mesh screen, and contains only 5 per cent. of silica. I remember reading of its being used under the name of "polarite" as a fitering medium, and selling at £6 per ton. Can anyone give me any information as to this? Will a metallurgist also tell me what flux would be needed to smelt this ore—which contains nearly 70 per cent. of metallic iron—into pig iron?—Magnetite.

[75709.]—**Gas-Making Machine.**—Will Mr. Fletcher, or some other able reader, kindly explain the working of the "Sun Auto-Pneumatic," "Helios," or any other make of gas-making machine? I am sure some readers, like myself, living in the country and away from the town gas supply, would be pleased to have instructions, so as to be able to construct a small machine, say, about six lights. I am aware that Argand burners are used for gasoline. How is the blower arranged to force air through the gasoline; and is there a valve between the gasoline tank and the governor or regulator before the gas is taken to the burners? To be driven by pulleys and weight. A rough sketch of the working parts, size of blower, reservoir, pipe leading from machine, &c., would greatly oblige.—Bruce.

[75710.]—**Preserving Oak Posts.**—Will some of your readers kindly inform me of a good composition for coating oak gate-posts to be fixed in a damp clay soil? Paint is expensive, and I have been advised not to use gas-tar. What is Stockholm tar?—W. W. H.

[75711.]—**Eucalyptus Oil.**—Will anyone kindly inform me how I can make this oil mixable with water for use in a bath? Also what is the preparation known as "soluble fir-tree oil," which forms a milky emulsion with water?—X. Y. Z.

[75712.]—**Electric Bath.**—Which is the best and cheapest way to apply an electric bath to a varicose vein in the calf of the leg?—TRITON.

[75713.]—**Astro-Photography.**—Would "F.R.A.S." or some other competent person give me the following information: (1) What kind of dry-plates are best adapted for lunar negatives? (2) What kind of developer gives the best results for this class of work?—SLADE, Hull.

[75714.]—**Dynamo Brushes.**—Would not platinum or aluminium be excellent for this purpose, or would the expense of them preclude their use?—BRUSH.

[75715.]—**To Mr. Bottone.**—I wish to light three rooms in my house with electrical lamps, if it can be done without using accumulators. Please advise me how to do it efficiently with a small gas-engine of ½H.P. nominal; the light must be regular and steady, or it would be no use, and I would rather not do it at all than have the expense and trouble of accumulators.—X. Y. Z.

[75716.]—**Restoring Faded Silver Prints.**—Will some photographic reader kindly inform me if it is possible to restore an old 1846 silver print, that has very much faded, sufficiently to enable me to take a negative copy? Also please fully describe process.—LUKE SHARPE.

[75717.]—**Galvanometer Mirror Scale.**—I have fitted an astatic galvanometer with a mirror made of a microscope cover-glass silvered. On arranging the usual slit and lamp at about 3ft. from the mirror, I cannot get a proper image of the slit: it is much too large, and blurred except at about 6ft. from the mirror. I have a lens of about 4ft. focus in front of the slit, and have tried a wire across the slit and lens, and also using a hole instead of a slit. It seems to me that the mirror is of very short focus. How can I get it to work without changing the mirror?—STUDENT.

[75718.]—**Adjustable Resistance.**—Can anyone inform me of a simple and easily constructed form of the above, with a fairly wide range, other than the ordinary methods of plugs and movable switch-arm bringing in coils of wire?—STUDENT.

[75719.]—**Gilding.**—How can I gild 9c. bright gold articles to give them the dead appearance of coloured gold, and if brass or steel scratch-brush is used?—RESISTANCE BOARD.

[75720.]—**Lifting Power of Air Propeller.**—Can you tell me if there is any rule or formula for calculating the lifting power of an air-propeller (ordinary screw-form, only run vertically)? I have looked through several engineering books, but cannot find anything to help me. If there is any book that would have it in I should be glad to know the title.—J. E. D. IMRIE.

[75721.] — **Red Spot on Jupiter, &c.** — Can "F.R.A.S.," or someone else who knows, tell me if the Red Spot on Jupiter is still visible in a 6in. reflector, and if so, at what times it will be best situated for observation? Also, if a "reticulated micrometer" is of any use for measurements of double stars, &c.—ETA ARGUS.

[75722.]—**To Mr. Bottone.**—Will you kindly inform me of the connections of Siemens's armature with two or more layers? And what is the difference of connecting in series and parallel?—A NEW SUBSCRIBER.

[75723.]—**Electrical Indicator for Induction Coil.**—Would any reader kindly tell me the way to make and join up an electrical indicator for an induction coil wound with ¼lb. of secondary wire No. 36 s.c.?—W. ROBSON.

[75724.]—**Arc of Contact.**—Can anyone give me a formula for finding the arc of contact of a belt on pulleys of any size at any distance apart?—CHARLES.

[75725.]—**Horse-Power.**—What actual indicated horse-power is required to work a cutting and punching press for ⅜in. boiler plate and a smithy fan 18in. diam. (3,000 rev.)?—CHARLES.

[75726.]—**Double Bass.**—To MR. PICKERING OR OTHERS.—Can you give me the dimensions, &c., of a double bass, and the best method of procuring materials to make same? I am by trade a—CABINETMAKER.

MR. W. WRAY, of North-hill, Highgate, has just issued a new price list of his "Photo. Lenses," which contains some information besides that will be useful to purchasers and users of lenses for photographic work.

DR. J. FRANK reports to the Chicago Medical Society the case of a man who sheds his skin annually. He is taken with feverish tremors, turns red, and then, after a period of twelve hours, peels. Finger and toe-nails follow. The new skin is as pink and soft as a baby's, and at first very sensitive. Practically, he blisters all over.

The Inhabitants of Siberia.—A St. Petersburg journal recently gave some interesting statistics respecting Siberia, where terrible suffering is at present being experienced in certain districts. The Government of Irkutsk, the capital of Siberia, which is divided into five districts, contains only 868,552 persons, of whom three-fourths are of the Orthodox religion. There are 487 schools of different kinds in Irkutsk, where Christian children are taught alongside of Pagans, Mohammedans, Buddhists, and the worshippers of stones and talismans. There are in this extensive region 60,000 of these latter worshippers, 12,000 Buddhists, 6,000 Jews, and 2,500 Mohammedans. In the Transbaïkal, where the political convicts are chiefly to be found, there are 110,000 women who do not belong to the Orthodox religion, and there are thirteen schools, the teachers of which are exiles or deported criminals.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, October 28, and unacknowledged elsewhere:—

ENQUIRER.—Medical Battery Co.—T. A. Mulcahy.—T. C. Smith, Brighton.—J. C.—Iona.—Electra.—J. C. M.—A. B. C. D.—Bent.—Early Riser.—Sm.—W. D. G.—A. W. G.—Inventor.—Would be Plater.—Chemical Student.—H. H. Headworth.—Boiler.—Autolycus.—J. A. Wilson.—Albert E. Bennet.—Grosby.—F. H. Wenham.—J. H. Pledge.—Organist.—A. S. F.—E. M. Richards.—W. Hosken.—T. Moore.

GEO. RILEY. (If, as you say, your invention is different to an existing patent though intended for the same object, it can become the subject of a valid patent, and certainly the Office will not refuse to grant protection. It would be specially advisable to consult a patent-agent in such a case, as more than usual would depend on the wording of the specification.)—CARPENTER. (You do not say what the pictures are made of. Are they lithos, chromos, steel engravings, or water colours? The white edge can be bleached by the careful use of a solution of chloride of lime; but every trace of it must be removed subsequently by washing with water that has been boiled, or with rain-water.)—R. P. (Iron filings or borings would, no doubt, extract, to an extent, other metals from water filtered through them; but not to such an extent as to render it potable. 2. By aërating water do you mean charging it with carbonic acid? If so, it must be forced in. Water is aërated in the simplest way by means of a garden syringe, the water taking up air as it leaves the rose of the syringe, and falls in fine streams into the tank.)—ANXIOUS READER. (A similar question answered recently. The steam meeting the water is condensed, and acquires so much momentum that it is able to force the water into the boiler. The subject is not one that can be explained in a short answer; but details are given in all the textbooks of the steam-engine, and in several of the back volumes.)—J. BOND. (Iron and steel must be coppered or covered with some other metal before they can be "electro-plated" in a satisfactory manner. But with what metal do you wish to "electro-plate" them?)—W. M. (Yes, such a motor would most likely do, unless the dentists' drill is very hard-running. 2. We do not know anything of the lamps referred to. Please see "Hints" above.)—S. N. D. (Similar queries have been answered many times. Please see indices of back volumes, or one of the manuals describing the dynamo.)—J. ASTOR. (We think Messrs. Lancaster and Son, Colmore-row, Birmingham, supply printed instructions as well as the materials for making such telescopes. 2. We do not think it can be done. Have you seen any ferrotypes of the kind?)—E. CULLINGTON. (We do not know of any such book, and think it extremely unlikely that such information would be published in book form. You may find much information of the kind in back volumes; but a training in the shop is required.)—WILLIAM TAYLOR. (You were, we think, answered recently. See pages 477, 501, 549, Vol. XXXIX. "A. S. L." described a method of cutting perforated strips in the No. for Feb. 1, 1884.)—CHEMIST. (We answered you to another signature a few weeks ago. Many of the principal publishers have textbooks adapted to the wants of students attempting to pass the examinations of the Science and Art Department.)—IGNORAMUS. (You can obtain full particulars by addressing a letter to the Registrar of London University, Burlington-house, W., and much useful information in the way of hints in the back volumes.)—MECHANIC. (Procure the lists issued by publishers—say Longmans, Crosby Lockwood and Son, Macmillan, W. Collins and Son, and others. Most booksellers have the textbooks in stock.)—J. B. H. (See previous answer, and read up the lessons on "Botany" recently given, and those on "Geology" now running through our pages.)—FRANK GAY. (We do not know of any useful work on coopering—that is, a work useful to a man who has served his time at the trade. There is a handbook giving some description of the work; but it is useless to a craftsman. Send any definite query you wish to put, and probably you will get a satisfactory answer.)—ALPHA. (No one can reproduce your book without rendering himself liable in damages; but it is usual to register at Stationers' Hall, which is taken as evidence of copyright. The fee is 5s., and a copy of the book must be left with it.)—L. D. S. (Better procure the Syllabus, and then get a list from J. and A. Churchill, New Burlington-street, W., and the lists of books published by Longmans, Macmillans, Spons, and other large firms.)—J. EVANS. (The numbers containing the articles on "Model Locomotive Making" can still be had post free for 5s. 5d. direct from this office. The articles were commenced in Vol. LI.)—KENT. (A solution is sold at the rubber-shops and by most leather dealers which will repair your waterproof if it is what is known as a mackintosh.) A CONSTANT READER. (If you mean caoutchouc, or indiarubber, see previous answer.)—INVENTOR. (For what purpose do you want a fading ink?)—LIMERICK. (Never heard of it. Please see Hints above. Is it possible you mean soldering fluid?)—G. W. JONES. (Perhaps the following list may suit you:—"The Gas-Engine," by Dugald Clerk, Longmans; "Gas Engines," by W. Macgregor, Symons and Co.; "Gas and Petroleum Engines," by W. Robinson, E. and F. N. Spon. See also the indices of back volumes, as you will find in many articles and letters information that is not to be found in books.)—T. J. (There is a work by Carl Hofmann entitled "Paper Manufacture in all its Branches," published by E. and F. N. Spon, Strand, W.C., which may suit. The price is, however, three guineas and a half. Possibly it is in the free library at Liverpool.)—STEPHEN. (It must be scraped off, as burning is risky in such a place. It can be softened by covering it first with some paste of caustic potash.)—ENGLISH MECHANIC. (Alumina is the basis of all the varieties of clay. Any of our advertisers who deal in such things can answer your question about precipitated alumina.)—J. JOHNSON. (Now that you forward a specimen we can tell you at once that the "horny" substance is xylonite, known formerly as Parkesine, and a forerunner of the white coloured imitation of ivory, known as celluloid. Put a strip of it in a flame, and note how readily it burns. It is prepared from starch or cellulose, treated with nitric and sulphuric acids. The Xylonite Company, Homerton, London, E., can supply particulars.)—G. Q. VERE. (You had better procure the "Directory" and some of the other publications of the Science and Art Department, from the Secretary, South Kensington. It is not necessary to attend classes.)—BOOTMAKER. (You can find them in most textbooks of anatomy. There is a special work on "The Foot," published by Bailliere.)—KEYS. (If the ivory is thick, the keys may be scraped and repolished; but the only thing to restore colour is what may be done by the action of sunlight exposing the keyboard to full light with glass intervening.)—VENDITOR. The numbers are out of print; but you could probably see the volumes at the British Museum library. We presume you mean Vol. XX.)—F. H. WHITE. (We quite agree with you; but after all, it is no business of ours to determine how many stamps an advertiser shall ask for his trade list. They advertise under a fresh name nearly every week, and in our opinion are a queer lot.)—T. BATTY. (Prof. Barrett's letter shall appear next week.)—J. R. (The personal discussion between "F.R.A.S." and Dr. Common must end with their communications in this number. We want no more fingers in a pie which is not at all to our own taste, or to that of ninety-nine readers out of a hundred. We wish correspondents would bear in mind that these petty personal matters are caviare to the general reader.)—MAGIC SQUARES. (Several letters on this subject are unavoidably crowded out.)

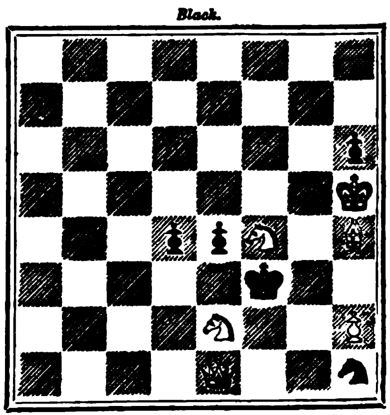
Brain and Nerve Exhaustion.—Electricity is the only safe and certain remedy. E. Arthur Silby, Esq., Barrister-at-Law, M.A., LL.M. (Cantab.), writing from Haywardsfield, Stonehouse, Gloucestershire, says:—"I must testify to the wonderful effect of Mr. Harness' Electropathic Belt treatment. My vital energy was so low that I was quite incapacitated for work of any kind. I have now regained all the vigour, both of body and of mind, and am completely restored to health." Thousands of other similar testimonials have been received. Copies may be had on application to Mr. C. B. Harness, the Electropathic and Zander Institute, 52, Oxford-street, London, W. Pamphlet and Consultation free, either personally or by letter.

CHESS.

All communications for this column to be sent to the CHESS EDITOR, at the office, 332, Strand.

PROBLEM MCCLXXVIII.—By T. H. BILLINGTON.

Black.



White. [6 + 5

White to play and mate in two moves.

SOLUTION TO 1276.

White.	*Black.*
1. Q-Kt 8.	1. Any.
2. Mates.	

(This problem can also be solved by 1. R to K 8.)

NOTICES TO CORRESPONDENTS.

CORRECT solutions to 1276 by G. Collins, W. T. Hurley (second solution), James Kistruck, H. N. Fellows, A. Fellows, R. W. Houghton (second solution); to 1275 by G. Collins, W. T. Hurley (three duals), R. W. Houghton (four duals); to 1274 by T. H. Billington (dual), W. L. Martin (two duals).

G. COLLINS.—We know of no such rule. Besides, a pawn is not a piece.

E. B. SCHWANN.—Problem received with thanks.

W. T. HURLEY.—Your problem shall be duly examined.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, NOVEMBER 6, 1891.

SOME REMARKS ON AËRO-DYNAMICS.

By F. H. Wenham.

I HAVE received an elaborate article, consisting of 115 pages, by Prof. Langley, under the title of "Experiments in Aërodynamics," published by the Smithsonian Institution in Aug. 1891, No. 801. Some years ago I gave much attention to this subject, and have, therefore, repeatedly perused this memoir, which must constitute a standard basis for all future work and construction in the direction of aërial flight, as it is a record of accurate experiments conducted regardless of expense on a considerable scale, with planes or surfaces impelled through the air at various angles and different speeds up to 100 miles per hour. The results are beyond the reach of adverse criticism, as they speak for themselves, and Prof. Langley is careful not to theorise on his own judgment, and though the experiments afford encouragement for the possible attainment of a successful mode of aërial transit, the author does not presume to describe any untried form of machine for this purpose merely imagined by himself. Nevertheless, the essay appears as the dawn of a new era, and anyone occupying himself with the problem of flight for man, based upon the facts described, can no longer be subject to ridicule or the "Impossible!"—always the ready remark from those who know nothing about the matter: but an inventor, on the strength of these facts, may confidently say, "I am working to design a machine on laws proved to be perfectly correct and rational. The difficulties to be overcome, though apparently insuperable, are entirely items of practicable construction."

During the last twenty-five years considerable attention has been directed to the subject of flying machines and the flight of birds, the cause of which has been attributed to all manner of fantastic actions and wing-movements, such as air passing through the interstices of the feathers in the up stroke of the wing, which are supposed to close like a valve in the down stroke.

It has also been suggested that the wing describes a figure of eight as a necessary condition of flight, or that flying is to be accomplished by loose undulating surfaces. All such suggestions are baseless. To attempt to imitate the construction of a bird's wing and the animal mechanism that actuates it is an irrational, if not an impossible task; yet, curiously, one of the first adaptations to a steam locomotive was an imitation of the reciprocating action of a horse's legs for propelling the machine; ideas had not then advanced beyond this stage.

There has been a mass of mathematical symbols, carried on without invention and ending with no interpretation, intended to elucidate and analyse the principles of flight, but having no reference to any practical facts that would, if left alone, be apparent to the eye of a mechanic: these symbols have only served to disguise and confuse the subject. Prof. Langley has avoided this too-frequent egotism of mere schoolmen by discarding mathematical deduction, using symbols extraneously, only to connect the results of his experiments, so that his work and description is perfectly plain and comprehensible. He remarks that "Mathematics, applied to physics, must always be trustworthy, or untrustworthy, according to the truth of the data which are employed. The most complete presentation of symbols and processes will only serve the consequences of error hidden in the original premises—if such there be."

As an instance of how the error of a mathematical deduction has been handed down for generations, is the statement that if a ball be shot from a cannon horizontally at any given height above the ground, and if a ball be dropped vertically at the same instant with the discharge, the two balls will reach the ground at the same time. Prof. Langley has demonstrated that there is no reality in this hypothesis, and shown, by actual experiment, the fact that air strongly resists the sudden impact of a heavy body, when moving horizontally at a high velocity, which consequently settles down slowly, as if the air were a highly viscous medium, and that with sufficient horizontal velocity the time of fall may be prolonged to any assigned extent, and that for an infinite velocity of translation, the time of fall may be infinite, or, in other words, the air will act as a solid support, just as water will continue to uphold a heavy body projected over its surface, so long as sufficient velocity is maintained. The rapid skater will be able to pass safely over ice that would not bear his weight if he were at rest; for while his weight remains the same, that of the ice called into action is only that corresponding to one unit of supporting area in an instant of time when he is at rest, but to many units per instant when he is moving forward; and so in the case of a heavy body, which will fall rapidly in air if it fall from rest, the velocity of descent will be more and more slow if the body be given successively increasing velocities of lateral translation, and caused to run—so to speak—on fresh masses of air, and resting but a moment on each. Consequently, the effort required to support a bird or flying-machine in the air is greatest when it is at rest in one spot, relatively to the air; and diminishes with the horizontal speed; and the experiments demonstrate that in actual horizontal flight it costs absolutely less power to maintain a high velocity than a low one. The inertia of the air, that is so much utilised by nature, has been hitherto almost wholly ignored and neglected, in the consideration of possible flight by man.

I have quoted the above remarks from Prof. Langley's memoir. He finally states that the most important general inference from these experiments as a whole is, that so far as the mere power to sustain bodies in the air by mechanical means goes, *such mechanical flight is possible with engines we now possess*, remembering that in *aërial horizontal transport the higher speeds are more economical of power than the lower ones.*

The experiments of Prof. Langley were performed by means of a revolving arm 30ft. long, driven by a steam-engine of 10H.P. At the end of this arm planes of various forms were attached, either singly or superposed, and set at different angles, and carried through tho air at assigned speeds. The results were systematically tabulated. This arrangement imitated the conditions of flight by transit through the air of surfaces carrying weight. An electric recorder was used for indicating the results, for the reason that we cannot possibly see the action at the place of the traversing planes, set at the end of the rotating arm. The electric recorder was no doubt perfectly accurate in its indications; but it would not be required if the surfaces themselves were under observation. We could then read off the results direct, and immediate access to the planes, or forms of surface would give facilities for trying experiments in greater variety, and perhaps for ascertaining the best form or contour of surfaces, for weight-carrying purposes in air.

A current of air moving against the planes gives the same force indications as if the planes themselves were carried through the air at the same speed, using an arrangement on a large scale for obtaining such a current. If an engine of 50H.P. were to be erected for the purpose, and 100 miles per hour through air is assigned as the maximum speed required, equivalent to a pressure of 50lb. on the square foot; this will represent 44,000ft.-lb., equal to 1·33H.P. for each square foot; therefore with 50H.P. at command, we could have a column of air equal to near 38sq.ft., projected at 100 miles per hour. Allowing for the loss occasioned by the use of the fan-blower for producing the current, the air might be conducted through a wooden channel 5ft. square, in order to confine it to a straight course. This would enable us to experiment with very large models, to which independent motions could be given. By this means we might eliminate errors arising from the momentum of travelling planes, loaded with weights, when the rate of fall of these required to be measured when free from this condition. For example, a heavy bird may entirely close its wings during flight, and yet be carried forward several feet without sensible fall, on account of the tendency of bodies in motion to maintain a course in a straight line at high speeds. For the purpose of experiment this arrangement would not be more costly than that of Prof. Langley.

In a paper read before the first meeting of the Aëronautical Society in Jan. 1866, I adduced many instances illustrative of the strong supporting power of planes at a small rise or angle, propelled through the air at high speeds, and suggested a series of them superposed or placed above each other. I then expressed the opinion, based on these results, that a man, by his unaided strength, with a suitable arrangement of supporting planes, would probably be able to transport himself through the air. I made some experiments with planes on a sufficiently large scale to test this idea, but which only served to demonstrate faults of construction. Other occupations compelled me to abandon these experiments, and as I did not fly, my paper attracted but little attention, and the principles enunciated therein were ignored and not generally understood, but all of which are now clearly proved by Prof. Langley's experiments; still, my work, so far as it was carried, seemed to be leading to some practical requirements for a flying machine, and if this is ever to become a success it can only be arrived at on the trial and error system of construction. I should define the arrangement on two methods—the girder and the suspension principle. The first I consider as impracticable, for every lath or stretcher added to give form and rigidity to the wing surfaces presents a serious obstacle to direct speed, and, however constructed, a rigid framework, combining all essential parts of the machine, would be at once crushed up at the first descent to earth.

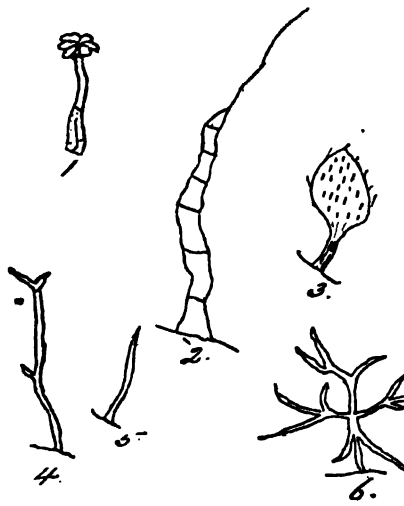
The suspension principle may be defined as an arrangement by which the aëroplanes or supporting surfaces are not combined in the machine, but should be self-sustaining, as an independent series situated above, and kept in position and restrained by light cords, and when by stoppage the wind support ceased to distend them in proper form they would be free to fall together. Experience alone can determine the most suitable form and arrangement of these supporting elements, which may be made very light and yet have great sustaining power. A silk handkerchief weighing less than an ounce can be arranged so as to support several pounds weight in safety.

An inventor, though working on a basis and theory of proved accuracy and reality, but, with the exception of mere toys, having no antecedent of a successful flying machine before him, has to take in hand a problem in construction of unprecedented difficulty.

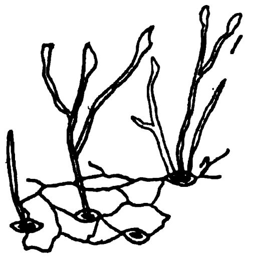
PRACTICAL MICROSCOPY FOR STUDENTS.—V.

By Frederick Davis, B.Sc.

IN examining the leaves of various plants, the student may have observed peculiar filaments, apparently growing upon them, for which he could not possibly account, somewhat resembling hairs, and yet differing totally from them; if he scrutinises these filaments with the 1in. objective he will perceive them to consist essentially of elongated cells, surmounted by, in some cases, a little knob growing from a mycelium beneath, and resembling a fungoid growth in every detail. The best leaf to examine for this purpose is that of the potato (Solanum tuberosum), the fungus devastating and existing upon this leaf, and intertwining among its cellular spaces, bears the name of Botrytis infestans. Let us examine the parts of the fungus which produce the so-called potato-blight, the "Peronospora infestans."

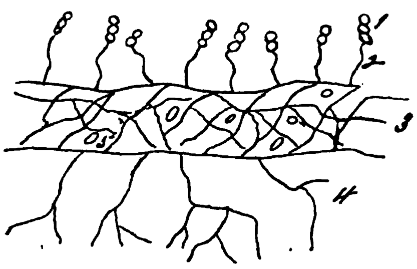


1, Hair of Garden Verbena; 2, Hair of Thistle Leaf; 3, Hair of Lobelia; 4, Hair of Plane Fruit; 5, Hair of Cabbage; 6, Hair of Lavender.



Botrytis Infestans, showing young plants proceeding from Stomata of Potato Leaf.

We have, in the first place, an immense number of elongated cells, called hyphæ, placed end to end, and intertwining, forming the mycelium, or spawn, and arising from this mycelium a few hyphæ, which apparently take upon themselves to stand upright—consequently termed aërial hyphæ. These by growth develop upon their extremities little circular bodies or knobs called conidia. When this occurs, the aërial hypha bearing the conidium is rechristened, and named the conidiophore. In course of time the conidium falls from the conidiophore, and finding itself in genial soil, sends out more elongated cells, which, in their turn, either go to extend the old mycelium, or to form a new one. We can now, therefore, understand how it is the potato blight's ravages are so merciless and extensive. The conidia or spores are blown and carried about by the wind, and the disease increases at a rapid rate.

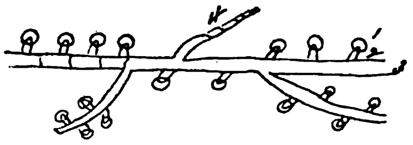


Diagrammatic Section of Penicillium.

1, Conidia; 2, Conidiophores; 3, Mycelium; 4, Loose Hyphæ; 5, Fallen Conidia.

The student will find the "mould" upon paste, the growth upon horsedung, the fungus found upon the walls of a damp cellar, all, with various modifications, built upon the same plan, and well worthy of study. The accompanying diagrams illustrate the parts described.

In our edible mushroom or Agaricus we have a modified form of the same arrangements. The mycelium constitutes, as it were, its root, the stalk or stipes being a mass of compressed hyphæ, whilst the lamellæ, hymenium or gills, and the pileus or cap have essentially the same constitution.

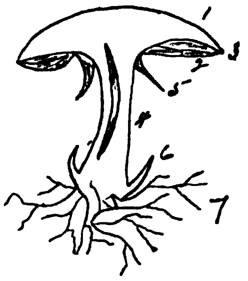


Peronospora Infestans.

1, Conidia; 2, Cellular projection piercing three cells of Potato; 4, Subaërial Hyphæ.

It will be observed the fungi are entirely devoid of both chlorophyll and starch. The student of botany will also know the fungi absorb oxygen and exhale carbonic acid gas, this alone distinguishing them from all other forms of plant life.

It will also be noticed the methods of reproduction must be one of two—either, firstly, gemmation or fission; and, secondly, by sexual intercourse or fusion of two distinct protoplasms. This latter has three modifications—that in which the sperm-cell pierces the germ-cell; that in which two indistinguishable cell unite, and, thirdly, that in which antheriozooids enter a germ-cell, much in the same manner as in the fern. The former of these may be observed in the Peronospore, and the latter in the Achyla. All fungi are either parasitic or saprophytic.



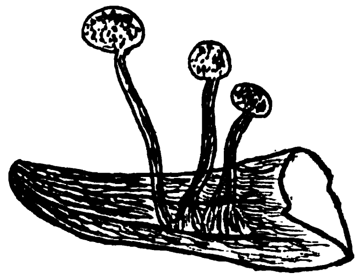
Vertical Section of Mushroom.

1, Pileus or cap; 2, Lamellæ or Hymenium; 3, Gills; 4, Stipe; 5, Annulus; 6, Volva; 7, Mycelium.

Among the fungi may be mentioned one of especial interest—namely, the Claviceps purpurea, owing to its extensive use in medicine; the portion employed is the sclerotium or compact mycelium, which is formed in and replaces the grain of Secale cereale, or common rye; it is called on this account the ergot of rye. Its form is essentially the same as the penicillium, except that the mycelium is more compact and harder; it is generally horn-shaped. Many external diseases are produced by fungoid growths, and if not the actual cause, are present during the course of the respective diseases. A certain form of aural disease is known to be produced by the Aspergillus.

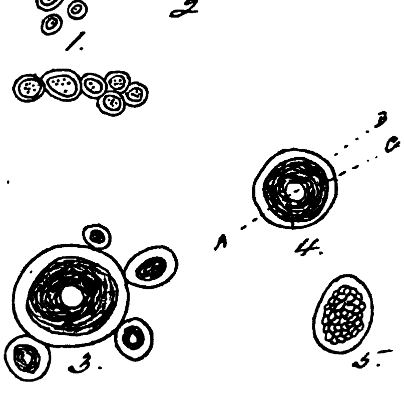
The Graminaceæ appear to be especially subject to the attack of fungi. The microscopist may frequently turn his knowledge to good account by employing the microscope for detecting the cells in flour or bread which has produced the malady known as ergotism.

The simplest form of fungi is that known as yeast. If examined, it will be found to consist of an immense number of minute cells floating in plasma. If we place a little yeast upon a slide and examine with the ¼in. objective, we shall notice each cell to be possessed of a transparent outer covering or sac, an inner substance called protoplasm, and various little spots termed vacuoles.



Claviceps Purpurea bearing stalked receptacles (Ergot of Rye.)

The yeast-cells should be examined without a cover-glass. If now we stain these cells by adding a little staining fluid, preferably magenta solution, we observe the protoplasm to be stained a decided pink, whilst the sac or cell wall remains unchanged; the vacuoles also remain unaffected. We thus prove positively the difference in constitution of these parts. If iodine solution be used instead of magenta, the same portion will be stained brown, the sac and vacuoles unaffected. If now we remove from the slide and boil in a test-tube with a little water, it still retains its colour, proving the absence of starch granules. If starch were present a blue coloration would be developed. By boiling the vitality of the yeast-cell is destroyed: it will be understood, therefore, why in bread-making the fermentation is completed before baking. Yeast-cells will grow and propagate as well in the dark as in the light. Chlorophyll is developed only by the influence of light. It is apparent from this, yeast contains no chlorophyll. Pasteur has demonstrated that if yeast be cultivated in a plasma containing sugar free oxygen is unnecessary to its growth. Yeast propagates by two methods—by gemmation or budding, and by cell-division: in the latter, the protoplasm divides itself into a number of cells, which grow, and eventually burst the containing sac—thus free themselves. Magenta solution may be prepared by dissolving a few grains of roseine in distilled water, and adding a little absolute alcohol: the intensity in colour, of course, depending upon the quantity of roseine employed. For experimental purposes, the microscopist should cultivate the yeast-cells in Mayer's solution, combined with a little pepsin, or, in Pasteur's fluid, with sugar. Mayer's solution is merely three grains each of acid phosphate of potassium, phosphate of calcium, and sulphate of magnesium, in about one fluid ounce of distilled water, to which a little sugar-candy and a pinch of pepsin has been added.



1 and 2, Yeast cells; 3, Parent cell of Yeast, young cells attached; 4, A Vacuole, B Sac, C Protoplasm; 5, Torula, showing Protoplasm broken up.

Pasteur's fluid may be prepared with or without sugar; the sugary being the better for yeast culture. It may be roughly stated to consist of twenty parts of phosphate of potassium, two each of calcium phosphate and sulphate of magnesium, one hundred parts of tartrate of ammonium, and 8,500 parts of water; if sugar is employed, add about 1,500 parts. Either the ordinary, or German, yeast may be employed for culture purposes; it must be borne in mind, however, German yeast is ground, or bottom, yeast.

THE LATHE INDEX.

BUT my intention is to describe more than one, only I cannot for dear life decide what the plural is of such an awkward title as index. If I write two or three indices, no one on earth would recognise the article in question; if I call them indexes, the word looks uncanny. Therefore, I must write about an index, and then again about an index, and a third time about an index, and so contrive to cheat the grammar and triumph over a difficulty by declining to meet it. The ordinary index consists of a spring with a point attached to it at the back, such point entering in succession certain equidistant holes drilled in the face of the lathe pulley, preventing the rotation of the mandrel. This is represented in Fig. 1, and is for many purposes an efficient and satisfactory contrivance, its simplicity recommending it for general use on inexpensive lathes. Two movements have to be provided for, one parallel with the face of the division-plate, and one at right angles to it. The first is met by the joint or pivot at the lower end, the other by the direct action of the spring when pulled back by the hand. It is superfluous to tell the majority of the readers of the "E. M." why it becomes necessary by means of this contrivance to prevent the rotation of the mandrel; but as I have come across turners who are ignorant of this necessity, and others—not turners—to whom such work as fluting, *e.gr.*, is a mystery, I may as well add just a dozen words of explanation, especially as it will help to make clear the inherent defects of this plain index, and pave the way to further developments of it. Briefly, then, there are several patterns and designs in turnery which are carved by revolving cutters of various forms, and while each separate cut is being made, the work itself is required to remain securely fixed in a certain position. Then it is moved forward to expose another part of its surface to the action of the tool, and so on, step by step, until a complete set of such decorations has been carved. The circular plate attached to the face of the lathe pulley is drilled with equidistant holes all round it, and there are often from two to six such circles, even numbers being selected, and, of these, a preference is given to those which will divide by the largest number of figures, 360, 240, 180, 100, 96, and some others answering satisfactorily this requirement. The index point is withdrawn from the hole in the division plate after a cut has been made, and the pulley rotated a little by hand till the point will drop into the next selected hole. A second cut is then made, and this manipulation is repeated till the whole series has been passed over. This operation is not fairly called turning: it is machine carving on a small scale, and the only use of the lathe proper is to hold the work in position for the action of the cutting tool. Any other machine or contrivance that will hold the work, and allow of successive changes in its position, would answer as well as a lathe, and such machines are also used.

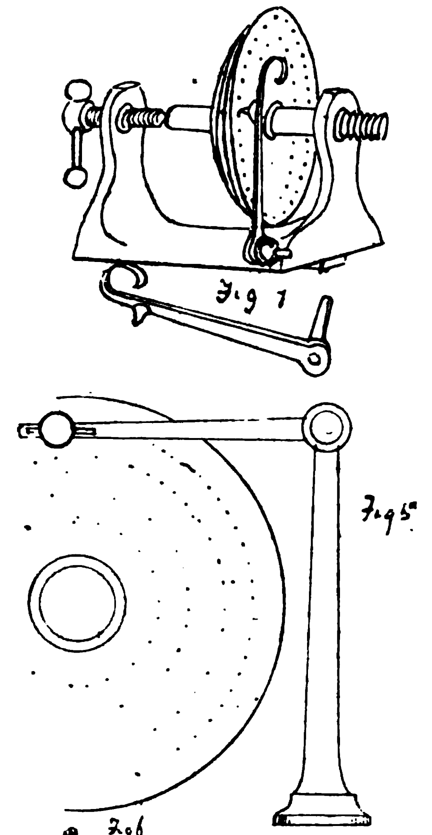


Fig 1

Fig 5

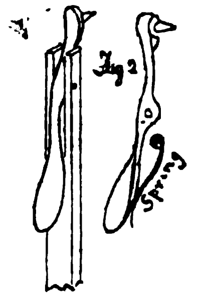


Fig 2

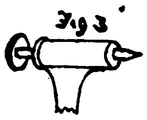


Fig 3

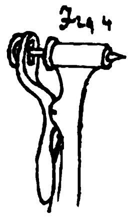


Fig 4

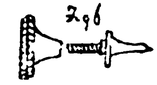


Fig 6

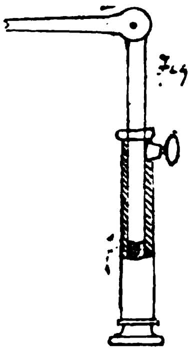


Fig 7

The first defect in this plain index is due to its position on the near side of the lathe, and this is very often made worse by the shortness of the spring, which places the point on a level with the axis of the mandrel, or but slightly above it. The result is that the hole in which the point has to be inserted is in shadow, and a tall man, especially if his sight is not over-good, has to stoop down awkwardly, and peer closely into the plate to enable him to read the numbers and count the holes. To do this 360 times is not a delight, and even 180 will test the patience and endurance of most men. The spring ought to reach as high as it can be made to do, which will at any rate bring the point more into the light. The better plan is, if possible, to let the normal position of the index point be at the very top hole of the plate vertically above the axis of the mandrel. In this position the fullest light will fall upon it, because a lathe always stands in front of a window, or with the light arranged to fall on the face of the pulley—a position I have sometimes found advantageous, as it enables one to see into deep hollow work. Some years since I came across an index in which the spring was done away with, and replaced by what proved to be in some respects an improvement. The upper part of the support was forked or slotted, and the actual index point was on a short trigger piece pivoted to it with a spring underneath it like Fig. 2. The point was raised, therefore, by pressing the knob instead of by exerting a direct pull. The action was decidedly easier, and there was less tendency to slip past the desired hole in turning round the pulley. Another plan I myself had, in which there was on a pedestal a short horizontal barrel containing a coiled spring (Fig. 3); but this was far less comfortable in use. It is the easier matter of pressing instead of pulling that is the advantage of the first. The pedestal is grasped by the hand, which is thus steadied, while the thumb presses upon the knob to release the point. Fig. 4 shows, however, a simple plan, by which the coiled spring and what I have called a trigger can be combined. On a stiff pedestal with no joint at the base, these can, however, only be used with a single circle of holes. That joint at the base is a defect, nevertheless, because the object of an index is to hold the pulley securely, and the firmest hold is obtainable from such an arrangement as shall enable a pedestal to be used without such joint. In this case the pedestal could be made with a foot to slide in a dovetailed groove in the base of the poppet, or in a block screwed to the base carrying such dovetails if the base is not thick enough to be cut into safely. This power of sliding towards the mandrel, or away from it, would bring the point opposite either of several circles of divisions upon the pulley. The movement being also horizontal, instead of radial from the centre of the hinge, as usual, the point would drop into the holes of the several circles at the same height. If the simple index first described is used upon a division-plate with half-a-dozen circles of holes, it needs to be placed at a very considerable angle from the vertical when the smaller circle is used. In this position its hold is scarcely to be relied on; hence this older pattern is less used than it used to be, especially upon high-class lathes or those upon which wheel-cutting is likely to be practised. Commencing with an alteration in the position of the index so as to get a better light, I have found it desirable to remove it to the further side of the headstock, mounting the actual spring on the upper end of a pillar, thus placing it horizontally, allowing the point in its normal position to drop into the top hole of the plate vertically over the axis of the mandrel. This is represented in Fig. 5 as made for a lathe with but two circles of holes: it was unnecessary to provide against having to slope the horizontal arm downwards, and so to weaken, as above alluded to, its hold upon the pulley. I did, however, go a step further towards making it adjustable—a modification to be discussed presently—by making the actual point slide in a slot at extremity of the arm, to which it is clamped by the milled headed nut (Fig. 6), which answers as a handle for pulling back the index. I shall recur, however to this matter subsequently. In order to meet the difficulty introduced by a division plate of many circles—of which I am now fitting one—the outer circle with 360, the inner with 7, nine sets in all, the pillar will be slotted to a greater depth, and holes drilled to take the pin on which the arm is pivoted, so that it can always be set horizontally, whatever may be the circle selected. The length of the arm, and, therefore, tension of the spring, will of course remain invariable, and when the smallest circle of holes is used, the arm will nearly, but not quite, rest upon the mandrel. Now I will say a word about the object of an adjustable index. It occasionally happens that after commencing with one set of holes, and making a trial cut or cuts, it may seem advisable to make a change to another row, and if the pulley is held quite still, and the point withdrawn, it will seldom be found that the point will drop precisely into a hole of any one of the other circles on the plate. But if there is contrived a method of lengthening or shortening the arm a small degree, it can be so adjusted as to bring the point precisely to the desired hole, and if it is clamped to retain this altered length, it can be used on the selected circle as usual.

Many other cases occur which necessitate adjustments of this kind, and several modes for effecting the operation have been adopted. In fact every lathe-maker has some pet arrangement of his own. I am glad to see that Mr. Evans himself is an advocate of the fixed pillar at the back of the headstock, instead of the ordinary index in front, for no one is better qualified to speak upon such a subject. I was not aware of this, however, till I chanced to refer to his book. There is no illustration of it in that volume, so I am not aware if he has adopted the mode of shifting the pin on which the spring is pivoted in the way I have described. If not, he will, I think, recognise the advantage of it for the reason stated. It is evident that the adjustment for length alluded to may occur either at the base or at the other end of the spring or arm; usually it is at the base. The lower end is made as a screw passing freely through a boss screwed into the headstock, and this carries a couple of nuts with milled heads, one above, and the other below the boss, and the spring is raised or lowered by the united action of these. In another, and better plan, the boss, besides being drilled to take the tail screw, is sawn across in the centre, and a cross slot formed in which a single milled nut works, through which the screw passes. By turning this in one or the other direction, the screw and spring of which it forms the tail-piece is raised or lowered. The other end of the spring is available for a similar purpose, and in the sketch given, in order to escape a difficulty, I have so arranged it in the simplest manner possible, but with the implied necessity of adjusting the point by hand only—not at all a difficult matter if the tail-piece of the point is made to fit and slide nicely in the slot of the arm; nevertheless, a screw is undoubtedly the better plan in all cases where fine adjustments have to be made. Here it can be managed by turning up the end of the arm beyond the slot to form one bearing, and doing the same at the other end of the slot, making use of a bit of the metal that has to be cut out to form such slot. The sliding piece with the point must then be tapped for the small screw, which turns in the bearings described, but is riveted or otherwise arranged to prevent endlong motion. A small milled head will have to be attached at the outer end, by which to turn it. This screw will draw the point or index to and fro. Another very neat method—when the pillar and horizontal spring are used—of raising or lowering the pivot, is to slot the pillar and fit in a sliding piece exactly in the way in which proportional compasses are jointed—with a screw and milled nut to clamp the slide. This is far neater than the pin-holes, but, of course, more expensive to make. It is, I think, as perfect a method as can be devised. There is, however, a simple plan, easy and inexpensive—viz., to let the pillar be hollowed out to about 3in. in depth, to form the socket for an inner pillar like the arrangement of the T of a hand-rest. A clamping screw near the top of the socket secures the pillar at the required height, enabling the arm to remain horizontal, whether the outer or inner circle of holes is used. The socket should be of the height of lathe centres, or a little more, and when the pillar is at its lowest point in the socket the index should fall into the top hole of the inner circle while the arm is horizontal. This will allow a sufficient length of pillar to remain in the socket when raised to set the index to the top hole of the outer circle. As a refinement on this last, the inner pillar can be cut as a screw, and actuated by a milled nut on the top of the socket, such nut being prevented from rising by a couple of screws projecting into a groove turned just below the top of the pillar. The annexed drawings will, I think, explain the devices sufficiently.

O. J. L.

PRACTICAL PHOTOGRAPHY FOR AMATEURS.*

By S. R. Bottone.

§49 THE collodion having been thus prepared should be kept in a cool, dark place, such as a cupboard in the dark room. The operator will next turn his attention to the preparation of the solution of nitrate of silver, which serves to convert the iodides and bromides in the collodion into the corresponding sensitive silver salts. This is known as the "nitrate bath." To prepare this, the operator will dissolve 1oz. of nitrate of silver in the smallest possible quantity of distilled water, which will be about 1oz. When dissolved, he will add one grain of iodide of potassium, agitating until the primrose-coloured precipitate first produced shall have been entirely redissolved. He will then add sufficient distilled water to make up one pint: this will be about 19oz. The addition of the water will cause a portion of the primrose-coloured iodide of silver to be reprecipitated. The bottle containing the mixture should now be stoppered and exposed for some hours to direct sunlight. The clear liquid may then be decanted from the sediment of iodide of silver and stored in a perfectly clean stoppered bottle. The reason for which iodide of silver is thus introduced into the nitrate bath is because a solution of nitrate of silver has the property of dissolving a small quantity of iodide of silver, and did we not saturate the nitrate bath with iodide of silver in this manner, when the collodionised plate came to be immersed in the nitrate bath in the after-process of sensitising the plate, the nitrate bath would dissolve out portions of the iodide of silver formed upon the surface of the plate, leaving thereon little bare spaces, technically known as "pin-holes."

§ 50. The developing solutions to be used in the collodion process will vary somewhat with the nature of the picture we desire to produce. If a direct positive on glass be the aim we have in view, then the following solution, which reduces the silver in a state of pearly whiteness is to be preferred:—

Developing Solution for Collodion Positives.—Pure crystallised ferrous sulphate, 2 drachms; glacial acetic acid, 1 drachm; nitric acid, 1 minim; water, 4oz.; alcohol, 1 drachm. The sulphate of iron should be dissolved in the water first, then the acetic acid and alcohol added, and lastly the nitric acid.

§ 51. If, on the contrary, the scope of the operator is to produce a negative picture on glass, from which prints may be obtained as previously described, it will be necessary to reduce the silver of a darker colour, and to increase the quantity deposited. For this purpose it will be well to use two distinct solutions: the one to develop the picture, and the other to intensify it after development. A good recipe for a developer for negatives is given below:

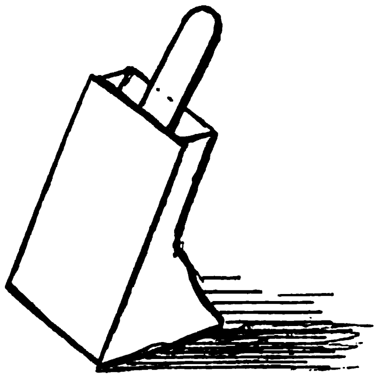


Fig. 8.

Ferrous sulphate, 2 drachms; acetic acid, 1 drachm; alcohol, 1 drachm; distilled water, 4oz. The intensifying solution may coveniently be compounded as follows: Pyrogallic acid, 12 grains; glacial acetic acid, 1 drachm; alcohol, 30 minims; distilled water, 4oz.

As this latter solution does not keep well, it is not advisable to make up large quantities. For the purpose of fixing these collodion pictures, the ordinary hyposulphite solution (of which the composition has already been given, but which for convenience sake is repeated here), is best adapted. Fixing solution for collodion pictures: Sodium hyposulphite (also called thiosulphite), 4oz.; rain-water, 1 pint.

§ 52. The apparatus needed for the production of the collodion pictures differs but little from that employed in the calotype process. The chief difference lies in the fact that we have to immerse the plate bodily, after it has been sensitised, into the nitrate bath. The most convenient mode of doing this is to have a square vertical vessel a little wider and a little longer than the plate itself, and not much more than three or four times its thickness, into which the plate can be slid edgeways, being supported at the same time by a holder or "dipper," consisting in a strip of glass which has a little ledge at the bottom to prevent the glass plate from slipping off it. This is illustrated at Fig. 8, which represents a glass or porcelain bath of this description, with the dipper standing in it. Baths are sometimes constructed of guttapercha, and even of vulcanite. This latter material is highly objectionable, in consequence of the sulphur that it contains, which is sure to act upon the silver and destroy the nitrate bath. Guttapercha is less objectionable, though the nitrate bath acts upon it after some time. Still, if it is kept scrupulously clean by washing in many changes of water after use, a guttapercha bath will do good service. The best bath is undoubtedly one of well-glazed white porcelain, and such may be procured from any of the dealers in photographic materials.

§ 53. As the developing, the intensifying, and the fixing solutions are poured over the plate instead of the plate being immersed in them, as in some other processes, the operator will do well to provide himself with several small glass beakers or jars, known as "developing cups," capable of holding about an ounce of solution. He must take the greatest care to keep these cups chemically clean, to dedicate each one to its own particular solution, and to use it for nothing else.

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FITTING.—VIII.

LINING out, or marking out, work for machinists and fitters is, in large shops, a special task performed by one man, or by two or three men, dependent on the size of the establishment. In small shops each fitter usually lines out his own work. In standard, and often repeated, work, little or no lining-out is done; but the parts are machined by metal templets. It would never do to shape work having several faces and centres, all mutually interdependent, at random. The relations of the several cardinal dimensions must be ascertained before beginning to tool any portion; otherwise, when half the work were done, the discovery would be made that a portion or the whole of the remainder would not hold up to correct dimensions. All work, then, except that of special and standard type, which is machined by templets, is lined or marked off before it is shaped to ultimate finished form. The time and trouble of lining-off is saved when templets are employed. But then templets, being costly, are seldom used, except when large numbers of pieces are required precisely alike. So that for nearly all the work of a jobbing shop, and for by far the largest portion of amateur work, the preliminary lining-off of castings and forgings is necessary.

In this article I propose to consider the principal appliances and tools required for this work; and in the next two or three articles to illustrate some typical examples of lining out.

Most of the appliances and tools used in lining out are shown in the accompanying figures, or have been illustrated in previous articles. They consist mainly of the table, the crane, vee, and packing blocks, wedges, scribing blocks, squares, calipers, and the necessary straight-edges, rules, compasses, and dividers.

Now, there are certain preliminary matters which lie at the basis of all accurate lining out, and it is as well that we should at the beginning have clear ideas of those fundamentals.

In the first place, the fitter provides an artificial level base, quite distinct from the work itself, from which to mark vertical distances, to set up lines at right angles, and to draw parallel lines in horizontal planes for the purpose of obtaining faces and centres. This is the marking-off table, Fig. 51.

The table A is a stout, strongly-ribbed cast-iron plate, planed over upon surface and edges. Its cross section is shown in Fig. 52. It has to be so rigid that it will not spring, and so true that lines can be squared from its surface and edges. Its size will depend entirely upon the nature of the work done. A useful surface plate generally serviceable for the work of a shop of average size, may measure from 10ft to 12ft. long, by 3ft. 6in. or 4ft. wide, by from 1½in. to 2in. thick in the plate, and 6in. or 7in. in total depth. The outside ribs *b*, and the transverse ribs *a*, being deep, afford extra rigidity to the plate. The plate is cast with its

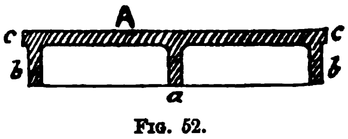

Fig. 52.

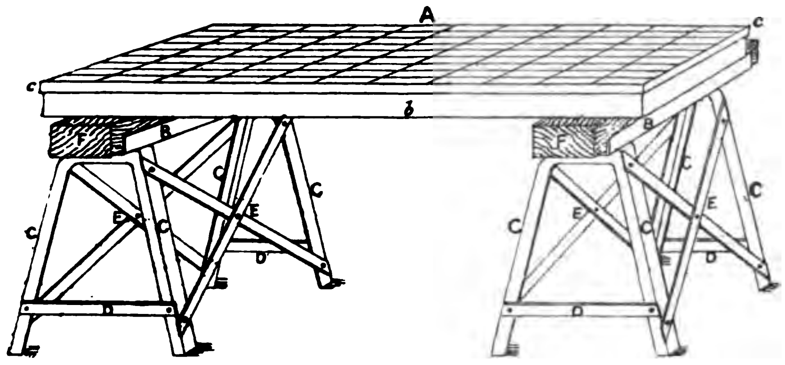

FIG 51

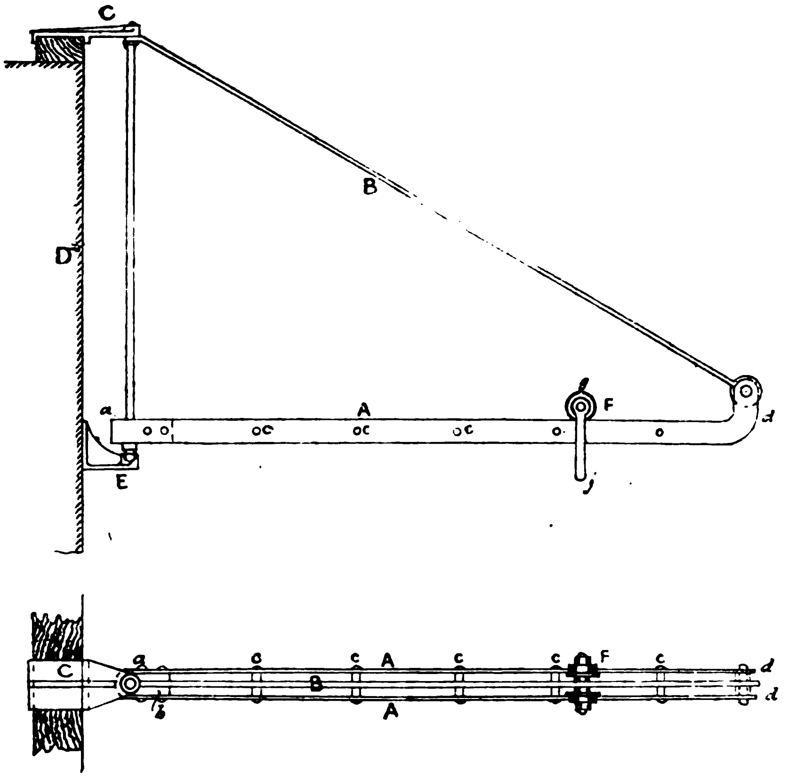

FIG 55

face downwards to get clean metal there. Two planing cuts—a rough, and a finishing one—will be taken off face and edges. No scraping is necessary. To save the cost of planing the edges throughout the entire depth of the ribs, strips *c*, equal in depth to the thickness of the table, are cast all round and planed. Lines and measurements can be marked from those edges. The surface is often crossed at right angles with fine scribed lines running parallel with each other at convenient distances apart (as shown in the figure) as at every 12in., or 6in., or 3in., or even less; this is convenient, but is sometimes omitted.

The table is supported upon any suitable basis, its surface being about 3ft. from the ground. Two very stiff wooden trestles, or, better still, two trestles made from channel and angle iron, with hard wood blocking, Fig. 51, are as suitable as anything. A piece of channel iron, B, is cut off, and supported with two legs of angle iron, C, bent as shown. These are stiffened with stretchers, D, and with diagonals, E, of flat bar iron, riveted to them. A block of wood, F, is fitted into the channel iron to form the top of the trestles.

It is necessary that the table shall be clear of walls or machines, so that the man can get all round it. This table is the sheet anchor of the marker out. Very seldom are lines set up from the edges of castings or forgings. Even if there are edges already planed true, it is better to set them upon the table, and square up or scribe from the table's face, rather than to use those edges for squaring or scribing from. There is less risk of error when working from a broad surface than when setting a square or compass caliper from a relatively narrow edge or face.

It is often quite impossible to mark a piece of work out at one setting. But always, before shifting the position of work upon the table for a second or a third lining out, it is essential that centre lines should be made the basis for accurate re-setting. Thus a horizontal line marked with a scribing block in one position of the work can be set in the vertical direction with a set-square, and other lines then marked with scribing block in the new position will be at right angles with the vertical line; and so with a vertical line brought into the horizontal position, other verticals then set up with the set-square will be at right angles with the first. These methods are invariably adopted in preference to setting one edge of a square against a line to mark another at right angles with it. In every case it is the table that is made the basis of lining out.

It is very advantageous when practicable, to have one face of the work planed true to lay upon the planed surface of the marking-off table. There is then no risk of the work becoming shifted during the process of marking out. It is, of course, frequently not practicable to start with a planed face, because of the necessity for tentative lining out in order to secure average allowances for machining. But often a rough lining-out is first made, sufficient to settle the position of the planing line for one cardinal face, and then a rough cut is taken off that, so that it may lie truly upon the table before the bulk of the actual lining-off is done.

When this is impracticable, or when the work is quite of an irregular character, the use of blocking-up pieces and wedges has to be adopted.

For supporting such work upon the table, vee-blocks, Fig. 53, A, parallel irons B, packing blocks C, and little iron wedges are used. The vee-blocks are employed chiefly for supporting shafts and circular spindle-like work generally. They are made in cast iron, in pairs of different sizes, planed both on the bottom and in the vees. The parallel blocks C are also planed all over on each face, and are kept in different thicknesses and lengths. They support and pack up flat surfaces. Very convenient light blocks are made by cutting off suitable lengths of H iron, B, of different sections, and planing the top and bottom faces, ends, and edges. The wedges are used for steadying work laid either upon the table or upon the parallel blocks when the under-face of the work in contact with the table or block is rough and uneven, as in the case of a casting or forging upon which no preliminary machining has been done.

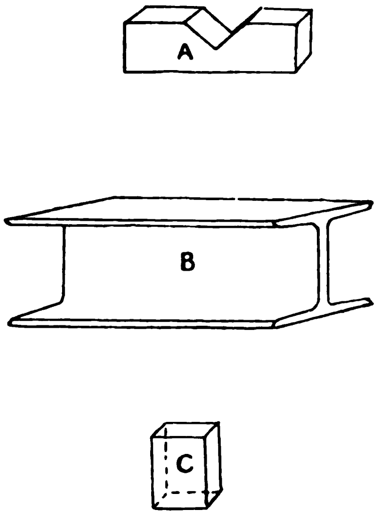

FIG 53

It is often the case that some lines and centres have to be marked upon portions of the work that stand very far above the range of the scriber-point when its base rests upon the table, and yet perhaps it is not convenient or desirable that the lines or centres should be marked except from the table as a basis. Then the parallel planed blocks B are laid upon the table, and the scriber base is slid along upon them. Blocks of various thicknesses are thus utilised singly or in series to raise the scriber sufficiently high to enable the point to scribe the required lines.

These channel irons B are used also for marking temporary centres upon for transference to the work. Thus, if there are centres situated upon faces that do not stand in the same plane, such as A and B in Fig. 54, then these centres are marked upon one face of the channel-iron at *a* and *b*—the iron being stood on end upon the table C—and the point of the scribing block set to each in succession, and transferred to the faces

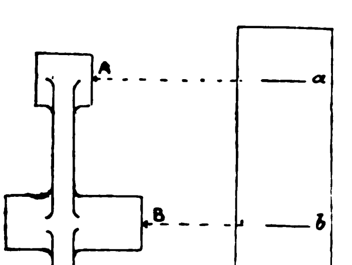

FIG 54

of the bosses. The other way of marking such centres is by means of trammels with one leg adjustable for vertical height, or with set squares, neither of which is so accurate as the method of direct transference.

Occasionally it is convenient to bolt small pieces of work to an angle-plate for lining out. It is so in some light forgings of very irregular form which cannot be packed up, or which, if packed up, would be so light that they would not remain sufficiently steady while being scribed off.

Scribing blocks or surface gauges (see article III., p. 8 of the present volume) are in constant request by the marker-out. Without these it would be impossible to line out work accurately. No matter how irregular the surface of a casting or forging may be, the scriber point will follow round and over it, and mark a line, or any number of lines, exactly parallel with the planed face of the table, over which the base of the scribing block is moved. Also the bent turned-down point of the scriber is used to test by contact the upper surface of a piece of work that requires to be set in a truly horizontal plane. The scriber has, moreover, a considerable amount of vertical range, by virtue of which it is adaptable to work of varying heights. And the length of the scriber and its horizontal range allow it to reach and mark surfaces that stand back and away from the general perpendicular level of the work.

Very neat centres and distances are not set off from the edges of rules, but with dividers, compasses, or trammels. One leg of the dividing instrument is set, not at the end, but in one of the divisions of the rule, usually in the first inch, and the other leg is set to the dimension required. The dimension so obtained is then transferred to the work.

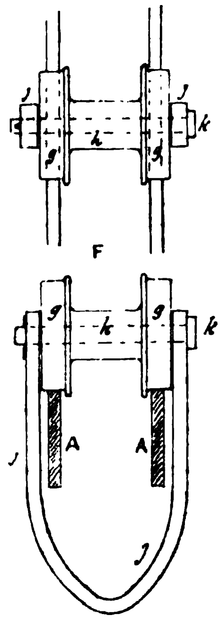

FIG 56

Clearness of definition is essential in lining out work. Lines must be reasonably fine, yet perfectly distinct. To give a good background it is the practice either to prepare the surface by chalking, or by brushing it over with a solution of whiting in water, left till dry. Not only are the lines scribed on this, but in case of their partial obliteration two devices are resorted to. One is to centre-pop the lines at intervals of about every half inch, the other is to scribe another line at a little distance outside the actual working line, and parallel with it, and centre-pop that also. When the working line has been obliterated by machining, the other, or "witness" line, is proof whether the machining has been done accurately or not.

No marking-off table, except the very smallest, is complete without a jib or wall-crane from which to suspend pulley-blocks for lifting heavy work. Many castings and forgings are too lumpy to be lifted and turned about by hand. But a simple pair of differential blocks is all that is required for any work likely to be put upon an ordinary table. Such a jib is shown in Fig. 55. The blocks are hooked on to the jinny that runs along the horizontal bars, and this, with the swing of the jib, allows the pulley blocks to cover the whole area of the table.

The wall-crane is of the simplest possible construction. A bar of wrought iron, A, is bent round at the end *a*, and maintained parallel by means of a cast-iron block, *b*, and distance pieces *c*. The ends *d* are turned up to take the pin of the tie-rod B, that is pivoted upon a cast-iron bracket, C, bolted to a piece of timber laid along the shop wall D. The crane is supported, and further pivots upon a pin fitting into a footstep casting, E, bolted to the wall. The jinny F, enlarged in Fig. 56, consists in very light cranes of this type of two cast-iron wheels, *g g*, about 6in. in diameter, cast together with a middle boss, *h*. They run upon the edges of the jib A. Sometimes angle-irons are riveted on the outside of the jib sides, but only in heavy smiths' cranes. The eye *j* to which the pulley-blocks are hooked is bent round, bossed up, and secured to the jinny-wheels with a central pin, *k*, upon which the wheels *g g* freely revolve. The jinny is moved along, and the jib is swung round merely by pulling at the chains of the pulley-blocks.

J. H.

HAMMERING SAWS.*

BARRING all mishaps to circular log saws, the natural work, so to speak, tends to change the tension from the edge to the centre, so that in time, according to stress, the saw becomes too large on the edge or rim; this is held to the same diameter by the centre size, and as there is a surplus of ridge it buckles or kinks, and, as before said, runs "snaky." To restore the tension so that the plate is true, and the tension is again equal throughout, is the subject of this paper.

First of all, some kinds of tools suitable for the purpose must be had. These consist of a hammer, a straight-edge, and a hard, smooth-faced anvil. To go at it systematically, lay the saw out in circles by revolving it on the mandrel and holding a piece of white chalk against the plate. The first circle should be one-third the distance from centre to rim, both sides alike; then five more circles about 1in. apart towards the rim, both sides; then, with a straight-edge for a ruler, place it at point of the saw-tooth and at centre of saw. Draw radiating lines across the circular lines, one line for every tooth. Then place the saw flat on the anvil, supported by a bench or an attendant. Place the intersections of the line first near the centre on the highest part of the anvil, then with a dog-head hammer weighing, for large saws, 6lb., strike a blow the weight of the hammer, and some more. Do this on all the intersections of lines, both sides, then test the saw with the straight-edge held at at right angles with the support, with the saw laid flat, one edge lifted about 4in. high. If you have not dished the saw it will drop near the centre about $\frac{1}{16}$in. This will do for a speed of 700 or 800 revolutions; but if the saw does not drop, but yet remains crowning, go over the lines again, both sides alike. The amount you have to do in this respect depends entirely on the temper of the saw. Some will drop with but little work, while others have to be hammered for two hours or more; but hammer it till it drops sure, at centre and parallel to about two-thirds of the diameter of the saw. When you have done this you have got to true up the plate. A good, large, hard-wood block of oak or maple will do for this. Hang the saw loose on a pin or bolt driven into a post, or on a mandrel if you prefer; but do not screw up the nut. Test the saw with a short straight-edge for high places, and chalk them with an X. Work carefully and closely, then lay the saw down on the block, high places up, and force them down with the hammer by blows delivered lightly on all the marked places, then test again. Continue this until the plate is level, then test with a long straight-edge for a true plane. The saw may be dished to log or reverse; when this is the case you must go over it with a hammer on the wood block, striking scattering but uniform blows lightly, and test often with the long straight-edge; do this until the saw is flat or in a true plane generally. Then again use the short straight-edge, testing for high places, and mark as before, forcing down flat, pretty much as you would straighten a piece of crooked iron. Pening or stretching the concaved side is all wrong. It has been taught in books; but I think it was done to mislead, for it is impossible to fetch up the hollow or concaved side in this way on a saw plate.

In truing the plate it sometimes occurs that the bend is in the form of a ridge extending in the same direction longitudinally. On such a ridge the twist pene is best. For convenience the pene is twisted to 45° with the handle; the other pene is reversed, so that, as the saw lies, if the ridge runs one way use one pene, if the other way use the other pene, striking blows that are parallel with the ridge. I will not here explain why this is better, but it is so. Sometimes the saw has been run foul and bent: this is the case many times with cutting-off saws, by the cant becoming swung round by pinching the saw. When the saw is bent in this way, hold it level with the eye and sight across the plate; you will at once note the bend. Mark the convex side and strike blows with the twist pene in the direction of the line of the highest place, be it circular or straight. It should than be tested for tension, and corrected, as before stated. It is much better to get a good set of tools, which can be had for about 12dol. to 15dol. Then you can work, for you have tools to work with.

NOVELTIES IN INCANDESCENT LAMPS.

THE novelties in miniature incandescent lamps here illustrated are made by Mr. Somoff, of New York. The lamps are useful at the present time, for there are new applications of electric light for miners' and firemen's lanterns, for surgical and dental operations, in a word, for purposes for which the old pear-shaped lamp does not answer very well, if at all. The little "pea" well known to everybody, is too big for such purposes as inspection of the bladder or stomach, and the "grain" lamp, Fig. 1, is just the thing that is wanted. The "tulip" lamp, Fig. 2, ready mounted, suits a surgeon better than the clumsy pear lamps, for the same holder or socket which fits an electro-cauterising knife will hold a "tulip" lamp; and to replace one by the other is a matter of only a few seconds. Then, again, in an electric lantern which is coming into use, the "bull's-eye" (Fig. 3) lamp takes the place of both the pear lamp and the concave curved lens, or bull's-eye, with which lanterns are usually equipped. The "grain" is perhaps the smallest lamp that can be made; its dimensions are three millimètres in diameter and five millimètres long. It is a 1c.p. lamp,

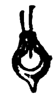

FIG. 1.

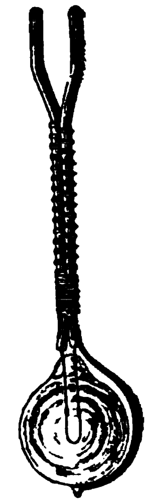

FIG. 2.

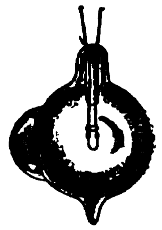

FIG. 3.

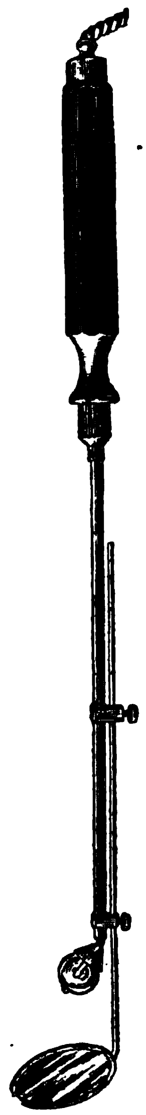

FIG. 4.

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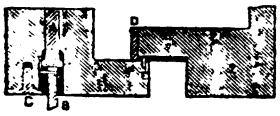
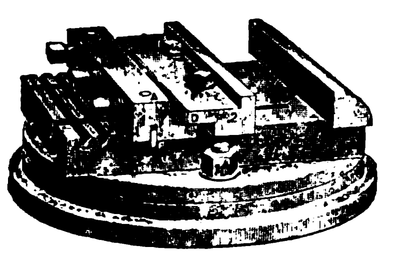
* By C. E. GRANDY, in *American Machinist.*

requiring from 3·5 to 12 volts pressure. The higher voltage is preferable when the lamp is intended for internal insertion into the stomach or bladder, for the small amount of current (·2 of an ampère) to bring to incandescence the very fine carbon filament would not heat up the globe to any more than the temperature of the human body. Fig. 4 presents the same lamp mounted in a laryngoscope. This instrument, too, presents some novel features, for all metal parts are electro-plated with platinum, which effectively keeps the tool bright and clean and allows washing in water, diluted acid, and all kinds of disinfectants without causing it injury. The lower half of the lamp globe is incased in a platinum shell or cup, the metal being reduced upon the glass from the chloride compound at a red heat and united with the glass by fusion. —*The Electrical World* (N.Y.)

JORDAN'S PLANER CHUCK.

WE present herewith illustrations showing the construction of an improved planer chuck made by the Worcester Chuck Co., of Worcester, Mass. In this chuck the holding strip B does not project from the end of the jaw, but is forced down into engagement with the base, by means of the pins A A, which slide freely in the jaw. Small pins are put through the strip B, which prevent it from moving endwise, and also from coming out, this latter being prevented by the pins coming into contact with the heads of the two screws C. The edge of jaw 2 is protected, where the set-screws come into contact with it, by a strip of steel, D, this strip being arranged in connection with the small pins E, to prevent the jaws 1 and 2 from being separated. The vice is made either with swivel bottom (graduated), or without it, as may be desired, and is so arranged that no dirt or chips can get into the base. Set-screws and strip D are of tool steel, other screws and nuts of machinery steel; wrenches, drop-forged.—*American Machinist*·





Handbooks for Engineers.—Those who so frequently write asking for the title and price of works on various subjects, may be directed to the useful list which Messrs. Whittaker and Co., of Paternoster-square, E.C., have issued in connection with engineering electrical work and the arts and crafts.

Adulteration of Food and Drink.—Mr. A. W. Stokes, F.C.S., public analyst for the parish of St. Luke's (East Finsbury), reporting on the results of his analysis of articles submitted to him during the past year under the Adulteration of Food, Drink, and Drugs Act, states that 23 per cent. of those articles purchased in St. Luke's were adulterated—a larger percentage than that of the rest of the Metropolis. Calculating the percentages of adulteration for each article analysed, he found that 43 per cent of the milk samples, 16 per cent. of the mustards, 14 per cent. of the coffees, 11 per cent. of the spirits, 11 per cent. of the butters, and 75 per cent. of the disinfectants were adulterated. The law allowed all spirits but gin to be of the strength 25 under proof, while gin might be as low as 35 under proof. A sample of rum proved to be 32 under proof. A sample of "butter" was composed of beef fat, water, and salt. A vendor of excessively-watered milk produced at the police-court a written warranty of its purity from his wholesale supplier, and he also showed that the milk had not been tampered with on his premises. Hence he escaped conviction, and the wholesale dealer likewise escaped a summons through lapse of the legal time in which it could be served. An extension of the time permitted by the Act was evidently needed in this and similar cases. Finally, Mr. Stokes remarks that, "with the small fines now imposed, there seems but little probability of the high rate of adulteration being much reduced."

SCIENTIFIC SOCIETIES.

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BRITISH ASTRONOMICAL ASSOCIATION.

THE annual general meeting of the British Astronomical Association was held at Barnard's Inn Hall, Holborn, on Wednesday, the 28th of Oct., the President, Captain Wm. Noble, F.R.A.S., taking the chair at 5 o'clock.

The general secretary, Mr. P. F. Duke, F.R.A.S., read the minutes of the first general meeting, and of two special general meetings, which were duly confirmed. The treasurer, Mr. W. H. Maw, F.R.A.S., then submitted his financial statement, which was of a very satisfactory character, showing that not only had the whole of the preliminary expenses been defrayed out of the first year's income, in addition to the ordinary charges of the year, but that the full actuarial value of the life subscriptions had been carried to a reserve fund, leaving, after all liabilities had been provided for, a balance in the hands of the treasurer of £14 odd.

Mr. Arthur Cottam, F.R.A.S., sectional secretary, then read the report of the council on the progress of astronomy during the year ending September 30th, 1891. Miss Brown, director of the Solar section, had furnished a most interesting résumé of the sun-spot activity of the year, referring in particular to a very beautiful group of spots, the finest on record for many years, which appeared in September, and to a very striking prominence outburst observed by M. Trouvelot and others on June 17, 18, and 19. The report also alluded to the very hopeful series of experiments on prominence photography being carried forward at present by Prof. G. E. Hale, director of a new observatory recently erected at Kenwood. Prof. Hale has secured several most promising photographs of prominences on the H and K lines, and has likewise obtained a series of bright lines in the spectrum of a prominence, several of which there can be no reasonable doubt correspond to the dark hydrogen lines which Dr. Huggins discovered in the ultra-violet region of the spectra of stars like Sirius and Vega. The report stated that the number of active workers in the department of Selenography is largely increasing, and that lunar photography with the aid of the great telescope of the Lick Observatory is making rapid strides, and by a special treatment of the positives many important features hitherto unnoticed have been revealed. Under the head of Planets, much good work is reported, both by papers contributed to the Association's *Journal* and in the Jupiter and Saturn sections. The "Canals" of Mars and the rotation period of Mercury and Venus have afforded material for much interesting discussion. With regard to Jupiter, the contributions of Messrs. Keeler, E. E. Barnard, A. S. Williams, and MM. Niesten and Stuyvaert are specially noted. The discovery of new members of the asteroid family has been more than usually rapid during the past year. The picking up of D'Arrest's comet on Oct. 6, 1890, by Prof. E. E. Barnard, and the very remarkable discovery by Prof. Zona and Dr. Spitaler on two following nights, Nov. 15th and 16th, 1890, of two comets, only twenty-three minutes of arc distant from each other, are noted. Reference is also made to the fact that Barnard's comet, 1889, I. was followed to a distance of 580 millions of miles by the Great Lick telescope, a distance exceeding the aphelia of some of the short-period comets. The photographic chart of the heavens, upon which some of the principal observatories of the world will shortly be engaged, is and will continue to be one of the most interesting astronomical facts of the day; the arrangements for carrying it out are now practically completed, and the result, it is hoped, will be a complete catalogue of stars down to the 11th magnitude, and a chart of all stars to about the 14th magnitude. The report then referred at some length to the rapid advance in Stellar Spectroscopy, especially that branch which comprises the estimation of velocities of stars and nebulæ in the line of sight, alluding particularly to the success of Prof. Vogel and his assistant, Dr. Scheiner, in calling in photography to help in the recognition of minute displacements of the spectral lines as compared with those of known bodies. Mr. Keeler's valuable investigations of the vexed question of the origin of the chief nebular line belongs to this department, and result in still further discrediting the theory that it is a remnant of the magnesium fluting. A well-deserved eulogium of that noble piece of work, the Draper Catalogue of Stellar Spectra, a classification under their various types of more than 10,000 stars the spectra of which have been photographed at the Harvard College Observatory, a reference to the probable desirability of subdividing the star types, and a passing note on Babylonian astronomy concluded the able and interesting report, which was followed with the closest attention and evident appreciation by all the members present.

The President, who, on rising, was greeted with loud applause, said: Our existence may be held to have commenced in August, 1890, and here, fifteen months later, and just one year and four days after our first general meeting, we find ourselves with a muster-roll of no fewer than 584 members, to whom we shall doubtless add, in the course of an hour, the five candidates who are up for ballot this afternoon. Surely nothing like this is recorded in the annals of any previous scientific society whatever. But if we may be proud of our numerical strength, with what pride shall we regard the fact that just one hundred of our number are engaged under our eleven heads of sections in defined and established systems of observation, as definite of its kind as that carried on at any public observatory. If we could obtain a thousand members, it would enable us not only to procure, but to house, a large and valuable astronomical library, than which it would be difficult to conceive anything more advantageous and useful to us all. Nay, I have heard it whispered (but this I utter in profound confidence) that when we do complete our 1,000 members, and have the means to house and to work it, there might even be an Observatory presented to us. Now think what this all means, and let each one of us try to get at least one recruit during the coming session. In the present stage of our existence the value of every additional annual £50 can scarcely be overestimated. What a success our meetings have been is known to all; but your council will gladly receive any suggestions which may tend to render them more useful still. Of the *Journal* it seems almost superfluous to speak. Under the most able and conscientious editorship of Mr. Maunder, it has attained a reputation and popularity to which the success of our Association is very largely attributable indeed. But excellent as it is universally admitted to be, even it could be improved, had we more money to spend upon it. The reports of the various sections speak for themselves, and call for no particular remark beyond that in the Coloured Star section, we have one observer in India, and two in Australia, and in the Variable Star section, one in South Africa, and one in New South Wales, thus providing for a watch over a portion of the sky visible to but too few practical astronomers. The work of our sections has, so far, produced no startling discovery; but it must be carefully borne in mind that it is the modest results of patient, persevering, and accumulated observation, which is of the greatest value to the theoretical astronomer, not the detection of isolated and unique phenomena which but too often only supply him with materials for the merest guesswork.

Votes of thanks to the retiring members of the Council, the auditors, the scrutineers of the ballot, and the editor, were carried very heartily.

A list of twenty candidates for election at the next meeting was suspended, and a list of papers and reports received was read by the secretary.

THE LANTERN SOCIETY.

AT the meeting of the above society, held at 20, Hanover-square on Monday, the 26th October. Mr. Stocks described his new patent mineral-oil lamp for the optical lantern. Mr. Stocks said that the lamp had four parallel wicks, the combustion-chamber was of small dimensions, glazed at both ends, the chimney had rackwork extension. A silvered copper reflector was placed at the back of the combustion-chamber, but outside the glass, so that it might not readily become tarnished. The focus of the mirror was adjusted to the lamp. The lamp could be placed close to the condensers, so that a condenser of large angle could be used. Gauze screens were employed to break up and regulate the draught. He next described a lantern he had designed with a new form of body. The condenser was mounted on an entirely new principle, so that air could circulate round it; this permitted any moisture that might be condensed between the lenses to pass quickly off. There were several ingenious arrangements which allowed the image of the flames reflected by the condenser to be examined without opening the lantern. There were some gauze draught regulators fixed at the back of the lantern, and also a metal shield to screen the operator from the heat radiated from the metal body of the lantern. The lamp was then lighted, and a practical trial made with the new lamp against another 4-wick lamp of well-known make, which was worked by the secretary. The lanterns were carefully adjusted so that the discs, with a given mask, were precisely the same size on the screen. The images were then superimposed, and the opposite halves of the respective condensers being stopped out, the illuminating power of the lanterns could be easily compared. The condensers and projection lenses were interchanged, and in every instance the superiority of the new lamp was evident. The secretary put through the new lantern some views taken by the chairman in Ireland, and also some photo-micrographs. The general opinion of the meeting was that, as regards brightness and evenness of illumination, the results were superior.

Mr. Taylor then exhibited a new pressure-gauge, invented by Mr. Sinter. The principle employed is the compression of a spring by a direct-acting plunger.

SCIENTIFIC NEWS.

THE position of Wolf's comet for Berlin midnight on Nov. 15 will be R.A. 4h. 34m. 40s., S. Dec. 8° 52·5′; brightness 10 as compared with unity at time of rediscovery. It will be remembered that on that date a total eclipse of the moon occurs about Greenwich midnight.

The comet discovered by Mr. Barnard on Oct. 3 has been observed sufficiently for Mr. Campbell to compute approximate elements of its orbit, which give the perihelion early in the present month. It is visible only in the southern hemisphere, and reckons as *e* 1891, Mr. Barnard having discovered *d* 1891 on Sept. 27.

In the supplementary number of the *Monthly Notices* of the R.A.S., Mr. Barnard, M.A., of the Lick Observatory, has an illustrated paper on Jupiter and his satellites made during 1890 with a 12in. equatoreal of that establishment. On Sept. 8, 1890, while Mr. Barnard was observing the first satellite transiting across the bright equatorial belt of Jupiter he noticed that it seemed elongated in a direction nearly perpendicular to the belts of Jupiter. With high powers and perfect definition the satellite appeared distinctly double, the components clearly separated, and dark against the bright body of the planet. Mr. Burnham also witnessed the phenomenon. The distance between the centres of the two images was about one second of arc. On August 3, 1891, when the satellite was in transit across the dark south equatorial belt of Jupiter, it appeared under careful examination with the great 36in. refractor as an elongated white spot, the elongation being nearly parallel to the belts on the planet. During this time satellite No. 2, which was also transiting, appeared perfectly round. Mr. Barnard infers that either the satellite has a bright belt on it similar and nearly parallel to those of Jupiter, and reasoning from analogy, it rotates on an axis nearly perpendicular to the plane of its orbit; or it is actually double. In another paper specially referring to the first satellite, Mr. Barnard says: "The true theory can be settled with absolute certainty by careful observations. If the phenomena are caused by a white belt, the satellite, when it transits a bright portion of Jupiter, should always appear double, the apparent components nearly vertical to the belts of Jupiter; when it transits a dark belt it should always appear elongated in a line nearly parallel to the belts of Jupiter. If it is actually double, the elongation or line of apparent duplicity should be seen under all angles." No indication of a belt has been seen on the other satellites. Mr. Burnham has no hesitation in stating that the satellite was as distinctly double as any double star he has seen.

Mr. Burnham is preparing a general catalogue of the double stars discovered by him, and will be glad of any unpublished measures of Nos. 1 to 1224.

Dr. J. Palisa has given the name Thora to minor planet 299 (Oct. 6, 1890); No. 304 (Feb. 14, 1891) he has named Olga, and 309 (April 6, 1891) Fraternitas.

The death is announced, in telegrams from Sydney, of Mr. Edward Hargreaves, one of the most widely-known men connected with the discovery of gold in Australia. In 1851 Mr. Hargreaves searched for gold in the broken country near Bathurst, New South Wales, believing that the geological formation indicated its existence. According to the finding of a committee of the Legislative Assembly, reported a few months ago, the actual discovery was made by Messrs. Tom and Lister, but Mr. Hargreaves has always been credited with having initiated the search which resulted in success.

The Rev. Dr. Dallinger has consented to act as secretary of the Royal Microscopical Society for a time. It will be remembered that Mr. J. Mayall, jun., the former secretary, died a few weeks ago during the recess. Dr. Dalinger, who was president of the society for several years, was warmly welcomed by a large number of the Fellows.

The Geologists' Association holds a conversazione at University College to-night, Nov. 6.

On Tuesday, Nov. 10th, Dr. Rideal will lecture at the Royal Victoria Hall, on "London Fogs"; and on Nov. 17th, Dr. W. D. Halliburton will lecture on "Skin and Bones."

Prof. Russell and his party have returned from the expedition to Alaska. They report that Mount Elias is higher than was estimated, as they reached an altitude of over 14,000ft., and found the mountain at least 5,000ft. higher.

Prof. C. V. Boys has arranged his apparatus for the Cavendish experiment in the basement of the Clarendon Laboratory, Oxford.

Prof. C. V. Boys commences a series of lectures to working men in the Museum of Practical Geology, Jermyn-street, S.W., on Monday, Nov. 9. The subject is "Foam and Bubbles." Other courses during the session will be "Recent Chemical Discoveries," by Mr. W. P. Wynne, B.Sc., and "Our Bones, and What They Teach. A Modern Version of an Old Story," by Prof. G. B. Howes.

A second edition of Mr. Lewis Wright's "Optical Projection" has just been issued by Messrs. Longmans. The work is a treatise on the use of the lantern in exhibition and scientific demonstration, and as most of our readers will remember the series of articles by Mr. Wright which appeared in our columns several years ago, and were afterwards published in an enlarged form under the title of "Light: a Course of Experimental Optics," it is unnecessary to tell them that the subject is a favourite with Mr. Wright. As the "lantern season," as it is called, is near, those who desire to know what can be done with modern optical appliances for the purposes of amusement, or for demonstration in connection with science lectures, should read what Mr. Wright has to say, as he is an accomplished master of the optical lantern.

A course of free lectures, mostly on scientific subjects, is being given on Saturday evenings in Leicester, and we note that our correspondent, Mr. C. E. Stretton, gave, on Oct. 31, some interesting notes on that historical line, the Leicester and Swannington Railway. In the course of his remarks, Mr. Stretton said that the line was one of the most ancient and interesting in the kingdom, and one of the least known. It was unique from the fact that a considerable portion of the old line remained to-day practically as it was 59 years ago, whereas the other old railways, the Stockton and Darlington and the Liverpool and Manchester, had been improved and brought up to date. He mentioned that the whole of the old documents relating to the history of the line remained intact at the West Bridge Station until the year 1868 or 1869, when, in consequence of a report by an official of the company that the old cupboards were full of useless paper, the greater portion of the documents were destroyed. Mr. Stretton said he took copies from them, and preserved as much as possible.

The first line of electric tramway worked in England on the Thomson-Houston overhead electric system was opened on Thursday last week in Leeds by the Mayor, in the presence of a large number of engineers and others interested in such work. The opening run was not a complete success, as several somewhat lengthy stoppages took place, caused, it is said, by the overheating of the engine at the power station. It is expected that such delays will not recur when everything is in thorough working order.

The paper presented by Prof. Ehrlich at the recent Congress of Hygiene contained conclusions favourable to Dr. Koch's tuberculin. It seems, however, that although it is now more than a twelvemonth since the "remedy" was introduced, "there has been no decided progress in the therapeutic aspect of the subject," according to Dr. Koch himself.

Powder for Coating Moulds.—Mr. D. Stephens, of Kidwelly, patented a powder for coating the interior of steel moulds. Rock containing a high percentage of silica is first-washed and then calcined; it is then ground first in an edge runner mill, and then in a pulverising mill which reduces it to a flour-like powder. This powder is then mixed with water or sour beer, and applied to the mould.

Photographic Veneering of Furniture.—In the application of photographs to cabinet-ware, Mr. J. K. France has patented the use of a substance that he calls "pyralin, or some other compound of pyroxylin." The print is fixed by means of alcohol. It is applied to the wood to be decorated, and the surface polished by pressure on a metallic plate, or by other means. This invention has for principal object the veneering of furniture.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

SCIENTIFIC ADVERTISING.

[32866.]—I READ the words "A 36in. mirror of 11ft. 3in. focal length has been made for the Science and Art Department, South Kensington," in the sense in which a form of expression that has become almost technical must have conveyed to 499 out of every 500 people who saw it. But, after reading the explanation in Dr. Common's letter (32857) on p. 222, I can take but the one possible course open to any gentleman who may have acted under a misconception, and that is, at the very earliest available opportunity to withdraw what I said on p. 89 (and, notably, any reference to our Council), to express my regret that I wrote it, and to apologise, frankly and openly, for having done so.

A Fellow of the Royal Astronomical Society.

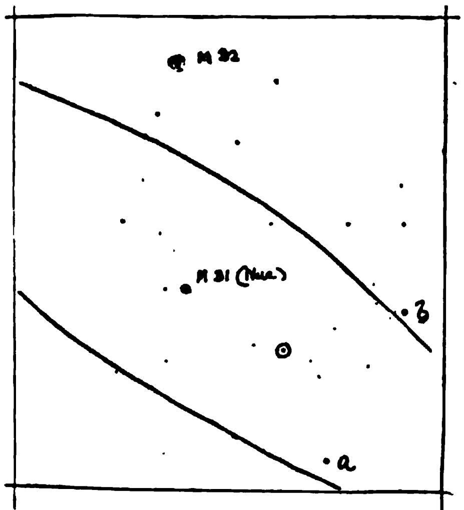
THE VARIABLE NUCLEUS OF THE GREAT ANDROMEDA NEBULA, AND AN ANOMALOUS STAR NEAR IT—OTHER VARIABLE NEBULÆ, AND ANOMALOUS STARS.

[32867.]—IN January, 1891, Mr. Roberts read an important paper at the meeting of the Royal Astronomical Society, on the photographic evidence of variability in the nucleus of the great Andromeda Nebula. The paper was duly published in the *Monthly Notices* of the above Society; but, as far as I can learn, it does not appear to have excited that interest and investigation which, I think, is its due. However, during the last twelve months, I have had this "queen of nebulæ" under constant examination on every favourable occasion, and find, as a resultant, ample confirmation of the suggested variation, and, from the testimony of other observers with my own results, the variability appears to be of a periodical character.

On the night of Sept. 7th, 1890, I noticed a bright star of about 8·5 mag. a little distance north following the nebula, which was more diligently observed on the 10th, when it was of the 9th mag., and its distance in R.A. about 60sec. N. following the nucleus. It formed the centre of an isosceles triangle, of which the stars *a* and *b* (see chart) formed the base, and the nucleus of the nebula the apex. Its brightness on the 10th was equal to star *a*, but as a bright star was shown in the same place in Mr. Roberts' photograph I thought it probably normal, when, chancing to look again on the 15th, I was surprised to find the star considerably diminished, and less than the 10th mag. I then assumed that this star was an unrecognised variable, and instituted a diligent watch throughout September and October—also during a considerable portion of the present apparition—without perceiving any definite change of magnitude except slight fluctuations; and at my request Prof. Pickering and Mr. Roberts kindly communicated the results of an examination of negatives of that region, which showed no variation of the star in question. It appears, therefore, that this star must be relegated to that list of mysterious objects which temporarily blaze out and fade again—a subtype of the so-called "temporary" class which will be treated of hereafter.

But on the night of Sept. 15 I also noted a singular phenomenon in the nucleus itself, which appeared unusually brilliant and shining with a star-like lustre. The night was fairly clear, and I resolved, as I had previously done on such occasions, to sweep the surrounding neighbourhood to determine approximately the extent of nebulosity. Judge my surprise when I found that with a low power I could only discern the nebulosity immediately surrounding the coma, and this nebulosity appeared as if neatly cut off all round in the form of an elongated ellipse, the edges apparently sharp and defined on every side, the effect being precisely the same as that produced by a bright star in the field. This singular apparent sudden fading of the outer nebulosity is a strong objection to the assumption that the greater brightness of the nucleus was only due to greater clearness of the air. On Sept. 16 the nucleus was noted to be still very bright, but was noticed to get markedly fainter night after night, as it was able to be observed. During the last twelve months it was constantly watched, and fifty observations of its apparent brightness, expressed in general terms, have been culled from my notebooks. These indicate nucleus variability in a manner not explained by atmospheric clearness, and as I have the testimony of others to bring forward, must, excepting in two instances, be referred to a future note. These instances are—1891: Aug. 27 and Sept. 3, when on both occasions I noted the nucleus to be exceedingly bright, and almost stellar. The following evidence is of great importance, showing a singular agreement among perfectly independent observers, and will be treated in the order of their occurrence from the present:—

The apparition of the new star of 1885 nearly in the centre of the nebula created considerable interest among observers everywhere, and both star and nebula were assiduously observed every clear night for several months by astronomers in every part of the Northern Hemisphere; yet it is singular that, although I have searched a considerable number of these observations, it appears that while most careful attention was devoted to the aspect, tint, and magnitude of the *nova*, little, if any, attention was devoted to the nucleus, except expressions of such a general character that no definite result can be obtained from them.



⊙ anomalous star of 1890 Sept. 7-15.

There are, however, two remarkable exceptions: the first was recorded previous to the apparition of the *nova*, and this is Mr. Tarrant's remarkable observation of a star-like appearance in the nucleus on July 2nd (*Observatory*, Vol. VIII. p. 333); and the second I have gleaned from a most interesting series of observations made by Mr. Peek at Rousdon (see *Rousdon Astronomical Observations*, 1882-85), which so admirably describes the appearance of this phenomenon that I give it in full.

"October 3, 1885.—There is a remarkable change in the aspect of the Nebula 31 M. The nucleus (which follows the new star by about a second of time) is singularly bright and condensed—so much so, that with low powers it appears a distinct stellar point—and the singular appearance is presented of the new star as a double, having a small companion on the following side. I am not certain, with all attention, that there is not a minute stellar point in the centre of the nucleus of the Nebula." . . . .

And again, four days later: "Oct 7. The nucleus of the nebula is still very bright, and looks stellar."

It will be remembered that a very widespread belief was current at the time to the effect that the new star was double; but it does not appear to have been known generally at the time that the *comes* to this mysterious star was none other than the variable nucleus itself.

In October, 1886, Herr von Kövesligethy drew attention to certain alleged changes in the nebula as observed by him and Baron Podmaniczky, at his (the worthy Baron's) private observatory at Kis Kartal. The observed changes were: An intense brightness in the nucleus on Sept. 26, and the reappearance of the *nova* near it. The news were duly announced to Herr von Konkoly at Ogyalla, who states (*Ast. Nach* 2571) that on Oct. 3 he actually saw it with a 6in. refractor as a star of 9th mag., and also examined its spectrum. He immediately telegraphed to Herr E. von Gothard at Herény, who photographed the object on the same night. But Prof. Krueger has pointed out that it does not appear clear whether the old stellar nucleus or the *nova* of 1885 was seen, as on Oct. 5 Dr. Lamp saw nothing abnormal with an 8in. refractor, nor he (Prof. Krueger) on the 12th with a 5in. finder. The anomaly, as we shall see, may be explained by assuming that a bright maximum of the nucleus was witnessed on these dates.

Although in Prof. G. P. Bond's important and detailed account of this nebula (*Mem. Amer. Acad.*, Vol. III. p. 75), there is nothing to lead us to believe that any abnormal appearance had ever been witnessed in the nucleus, it is remarkable that on one occasion his illustrious father (the elder Bond), in a letter to President Everett, in describing the performance of the then new 15in. refractor at the Harvard College Observatory, writes under date 1847, July 15: "The great nebula in Andromeda has a strong central point closely resembling a star; I do not recollect to have seen any notice of its appearance" (*Ast. Nach.* No. 611).

This stellar appearance was seen and recorded by Le Gentil during the middle of last century, although his observation was regarded by Sir J. Herschel in his account of this nebula (*Memoirs* R.A.S., Vol. II. p. 497) as "extraordinary, and probably the effect of the use of a very bad telescope."

Still earlier, in the 17th century, the astronomer, Bouillard (*Bullialdus*), is alleged to have recorded these words, quoted by M. Charlier (*Ast. Nach.* 2687) from an old and rare work. [This rare work is entitled "Ismaelis Bullialdi ad Astronomos Monita duo," &c.; 4to, Paris, 1667 (19 pages). In *Phil. Trans.* Vol. I. (1665-66) pp. 381-3, is an interesting account of this work, where the above extract will be found couched in more moderate language. Bullialdus compares these changes as similar to those of *o* (Mira) Ceti and χ Cygni. Again, in *P. T.* Vol. II. (1667) p. 459, is another extract: "Anno 1667, in January, when the cloudy and misty weather, which had continued for a good while, did permit us to observe, the star Nebulosa, in the girdle of Andromeda (which may well enough be seen by the bare eye), appeared much obscurer than the year before. In the months of February and March I did not see it."] "Since it (the Andromeda Nebula) was observed neither by Hipparchus nor by any of the ancient observers, nor, indeed, in the last century, by Tycho, the prince of astronomers, nor by the venerable Bayer, and since *in this month of November*, 1666, *in which we write, it appears very much diminished and dull, after having shone with extreme brilliance two years ago, it follows, of necessity, that it is seen bright and dull by turns*" (*Ast. Reg.* XXIII. 255). Such an expression may have given rise to the early impression that this nebula was variable.

Mr. Roberts's results from a rediscussion of his negatives (*Monthly Notices*, R.A.S., Vol. LI. p. 116) may be briefly stated as follows, the date, exposure, and appearance of nucleus, following in order:—1885, Aug. 30, exp. 30 minutes, not distinctly stellar: 1886, Oct. 24, exp. 73 minutes, faintly stellar; 1887, Oct. 10, three hours, v. faintly stellar; 1887, Nov. 15, two and a half hours, no trace of stellar nucleus; 1888, Oct. 1, 2, Dec. 29, exp. two hours to four hours, no trace, &c.; 1890, Oct. 12, three hours, not stellar; Nov. 1, fifteen minutes, very strongly stellar; Dec. 9, five, fifteen, sixty minutes, stellar on each plate. The nucleus was more strongly stellar on the plate exposed on Nov. 1 than on any other, and was probably the one that led Mr. Roberts to infer variation. Assuming that on this date a maximum took place, I found an interval of 47 days from my own observation on Sept. 15. If we take the dates of Mr. Tarrant's and Mr. Peek's observations 1885, July 2, and Oct. 3, we shall find intervals of 48 and 45 days respectively, before and after the ascertained date of the appearance of the *nova* of 1885 (Aug. 19). If we regard 45·2 days as the nearest approximation to a period and take the date of Mr. Peek's observation, 1885, Oct. 3, as a starting-point, we find a maximum fell on 1886, Sept. 29-30, which agrees fairly well with the observations of Kövesligethy and Konkoly in Hungary at that period, also if carried forward to 1890, Sept. 15 (the date of my observation) it is still in agreement. From this also we draw the interesting conclusion that the *nova* appeared during a maximum of the nucleus—an inference which is amply backed by recorded observations of the great brightness of the nucleus at, and just previous to, the memorable outburst of 1885. The assumed period (45·2 days) carried forward give a maximum 1891, Sept. 11, and it is interesting to record that an unusual brightness was witnessed in the nucleus by an astronomical friend on Sept. 8, who at first suspected the *nova* had reappeared. The fall to minimum appears to be more rapid than the rise to maximum.

Thus it has been shown that the nucleus is variable, that the variability is probably periodical (a provisional period of 45·2 days accepted, epoch 1891, Sept. 15), and that on 1890, Sept. 7-15, a star in the nebula was seen to diminish from 8·5 to 11·0 mag. The approximate position of this star for 1890 is R.A. 0h. 36m. 3s., N.P.D. 49° 23·7′.

There appear to be two other nebulæ in whose nuclei I have found decided indications of variability, both from my own observations and from discordances among the records of other observers. These are:—

N.G.C. 1068 = M 77 *Ceti*. R.A. 2h. 36m. 31s., N.P.D. 90° 36·7′. Webb calls this *faint*. I found it, 1890, Sept. 20, v. bright, with a brilliant nucleus equal to a star 8 mag. This subsequently faded, till on Oct. 15 the nucleus was scarcely perceptible.

N.G.C. 5055 = M 63 *Canum Venaticorum*. R.A. 13h. 9m. 32s. N.P.D. 47° 13·7′. The nucleus is variable. A number of observations of both nebulæ have been secured, which will be discussed in a future note.

The anomalous star of 1890, Sept. 7-15, appears to bear the same relation to a so-called "temporary star" as a short-period to a long-period variable. I have therefore regarded it as a sub-type of this class of star. Several instances are on record, and although they each depend entirely upon the testimony of one observer, it is important that such minor outbursts should be recorded, as such evidence may bear important weight in future discussions of the spectrum of the said stars. I will briefly note the following instances:—

83 *Ursa Majoris*, 4·8 mag., 13h. 36m. + 55° 17′ (1880), was seen by Birmingham, 1868, Aug. 6 = δ *Ursa*, subsequently fading (*Ast. Reg.* vi. 249).

δ *Cassiopeia*, 2·5 mag., 1h. 17m. + 59° 37′, seen by Prof. Colbert, of Chicago, 1886, Aug. 20, a full half-mag. brighter than usual, and, for about half an hour after it was first observed, the star began to diminish. Doubtful—probably due to invisible cloud.

Propus, H (Fl. 1) *Geminorum*, 4·5 mag., 5h. 56m. + 23° 16′. This star was seen by me on the night of April, 22, 1890, unusually bright, and very little inferior to η, but ½ mag. brighter than υ. I rated it 3·7 mag.; the night was very clear, and the magnitude of the star was well determined. Clouds intervened till the 25th, when the star had diminished to its normal magnitude.

In a future note, I will deal with the many difficulties in the way of observing the variations of a nebula nucleus, and will bring forward a method of successfully overcoming them.

The chart is taken chiefly from Gothard's photograph, dated October 3, 1886. The curved lines are to indicate roughly the boundary of nebulosity as seen in a small telescope. Star *a* is D.M 40·151°, and *b* D.M. 40·154°. The object of the chart is to show more readily the position of the anomalous star mentioned above.

D. Packer.

THE LUNAR ECLIPSE NEXT MONTH.

[32868.]—Diagram No. 1, which illustrates the first part of my letter on this subject, and which appeared in last week's issue, is lacking a line and a letter. The latter—viz., H, is situated on the line B F, and where it cuts the moon's orbit in close proximity to M″. The missing line joins the points E and H.

H. P. Slade.

JUPITER.

[32869.]—Oct. 30, 9.30 to 11 p.m. While observing Jupiter during the above time, I noticed Satellite III. as a light brown spot about one-third across his disc. It continued to grow darker till, when on the Central Meridian, it was quite black, and thence to two-thirds across, grew lighter, so that, when a little more than two-thirds across, it, to me, disappeared till egress, when it appeared as usual. Could "F.R.A.S." or any of "ours" give any reason for such remarkable phenomena? If so, I would be obliged. I have often seen replies anent the power of Huyghenian eyepieces. The answers that I have seen leave out the distance apart—of course, the regulation distance apart is half the sum of the lenses; but if they are less than that, the power is greater, and, if more, the power is less. The Pancratic or many-powered eyepiece, as its name implies, is according to the distance of the lenses apart. The way to calculate the power is to divide twice the focal lengths of the lenses, minus the distance apart, by their sum. And if the distance be the sum of their focal lengths, the power of the eyepiece is about what a lens would be of half the focal length of the field lens.

Darlington. W. H. Harris

A BRILLIANT METEOR.

[32870.]—A meteor, much resembling in path and somewhat in characteristics the object seen by Mr. Milligan at Dublin, on Oct. 11 (letter 32851), was seen here on Oct. 27, at 7.44. I did not see the whole of its path, as its probable starting-point (in Aries) was hidden by houses. When first seen by me it was a little below α Pegasi, and presented an almost straight line downwards as far as Jupiter, a little above which it disappeared.

It lasted about 6sec., and moved very slowly. Its colour was at first white, which changed to yellowish as it approached α Piscium. I estimated its brightness as more than twice that of Jupiter. Before it disappeared, it fluctuated in brightness into a series of violent twinkles.

Mr. James Preston observed it at Birstall (about four miles from here), and confirms me in the above particulars.

From its slow motion, brightness, and what I saw of its path, I think it was very probably an Arietid, as the one Mr. Milligan saw appears to have been.

Dewsbury. **E. Reginald Blakeley.**

METEOR OF OCTOBER 11.

[32871.]—I CANNOT quite understand Mr. E. G. Cope (32825) as quoted by Mr. Mee. He says the meteor was so bright that one could read small print by its light, and that it looked as large as the moon; time of flight being about 15secs. Has Mr. Cope had any experience as an observer? Untrained people, I find, always get in too many seconds in a given space of time. My wife and I were once pretty well accustomed to counting by the tick of the sidereal clock, and we made time of flight 6secs. and 4secs. respectively. This, of course, was only an after estimate, and for a horizontal angle of 40°. If Mr. Cope saw it during its passage over the visible vault of the heavens, there would not be such a discrepancy between our estimates. Regarding it being as *big as the moon and below the clouds*, and *reading small print by its light*—all that reminds me of the great meteor of July, 1860, in the United States, where the climax was capped by the newspaper correspondent, who affirmed that, being a prudent man, he "dodged" when it came close to him.

It may interest some of your readers to hear how I was enabled to fix the apparent path of the meteor in a starless sky. I was in the act of closing the parlour shutters, when it suddenly attracted my attention nearly over the dome of the observatory. That gave its bearing. I called out to my wife, "Look, look at the fireball." She moved her position about four yards, and saw its disappearance. I fixed its point of termination as accurately as I could by means of the top of a tall, silver fir-tree and the planet Jupiter. Then, without stirring from my position, I marked with pen and ink (brought to me by Mrs. R.), on the large pane of glass forming the lower half of the window at which I was standing, the initial and terminal points of flight. The angles were afterwards measured. I did not rely altogether on the ink-spots in the final estimations; but, at the same hour on a following day, checked them by independent estimations, based on the positions of the meteor as referred to the summit of the dome and top of the fir-tree. It is to be hoped that some one else was as favourably situated, and by a comparison of the obervations the elements of the object may be determined.

Edward M. Richards.

Grange, Enniscorthy, Ireland, Oct. 24th.

COMET WOLF.

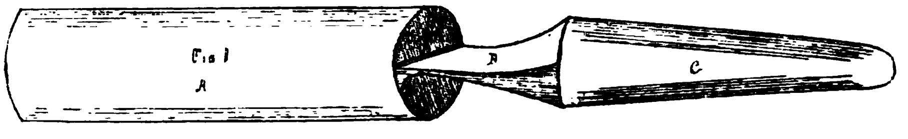
[32872.]—I OBSERVED Comet Wolf with 3½ refractor at 10.30 p.m., when not far from the horizon. By differential observation with δ Orionis, I found its R.A. 4h. 40m. 52s., its Declination South 31′20″. It was far from bright, and its outline very indistinct; a very faint nucleus could with difficulty be occasionally glimpsed. I reduced the aperture to 2in. It was still visible, but I doubt whether it would have been primarily observed with that aperture. In the finder of 1in., with a large field, it was quite invisible. In all such comparisons of the lowest apertures with which a faint object can be seen it must be remembered that the state of the atmosphere, the age of the moon, and the altitude of the object so much affects its visibility, that observers, when contradicting each other without precise knowledge of such points, are often "reckoning without the host."

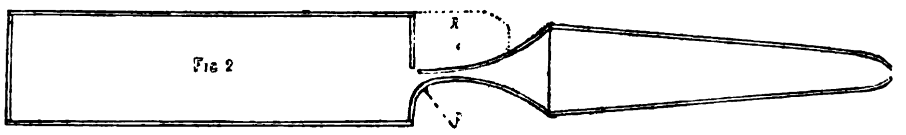
John Bone, F.R.A.S.

St. Thomas's Vicarage, Lancaster, Nov. 2.

THE MICROMETRICAL MEASUREMENTS OF THE PLANETS.

[32873.]—ASTRONOMERS are aware that this is one of the most difficult matters in practical astronomy, and requires a considerable number of measurements to be taken before anything like a reliable value can be obtained, and the discrepancies in the various authoritative measures differ considerably, so that it is nearly impossible for anyone to arrive at the true value. For instance, we find that the greatest angular diameter of Mars (according to Young's "General Astronomy") is 24·5″, whereas in Chambers's "Descriptive Astronomy," it is given as 30·4″; but it is thought by some that Leverrier, who arrives at the latter value, did not make any allowance for irradiation, which may amount to 2″, or even more. Even then there is a wide difference between the measures, which can only be due to the imperfections in instruments or to error in observation. Indeed, I have known as much as 7″ difference in the measurement of a planet's diameter made by a skilled observer on two different nights. Now I am confident that the diameter of a planet can be obtained to less than 1″ on any night when the air is fairly steady, and by making use of the following experiment—which I have found out





since I came into possession of one of Slade's universal micrometers—which was described in the ENGLISH MECHANIC, October 24, 1890. My method of procedure is briefly this:—Having obtained the exact value of the divisions on reticule, or the distance apart of the parallel lines, I revolve the draw-tube until these are in such a position that when the planet enters the field of view it moves in a slanting direction across them. I then watch until the planet's upper limb come in contact with one of the lines, and then count the number of seconds which elapses before the planet's lower limb comes into contact with the same line; this time varies according to the inclination of the micrometer lines to the planet's path across the field of view. I then mark the time in which it takes the planet to move over its own diameter, continuing counting until I observe the upper limb touches the next line, which gives me the time the planet has taken to move through one of the large divisions of, or line of, micrometer scale—or, what is the same, the distance apart of the lines. Let us suppose that the divisions or lines are exactly 60″ apart, and that the planet takes 85 beats to move over its own diameter, and 132 to move over the space between the lines; then the diameter will equal $\frac{85 \times 60''}{132} = 39{\cdot}61''$.

The value of the divisions on my reflector is 76″, and on Oct. 19 I took twenty measurements of Jupiter, the results being as follows:—

Mean of 5 measurements	$\frac{184 \times 76''}{302}$	= 46·3″
,, 5 ,,	$\frac{205 \times 76''}{337}$	= 46·7″
,, 5 ,,	$\frac{104 \times 76''}{170}$	= 46·5″
,, 5 ,,	$\frac{107 \times 76''}{174}$	= 46·5″
Total.. 20		4)186·0″
Mean		46·5″
Irradiation, say		2·0″
True diameter		44·5″
The *Nautical Almanac* gives for the same data		43·4″
Difference		1·1″

And as I find that the *Nautical Almanac* gives only the Polar semi-diameter, which corresponds to 92·345″ at the earth's mean distance, and not the equatorial, which is given on p. 6 as 98·19″, I think my measurements are not very far from the mark. The following night I took twenty more, and they worked out to 46·6″. I consider these results so satisfactory as to merit the attention of your readers. With Slade's micrometer, used on a long-focus microscope, it appears to me that even better results might be obtained.

I beg to state I count the half-seconds, as it gives more accurate results.

Hatfield, near Doncaster. **T. Moore.**

A NEW ORGAN-PIPE.

[32874.]—I HAVE attempted to show in what manner I have modified an organ-pipe, and successfully gained a new quality of tone. Fig. 1 is the pipe, and Fig. 2 outline section. Now, though imperfectly constructed (being no metal-pipe maker), the speech is quick and sure, with a surprisingly pure and beautiful quality of tone, quite out of the common. Virtually it is a stopped pipe—I have not yet tried an open one—the cylindrical body A being some 6½in. long, 2¼in. diameter. The top end furnished with cap or stopper for tuning purposes; the bottom, or mouth part, has an end soldered in to half pipe's diameter, and answers to the top lip of ordinary pipe (see M in sketch). The lower under half is also soldered to the end, and is a semicircular appendage or portion of the "throat" or windway B, extending from, and as part of, the foot C.

Observe, the bent under part is not entirely soldered to the body at its upper edge, so that, in voicing, the "bottom lip," or straight edge of B may have this under part bent outwards and downwards very slightly, and as shown at P. Fig. 2 is a relative position of these parts when in speech. Voicing consists simply in getting edge of M and B parallel, the latter a little lower than level, and by depression of throat-piece very slightly, till the best quality of tone comes. No trouble with speech, as promptitude is well nigh inevitable. The mouth being so wide, big ears or side-pieces are wanted, which are represented by dotted lines in Fig. 2 at R. Of course, these ears are soldered on when voicing is complete.

To a voicer many points seem paradoxical. To wit: the extreme gravity of tone from size of pipe; mouth extending whole diameter, whilst its height does not exceed one-tenth this width; extra wide flue, little or much wind at pleasure, yet without flying off; one might reasonably expect the stream of air would ineffectually pass into body of pipe. All voicing precedents seem at variance!

I had better say this eminently musical tone resembles a clear clarionet, with a light-quality Gedeckt covering it, and has also a pleasant burr, not unlike the throatiness of a strong tenor voice. A small treble pipe (I have but three) gives a delightfully liquid, limpid tone, so clear and round, yet with the pleasing burr (not at all reedy or stringy).

The idea may not be new to others, but is certainly so to me. Anyone able to cobble with a soldering-iron can do the job, and, to be candid, my first "pipe" was made from a small oval mustard tin—and the tone *is* charming! Certainly this bantling wants investigating—culturing—that a better acquaintance may show its capabilities. I am engaged in putting together a large C C pipe, and intend trying an open one.

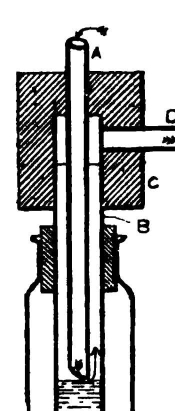
Amongst our readers may be some whom this account will interest. Possibly professional pipe-makers might care to make a properly-constructed article, have it voiced, and kindly report with what success they meet in this our ENGLISH MECHANIC organ-pipe. **Devoir.**

DIALLING.

[32875.]—IN my letter, p. 223, the angle L A B ought to read L A B′, the accent above the B having been left out in copying. **A. S. L.**

INCUBATORS.

[32876.]—HAVING given several incubators, it may be as well to say a little about regulators. It will be obvious that the main thing to be looked to is the prevention of the temperature rising much above 104° Fahr., as that does injury, whereas a fall of a few degrees for a short time is comparatively of little moment. The hen herself, it may be remembered, often leaves the nest for several minutes while she stretches her legs and feeds; so that if we can devise a regulator which will act either side of 90—104, that will do. I copy one for-



warded by "Glatton," appearing in the number for April 29th, 1887, which is intended for use with gas, but may be suggestive to others who are skilled in devising such things. The illustration shows a thermostat in which A is a glass tube through which gas enters and descends into a tube, B, reascending through B to a space in the cork C, and issuing through glass tube D. A little mercury at bottom of the bottle rises as air in upper part of bottle, expands and closes the gas-way. The bottom of A is cut aslant; the bottle should be long, stopper made air-tight with paraffin. Temperature adjusted by sliding A. Incubans.

THE PHYSICAL BASIS OF MUSIC.

[32877.]—It may well be doubted whether the physical basis of music does not lie in the nervous organisation of those gifted with a "musical ear," rather than in the harmonic scale given by your correspondent, Mr. Purday, on p. 16 ante, "E. M." No. 1379, Aug. 28. Be this as it may, I would like to point out that this scale is only an approximation to the true musical (vocal or melodic) scale, which is that naturally used by vocalists and performers on such instruments as require for the production of correct intonation a good "musical ear," and sufficient skill on the part of the player.

The musical scale, like many other natural phenomena, is determined by a law expressible in a simple arithmetical statement. This is not the law of vibrating strings, although that is so far connected with it that it is surprising that the acoustic experiments which led to the invention of the harmonic scale did not also suggest the simple law of the melodic or true musical scale. Their failure to do so no doubt arose from the fact that the harmonic scale is partly correct, and where incorrect its false notes are so far passable imitations of the true ones as to satisfy a not very critical "musical ear." These false notes are the third (E, if C be the keynote), the sixth (A), and the seventh (B), which are all slightly flat. They have been determined in accordance with the erroneous assumption that *every* note in the diatonic scale *must* be producible by some simple aliquot part of the length of string which sounds the keynote. This assumption may have been suggested by the fact that some of the notes of the scale are certainly so producible—the string-length giving the fourth note (F) being exactly $\frac{3}{4}$, that giving the fifth (G) $\frac{2}{3}$, and that giving the second (D) $\frac{8}{9}$ of the keynote string. The simple fractions $\frac{1}{9}$, $\frac{1}{4}$, and $\frac{1}{3}$, having been thus disposed of, there remained the $\frac{1}{5}$ and $\frac{1}{7}$. No note of the scale could be found to correspond in any way with the last fraction; but, unfortunately, $\frac{4}{5}$ and $\frac{3}{5}$ of the keynote string gave notes closely resembling E and A respectively. $\frac{8}{15}$ of the keynote string (not a very *simple* fraction) was found to give a tolerable B or seventh note of the scale, and this has at least the merit of putting the direct interval between E and B, and also makes the semitone between B and C equal to that between E and F; but then, as the E is incorrect, B must be wrong likewise. The falsity of the harmonic E and B is, indeed, quite apparent to the ear, for it makes the two semitone intervals too wide.

Before stating the law which regulates the true or melodic scale, it may be well to point out some of the inconsistencies of the harmonic one. The intervals between the notes of it are represented by fractions as follows:—

C $\frac{9}{8}$ D $\frac{10}{9}$ E $\frac{16}{15}$ F $\frac{9}{8}$ G $\frac{10}{9}$ A $\frac{9}{8}$ B $\frac{16}{15}$ C.

Here it will be observed that three of the whole-tone principles are valued at $\frac{9}{8}$, and the other two at $\frac{10}{9}$. In the true and natural scale no such inequality exists. Every musician understands that the five whole-tone intervals of the diatonic scale are equal; no differences can be detected by the ear. Besides this error of inequality in its whole-tone intervals, the harmonic scale, as stated already, has the defect that its semitone intervals are too wide.

It is a necessary consequence of these irregularities in the intervals between the consecutive notes of the harmonic scale that corresponding defects occur in its longer intervals. All the major thirds are short. Of the minor thirds D—F only is correct, E—G and A—C being too long. The fourths C—F, D—G, and G—C^1 are correct, and E—A is so within a small fraction, although the notes themselves are both flat. The fifths C—G and F—C^1 are true, but D—A is short, while E—B is correct, although the E and the B are flat, being equally so. Of the sixths, C—A and D—B are short, but E—C^1 is long. The sevenths, C—B and D—C^1 are short, and true respectively.

Another result of the harmonic irregularities is that when the keynote is changed the resulting scale is no longer harmonic, and new irregularities are introduced. Take, for example, the scale of D. As Mr. Purday mentions two new notes, F sharp and C sharp are needed to put the semitone intervals in the proper places. Making these two new notes in harmonic relation to the keynote D, the result is the scale whose consecutive intervals are indicated below. And to show how these two differ from those of the real harmonic scale, I have placed underneath them the corresponding measures of that scale—

D $\frac{10}{9}$ E $\frac{9}{8}$ F sharp $\frac{16}{15}$ G $\frac{10}{9}$ A $\frac{9}{8}$ B $\frac{9}{8}$ C sharp $\frac{16}{15}$ D.
$\frac{9}{8}$ $\frac{10}{9}$ $\frac{16}{15}$ $\frac{9}{8}$ $\frac{10}{9}$ $\frac{9}{8}$ $\frac{16}{15}$.

From the above it is plain that the intervals of the D scale are not harmonic. To make them so, new notes must be substituted for E and A, as well as for C and F. Moreover, the C sharp, and F sharp, if in true harmonic relation to the keynote D, cannot be the same notes as those so named in table headed "Just Intonation" on p. 16. If any other note be adopted as the keynote, similar inconsistencies will be found in the resulting scale.

From all these defects the true or melodic scale is free. In it all similar intervals are equal, in whatever part of the scale they occur, and a change of keynote involves only those substitutions (of sharps or flats) required to shift the semitone intervals to the right places in the new scale. It is founded on the fact that the ratio of vibration of every note, without exception, is to that of the fifth below it as 3 is to 2. It is through non-conformity with this law, and the adoption of the ratios 5 to 4 and 5 to 3 as those in which the third and sixth notes of the scale respectively are related to the keynote, that the errors of the harmonic system have arisen. The melodic scale has no notes bearing these ratios to one another.

As the number of vibrations of every note in a given time is inversely proportional to the length of string producing it, string-length becomes a convenient measure when comparing one note with another. Thus since the vibrations of any note are to those of the fifth below it, as 3 to 2, the lengths of string producing them are as 2 to 3. This fact, and this alone, is the key to the structure of the true musical scale. A series of simple calculations in accordance with it gives the proportional string-lengths of all the notes, both diatonic and substitutional, of this scale, as exhibited below.

MELODIC SCALE.

Diatonic Intervals.	Name of Note.	String-Lengths.	Vibration Ratios.
	C	1·0000	1·0000
$\frac{9}{8}$	D flat	0·9492	1·0535
	C sharp	0·9364	1·0679
	D	0·8888	1·1250
$\frac{9}{8}$	E flat	0·8437	1·1734
	D sharp	0·8326	1·2010
	E	0·7901	1·2656
$\frac{256}{243}$	F	0·7500	1·3333
$\frac{9}{8}$	G flat	0·7119	1·4046
	F sharp	0·7023	1·4238
	G	0·6666	1·5000
$\frac{9}{8}$	A flat	0·6328	1·5802
	G sharp	0·6242	1·6020
	A	0·5926	1·6874
$\frac{9}{8}$	B flat	0·5625	1·7777
	A sharp	0·5549	1·8021
$\frac{256}{243}$	B	0·5267	1·8986
	C	0·5000	2·0000

On comparing this with the harmonic scale, as represented on page 16, we see that the relative positions of the sharp and flat occurring within each whole-tone interval are reversed. In fact, the sharps of the harmonic scale are too flat, and its flats too sharp; while its two diatonic semitone intervals are too wide,—wide enough to admit two notes within each of them.

On the same page, 16, Mr. Purday gives us a table whereby we may compare the harmonic vibration ratios with those of the equal temperament scale, and showing the differences between them. If a similar comparison be made of the melodic and equal-temperament vibration ratios, the differences are found to be less in the case of nearly every note. The two sets of differences are shown below:—

	Harmonic differences.	Melodic differences.
C..........	0·0000	0·0000
C sharp..	− 0·0014	− 0·0013
D..........	− 0·0026	− 0·0026
D sharp..	+ 0·0033	+ 0·0020
E..........	+ 0·0098	− 0·0058
F..........	+ 0·0014	+ 0·0014
F sharp..	− 0·0002	0·0000
G..........	− 0·0018	− 0·0018
G sharp..	+ 0·0062	− 0·0037
A..........	+ 0·0151	− 0·0057
A sharp..	+ 0·0137	− 0·0082
B..........	+ 0·0127	− 0·0109
C..........	0·0000	0·0000

This closer agreement of the equal temperament with the melodic scale shows that the former is not so much out of tune as is generally supposed.

I think the inconsistencies of the harmonic system are well shown in connection with the violin. In tuning this instrument the usual method adopted is first to tune the second (A) string to the proper pitch, and from that (by "ear") to tune the other three strings, so that there shall be an interval of a perfect fifth between the notes sounded by each pair of contiguous strings—that is, three consecutive perfect fifths between the notes of the highest and lowest strings. Now, if the harmonic system be adhered to, this can be effected only on one condition—namely, that the third (D) string shall be the one from which the others are to be tuned. Taking this starting note as keynote, the harmonic scale yields one perfect fifth downwards and two upwards, giving the three desired perfect fifths. But if either of the other strings are used for the initial note, at least one of the fifths must be short. If the first or highest string be chosen as the starting-point, the short interval would be the middle one. The effect of the usual practice—fixing the pitch of the second string first—would be to make the lowest interval the short fifth. If the lowest string be chosen for the initial note, the short fifth would fall between the notes of the first and second strings. Now, here are four possible modes of tuning, each of which gives a different result, three of these being wrong if the harmonic scale be followed. But as the tuner always follows his "ear," it *naturally* leads him to tune in accordance with the melodic scale, and he gets the three desired consecutive perfect fifths. It really does not matter which of the strings he starts from, although, no doubt, there are considerations which make it preferable to begin with the second.

Edinburgh. **Walter M. Hardie.**

THE NEW GAS-GLOBE STOVE.

[32878.]—When Mr. Batty's new gas-globe stove was first brought under my notice I entertained and expressed precisely the same views as those so clearly put forth by Mr. Thos. Fletcher in his letter to the Eng. Mechanic (No. 32775). In fact, I hardly thought the experiment worth trying when one of the globes was sent to me. I was therefore considerably surprised to find that the stove *did* work very successfully, and this by converting a large portion of the convected heat of a luminous gas-flame into radiant heat, the bulk of which is radiated downwards and sideways. Actual thermometric experiments established the fact that the lower strata of air in the room were warmer by 10° F. with the globe than without it, the same quantity of gas being consumed in each case; and as we do not live near the ceilings of our rooms, the globe is so far effective. Its power is, of course, limited, and it is, I presume, not intended to compete with Mr. Fletcher's admirable gas-stoves, but only as a handy and cheap adjunct to an ordinary gas-bracket, and as such it is a useful contrivance.

W. F. Barrett.

Royal College of Science, Dublin.

[32879.]—In my previous note on this subject I wrote from experience of similar appliances which have been invented and re-invented many times during the last 20 years, but without any special knowledge of the details of the one referred to, and I should have preferred to report my results, after trial, to the inventor privately; but as he asks for these in the "E. M.," I give them at his request. As I explained to him in a private letter, my experimental room is at present in the builder's hands, and exact results are not possible in any room not specially constructed for the purpose. The claim, again repeated, that this, or any other appliance, will increase the *total* heat evolved is to be regretted, as it is a false and impossible basis. On this subject theory and practice go hand in hand, and it is a simple matter, with proper appliances, to trace and account for the total heat evolved under any possible conditions, to measure it exactly, and to state, from calculations only, the precise amount of heat originally evolved. On this point there can be no possible doubt, and if heat is evolved in an unexpected manner, its source and its absence in other directions can be traced and measured with absolute certainty—a fact which the inventor could, with sufficient experience, prove for himself.

I tested his arrangement, not against an open flame, but one with an opal globe, with a 6in. opening underneath, such as I commonly use in my own house, both being 6ft. from the floor. The difference at the floor level did not exceed 1½° in favour of his arrangement, and possibly no difference would have existed if both tests had been made under absolutely the same conditions. The curious variation in the temperatures at different levels in the first experiment, no doubt, was caused by the fact that the room had been closed as tight as possible for twelve hours previously.

The rise in temperature at the ceiling was fully four times as great as at the floor level, bearing out my previous statements fully. The value of any heating arrangement depends on its power to raise the temperature at the floor level at least as much as it is raised in the upper part of the room, and, as a matter of fact, the best incandescent fires will raise the floor temperature at least three or four times as much as the upper air, the result being that gas burnt in an incandescent fire is, beyond all comparison, more effective than the same gas burnt at a higher level.

GAS CONSUMPTION 7C.FT. PER HOUR.

BATTY'S GLOBE STOVE.

Position of Thermometer.	Initial temperature.	After one hour.	Rise of temperature.
Ceiling, 18in. from vertical line above globe	54°	74°	20°
6ft. from floor, 3ft. from globe	53	58	5
Under globe, 3ft. from floor................	51	56	5
Under globe, floor level	49½	55	5½
COMMON OPAL GLOBE.			
Ceiling, 18in. from vertical line above globe	57	90	33
6ft. from floor, 3ft. from globe	55	60	5
Under globe, 3ft. from floor................	55	59	4
Under globe, floor level	55	59	4

With regard to the apparatus itself, it has the very serious objection that, without experience, it is most difficult to light. That this is the case is shown by the precise directions printed. This difficulty is quite unnecessary, and is caused solely by the incorrect proportions of the burner. A similar burner, correct in details, would be totally impossible to light back under any conditions whatever, and this is a serious defect which ought to be remedied. I can only again express my regret that Mr. Batty has thought fit to make this a public matter, and I have only given my results at his special request. Many years ago I had a similar arrangement to test, in which the radiator was a plate of pumice-stone, and, so far as my memory serves, I believe it was slightly better than the iron one now brought out; but the results were so unsatisfactory that I did not think it worth further consideration, and I believe the arrangement has gone entirely out of use. It is evident to all who have devoted any attention to exact testing and results, that any heating arrangement, to be economical and satisfactory, must be as near the floor-level as possible. Thos. Fletcher.

ORGANETTES.—IX.

[32880.]—THOUGH I still use the same heading, some of the instruments now to be described scarcely come under the title of organette, as they contain mechanism for vibrating steel tongues, striking strings, &c., these latter being in certain cases combined with reeds, and in others forming independent sound producers.

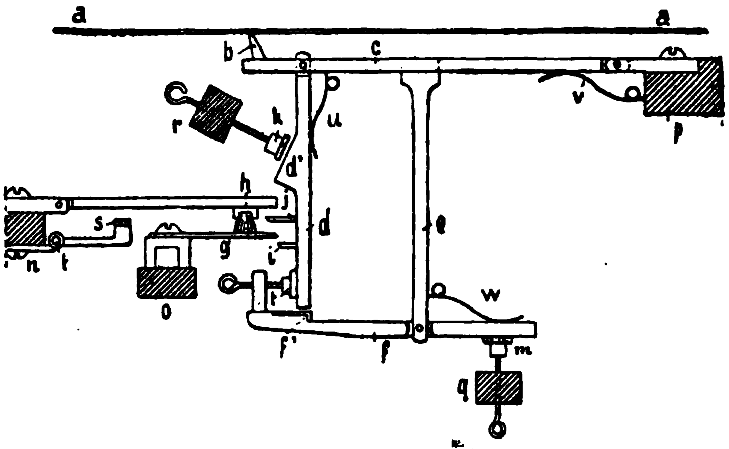
These Ehrlich patents are so numerous, and include such an enormous variety of constructions, that it is only possible to describe some few of the more characteristic examples, and as regards those for playing on a piano or other keyed instruments, it will be better to leave them for a subsequent letter.

It will be well to divide the whole (as far as possible) into three classes—those in which the movement of the tune-band or disc *directly* produces the blow or required action, those in which the band or disc brings the hammer or lever or "jack" (to use the old Harpsichord term) under the influence of the principal movement, and those in which one or the other of these is additionally complicated by a double combination as of reeds and strings with their valves and hammers.

The first example, Fig. 21, shows an ingenious arrangement for vibrating steel tongues, such as those of a musical box or (so-called) Bell piano. Here we have the perforated tune-band or disc *a*, *a*, with the point *b* to enter the perforations. This point is carried by the lever *c*, to which is fixed the vertical bar *e*, at whose lower end is pivoted the horizontal bar or lever *f*, with its upright stud *t*, carrying the pad and adjusting screw.

To the lever *c* is also pivoted a second vertical bar *d*, of which one part, *d'*, forms a bevelled projection. This bar *d* has two pins, *i* and *j*, of which the former serves to vibrate the tongue *g*, and the latter to simultaneously lift the damper *h*. The way it works requires a little examination to render it plain. If the bar *d* moved straight up and down, the pin *i* would catch in the tongue both in the upward and downward movement, and it is therefore necessary as soon as *i* has got above the tongue to hold it back free of the tongue till it has been sent back into its original position by the passing onwards of the tune-band. This is the duty of the catch or locking lever *f*. It has been mentioned that the vertical bar *e* is *fixed* to the lever *c*, and in consequence of this the lower end of it is thrust forwards from right to left, when the lever *c* is permitted by a perforation to move upwards, and in so moving it carries the locking lever with it sufficiently far to let the notch at *f'* catch the lower end of the bar *d*. In order to bring about this, the inclined block *d'* in moving upwards pushes itself back by rubbing against the stop *k*, which action necessarily also carries back the pin *i* free of the tongue. The next moment the notch *f* secures *d* in this inclined position, and retains it till the original position is regained, the block *m* at the same time causing the tail-end of the lever to rise and unlock *d* ready for a fresh up-stroke. Fig. 22 shows the action just as the upward motion is completed and the lower end of *d* has been caught by the notch of the locking lever. The part marked *s* is merely a bar for lifting the whole set of dampers and leaving the tongues free to vibrate.

FIG. 21.



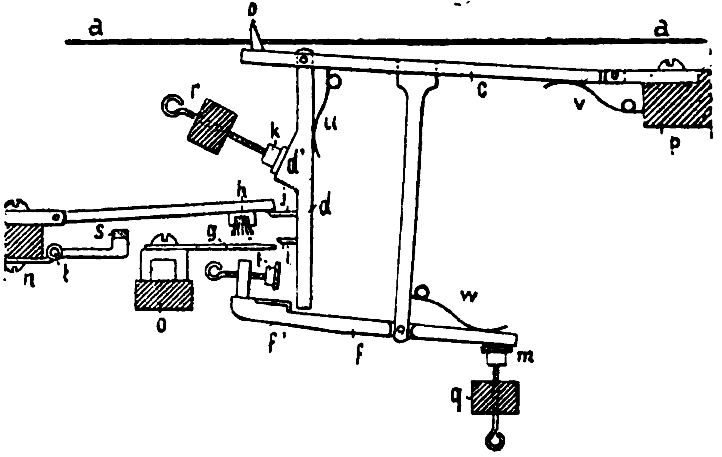


FIG. 22.

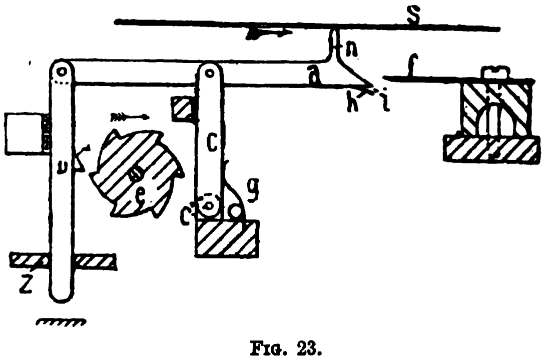


FIG. 23.

The same specification shows the mode of applying a very similar contrivance for the purpose of vibrating strings by "plucking" them. In Figs. 21 and 22 we may consider the "tongues" *g*, with their dampers *h* and lifting-pins *i* and *j*, removed, as well as the supports *n* and *o* and the parts *s* and *t*, the other parts remaining as shown. Then to the lower end of *d* is fixed a long depending wire slightly hooked at the point, and this hook, when *d* rises, plucks the string that lies just above the hook. In the return stroke the hook is kept clear of the string, just as the pin *i* was kept free from the tongue. Above the string is a lever-damper, much like that at *h* in Figs. 21 and 22. When there are (say) three strings, there are three hooked wires instead of a single one. The string being plucked by the action of the spring *v*, this must be pretty strong, and as the spring has to be bent originally by the edge of the perforation in the tune-band the latter would be subjected to great wear and tear. The specification accordingly shows and describes "a music sheet with recesses" instead of ordinary perforations, the edges of the "recesses" being shown slightly rounded off as if stamped in metal, though the actual material is not mentioned. This question of material for the tune-bands will, however, occur again in connection with some of the other patents.

As the first example of the second class of "actions" in which the sound-producing parts are merely *brought into connection* with the primary motive parts by the tune-band and levers, I give Fig. 23.

In this we have the lever *d* with its projection *n* for entering the tune-band *s*. This lever is pivoted on the top of the oscillating bar *c*, controlled by a check-spring *g*. It also carries the vertical bar *v* passing somewhat loosely through the guide *z*. The end of the lever *d* acts on the tongue *f*, and carries a little damper *h* underneath the point *i*. At *e* is the revolving "tappet" which catches in the projection of *v*. This tappet-wheel is kept constantly revolving, but does no "work" until *n* enters the perforation. When this takes place the advancing tune-band *carries with it* the projection *n*, and consequently throws over towards the right hand the whole system of jointed levers, thus bringing the point *i* above the end of the tongue *f*,

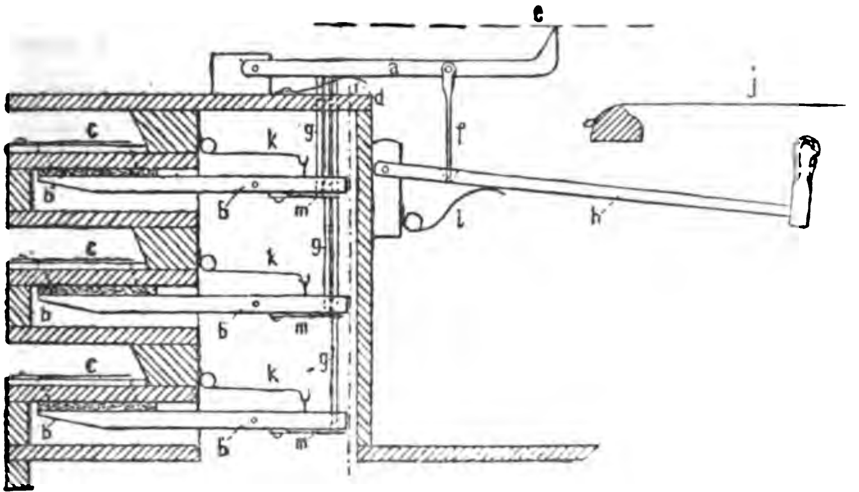


FIG. 25.

and at the same time enabling the tappet-wheel to push up the bar *v*, and so depress the other end of *d*, and cause it to vibrate the tongue. The same movement obviously brings down *n* clear of the perforation in the tune-band, and on the tappet escaping from its hold on *v*, the whole is by the action of the spring *g* replaced in position for a fresh movement.

Various modifications of the relative positions of the links, levers, &c., are shown in the specification; but I need only give one of them, which is selected as leading up to one form of instrument for playing a piano. In Fig. 24 we have the vertical bar *k* pivoted to the horizontal lever *l* with its spring *g'*, the upper end of *k* being formed to enter the holes in the tune-band. Instead of the tappet-wheel, there is a roller, *e'*, with an indiarubber or roughened surface, of which the friction is sufficient to cause the hook *j* to vibrate the tongue *f*. In this case, also, the tune-band carries the rod *j* a little to the right, so as to bring it into contact with the roller, and (as before) the projection *n* is, by the depression of *k*, carried down out of the perforation in the tune-band, thus setting the parts free for a repetition of the process. The patentee points out that, as the force of the spring *g'* need only slightly exceed that required to sustain the weight of the rod and lever (more correctly, "radius bar"), the upward pressure on the tune-band is but small. Suppose, now, the lower end of *k* was made to press down a piano-key, we should get the idea of one kind of pianista; but though mentioned here in connection with Fig. 24, the details of the apparatus as actually constructed will more conveniently come later on. I, therefore, pass to the third class of these particular arrangements, which, as already mentioned, comprises those more complex forms combining two instruments in one.

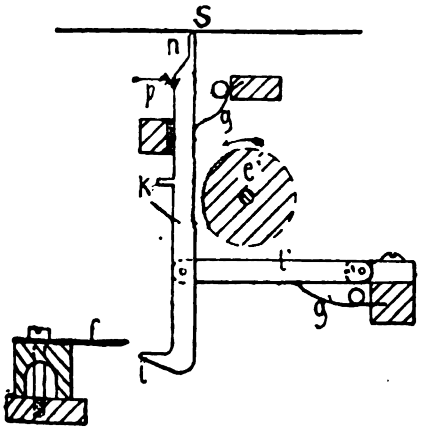


FIG. 24.

In the one shown in Fig. 25 there are reeds combined with strings. The reeds are arranged in three rows, *c c c*, one over the other, each with pallet-valves and levers, the latter being pivoted at *b*, and prolonged to receive the "stickers" *g g g*. These stickers do not rest immediately on the lever ends, but on the springs *m m m*, so as to insure the closing of the valves. The stickers are kept depressed by the tune-band till a perforation allows the nose *e* of the lever *a* to rise; the sticker then allows the spring *k* to pull up the outer end of the lever, and thus open the pallet. Simultaneously with this opening of the reed-pallet, the pivoted sticker *f* permits the hammer to strike the string *j*, under the impulse of the spring *i*.

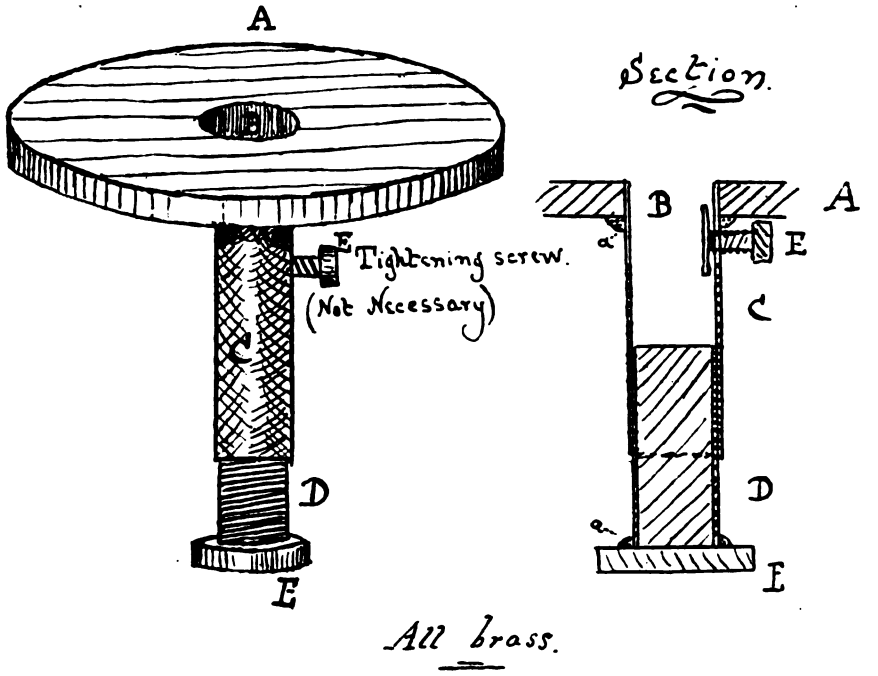
How far this could be put into a "workable" design is doubtful, for unless the spring *i* were a very strong one, the blow of the hammer would be too feeble to be effective. If, however, the spring were sufficiently powerful to cause the hammer to give a good blow, it would require corresponding force to depress it, and this would put great strain and wear and tear on the tune-band; so that on the whole it seems rather a "suggestive" claim than a real one. I have nevertheless inserted it, as reference will have to be made to the hammer action in connection with another instrument that I propose describing when dealing with pianistas.

A. S. L.

P.S.—Since writing the above I have come across the description of an early form of organette made under Mathews's patent, in which the mechanism much resembles that in Fig. 23, but employed to actuate the pallets of reeds instead of to vibrate the tongues.

THE CUTTING OF SIMPLE MICROSCOPICAL SECTIONS.

[32881.]—In case some of the readers of the "E. M." are quite fresh to the work of preparing objects for microscopical investigation, and would be glad of a few hints on the very first rudiments of the matter, I venture the following remarks, which might lead such readers up to the more useful and technical work that they would like to do afterwards, had they any familiarity with the initial difficulties already, and for want of which they are not so well able to avail themselves of such a chance as that which Mr. Davis now offers them, as they would wish to be.



A, Flat surface-plate; B, Tube inside; D, Fine screw-shaft; C, Tube outside; E, Let in to tighten the bedded stem, which is placed in at B; *a*, solder. D should get as long a bearing in C as is possible, for firmness; or it may be simply a sliding piece, raised by a wedge, if the whole is fixed to a table.

With a hand lens, it is easy to look down on the outside of an object and observe it. With the higher power of a microscope, it is almost necessary to be able to see through the object, so as to light it up from the other side, on which the lens does not get in the way of the light. It is also very useful to be able to look at the interior of many objects; and thus, chiefly for the sake of the transparency, it becomes very necessary to be able to prepare a thin slice of an object, whenever its structure allows of it, before we can bring the microscope to bear on it with much effect. For very many reasons, which will become plain to the student as he proceeds, it is better to have this slice as thin as it possibly can be got; and as this is so, and as it is the object of the microscopist to do away with thickness, and to look upon his slice as a sectional elevation of the object he is examining, the slice is spoken of as a section.

Now, to get practice in preparing such sections, we may at once say that there are a great many objects that are more or less difficult to make into sections—and this for many reasons; but amongst those that are easiest for a beginner to deal with, and which also repay his even clumsy attempts, are the stems of plants. An old, thick stem is too hard; a very young, thin one is too soft; but he should try to get an intermediate one, that is neither the one nor the other. The size should be rather less than that of an ordinary cedar pencil, or of about that diameter; if too large, we shall not get a section alike in thickness all over; if too small, we shall not easily see what we are doing. A bramble shoot is not a bad thing to try, or a geranium, or bean-stalk, but one should try as many as can be got. A razor, as sharp as ever it can be made, is the thing to cut with, and it is best to have it not hollow ground,—although that should not deter one from trying, if another is not to hand. Now, try first to cut without other assistance than your two hands. Hold the stem in the left hand, and cut it across with a sharp knife first, so as to make a flat end. It is best then to moisten this upper cut end with spirits of wine, or methylated spirit, and the razor also; and to have by one a small saucer, with water in it, to put the sections into when cut; and a camel's-hair paint-brush, of small size to brush them off the razor with. Hold the razor in the right hand, with the edge away from you, and hozizontally, and hold the stem of the plant upright in your closed fist, pressing both arms against your breast to steady them and keep them together. Cut outwards by drawing the razor along the cut obliquely in one direction, and then return it, with a sawing but gentle motion, keeping the same pressure up, and never stopping the cut till you are through. Do not make two cuts at the section, but have it off in one long one if you can. Keep the razor and plant-surface wet, and brush off the sections into the saucer with the brush, till you have a lot done. You will find it difficult to keep the cut quite horizontal, and not oblique, and still more so to get a whole section that is of at all equal thickness all over. Therefore it will be almost certain that you will not attain to any great degree of perfection like this, although it helps to get your hand in. You will want some form of a support. A flat brass surface, with a hole for the stem to come up in, will suggest itself, and if you let a tube of brass into this hole, cut off flush with the surface, that will keep the stem upright; and, again, if you had a finely-cut screw to fit in the bottom of this tube, and push up the stem by a very, very small amount each time that you took off a section, you would have a simple form of section machine that is quite good enough to make good sections of stems, with patience, care, and a little practice (see sketch). The main point is to have a sufficient number of turns to the inch, and to have the screw work steadily. It will also be necessary to pack the hole, so that the piece of stem that you put in may be firm, and this may be done with pieces of carrot, of pith, &c., wedged pretty tightly. If your stem is a dry one, you can do it by melting up the mixture of paraffin that is recommended by Mr. Davis, and pouring that in a warmed tube for a mould, with the stem in the midst, as he described; but at first you will find it easier to cut a carrot to the shape required, and leave just enough space for the stem, by means of two grooves cut in the face of the carrot after it has been sliced in two. With such an instrument, which I think many of the readers of the "E.M." would make for themselves, many sections should be cut of one stem, and the best of these selected. It will be easy to examine them mounted in water between the cover-glass and the slide, and it will give the learner the useful practice of trying to get the section free from air-bubbles and the cover-glass successfully on it without admitting air or spoiling the section, which will be useful when he deals with other fluids and valuable thinner sections.

I have myself cut many sections of the stems of most common trees and shrubs at the age of one year or thereabouts, and I think that anyone who could command such an instrument as I describe would be able to cut sections of stems that would repay him by their interest when stained; and most of the harder of these could be mounted permanently with but little trouble, in a manner that I would describe, if it were wished, in a second letter, and which has the advantage of allowing a variety of kinds to be collected and mounted under one simple plan of treatment that may be more or less perfected; and, whether or no the student passes on to more complicated mountings, it has its results, so far as they go, left in a permanent form, which is pretty and interesting. Instead of having a screw to raise the stem in the tube of the section cutter, this can be done by means of a wedge, or both methods may be combined, while the instrument itself can be purchased of most opticians, in some form, for a few shillings.

Shanklin, I.W., Oct. 23. **H. G. Dixon.**

MAGIC SQUARES.

[32882.]—Before you put the closure on this subject I have been asked to send you some account of a new way of making *even* squares, which does not require any previous knowledge of magic squares, and which, too, is equally applicable to both evenly-even and oddly-even roots. In the method recently explained in these columns by Mr. Cram and Dr. Willis, after the skeleton has been formed, its four compartments have to be superimposed with magic squares of half the root—that is, we have to use four squares of 3 to make a 6-square, four squares of 4 to make an 8-square, and so on. This implies a previous knowledge of how to make the smaller squares. Mr. Cram suggested to me that the small magic squares might be dispensed with, and natural squares substituted for them. A "natural" square is simply the numbers arranged in natural or consecutive order.

1	2	3	7	8	9
4	5	6	4	5	6
7	8	9	1	2	3
3	2	1	9	8	7
6	5	4	6	5	4
9	8	7	3	2	1

Fig. 1.

The above figure shows the "aspects" that the four natural squares must take in order that the summation of the complete square shall be correct, and needs no further explanation. The skeleton square with which it is superimposed must be such that its second, third, and fourth quarters may be turned into the same aspects relatively to the first, as the second, third, and fourth in Fig. 1 above are in relation to its first quarter, without destroying its magicality. The way of making such skeleton squares is to make a skeleton of quartets, as described in my letter of Oct. 9, and to disperse the numbers in the order 1, 3, 5, 2, 4, 6 (and *not* in the order marked round the diagram in that letter). The resulting square is to be superimposed with four natural squares, all with the *same* aspect; and *then*, on turning the 2nd, 3rd, and 4th quarters of the combined square into the aspects indicated in Fig. 1 above, the magic square is formed.

It is not even essential that natural squares shall be used. A very great number of variations are possible by using any square that possesses the same complementariness of numbers that the natural square has. This requires a slight explanation. In the natural square of 3—e.g., all pairs of numbers adding 10 are complementary—e.g., 3 and 7, and 2 and 8. Accordingly, we may transpose these pairs by putting the 3 and 7 into the cells occupied by the 2 and 8, with or without first transposing the 3 and 7, or the 2 and 8, or both. Hence, every two pairs of complementary numbers may be transposed in eight ways, three pairs in forty-eight ways, and so on, *n* pairs being capable of $|\underline{n} \times 2^n$ transpositions. When the root of the square is high, it is obvious that the number of variations becomes very great.

Before concluding, it may be interesting to observe that there is another use to which natural squares may be put in the formation of large magic squares; but want of room will not allow me to give much more than a hint. If the natural square of 4 be divided into its four quarters, each of these may be substituted, under certain circumstance, for 1, 2, 3, 4 in the quartets—

1	2
3	4

&c. Thus—

1	2
5	6

may be substituted for 1;

11	12
15	16

for 4, and so on.

1	2	4	1	3	4
3	4	2	3	1	2
2	1	1	4	4	3
4	3	3	2	1	2
4	2	1	3	4	1
1	3	4	2	2	3

Fig. 2.

Let Fig. 2 be the model for constructing a 12-square. Substituting the natural square of 4 for each quartet, as just hinted at, we get the following skeleton square:—

1	2	3	4	16	15	2	1	13	14	15	16
5	6	7	8	12	11	6	5	9	10	11	12
9	10	11	12	8	7	10	9	5	6	7	8
13	14	15	16	4	3	14	13	1	2	3	4
4	3	2	1	1	2	15	16	16	15	14	13
8	7	6	5	5	6	11	12	12	11	10	9
12	11	10	9	9	10	7	8	5	6	7	8
16	15	14	13	13	14	3	4	1	2	3	4
16	12	8	4	1	5	9	13	16	15	2	1
15	11	7	3	2	6	10	14	12	11	6	5
2	6	10	14	15	11	7	3	8	7	10	9
1	5	9	13	16	12	8	4	4	3	14	13

Fig 3.

This may be superimposed, as it stands, with the series 16 (0, 1, 2 . . . 8), each number repeated 16 times in the same compartment, and arranged in the usual way as a 3-square; or the numbers may be dispersed, either singly, in the order 1, 5, 9, 2, 6, 10, 3, 7, 11, 4, 8, 12 in both rows and columns, or in quartets, in the order 1, 3, 5, 2, 4, 6, which, cell by cell, is the order 1, 2, 5, 6, 9, 10, 3, 4, 7, 8, 11, 12. In the case of the former dispersion, we get a skeleton of 16 compartments, capable of being superimposed with 16 squares of 3; and in the latter one of four compartments, capable of being superimposed with 4 squares of 6. I do not give examples of these dispersions, as my letter is long enough already; but the reader who cares to follow up the matter will be able to understand how it is done by perusing the recent letters of Mr. Cram and Dr. Willis.

New Athenæum Club. **T. S. Barrett.**

[32883.]—Inclosed I send you a magic square of 64 cells. The sum of the numbers in each row, column and diagonal, is 260. The square itself can be divided into 16 squares, or into 16 oblongs, as

64	2	62	4	5	59	7	57
9	55	11	53	52	14	50	16
17	47	19	45	44	22	42	24
40	26	38	28	29	35	31	33
32	34	30	36	37	27	39	25
41	23	43	21	20	46	18	48
49	15	51	13	12	54	10	56
8	58	6	60	61	3	63	1

Fig. 1.

64	2	62	4	5	59	7	57
9	55	11	53	52	14	50	16
17	47	19	45	44	22	42	24
40	26	38	28	29	35	31	33
32	34	30	36	37	27	39	25
41	23	43	21	20	46	18	48
49	15	51	13	12	54	10	56
8	58	6	60	61	3	63	1

Fig. 2.

shown by thick lines in Figs. 1 and 2, the sum in each being 130, or $\frac{1}{16}$th of 2,080, the total sum. Other groups of four numbers can be found in this square.

The method which I adopted to arrive at this result I will try to make clear by referring to Fig. 3, trusting I shall not be occupying too much of your space.

Divide the total sum—viz., 2,080, by the total number of squares, the quotient is 32½. Subtract 32½ from 64, 63, 62, &c., to 33, and insert the results successively in the rows 1, 2, 3, 4, and omit the signs. They will appear as 31½, 30½, &c. The sum total of the numbers in the 4th row is 32. By symmetry we want four of these to be negative and = 16, and four positive. This is possible, for ½, 2½, 5½, 7½ added together make 16. These, then, must be either positive or negative. Suppose them positive. Then the numbers 1½, 3½, 4½, 6½ should be negative, as shown, in order to make the total of the row zero, as it should be, and similarly in regard to the rows 1, 2, 3.

To form the rows 5, 6, 7, 8, make the numbers in row 5 the same as in 4, but in the reverse order, and the same with 6 and 3, 7 and 2, 8 and 1.

To settle finally the signs, if we take column 1, the sum of the figures themselves is 128. By symmetry four of these are required to be plus and four minus, and each set = 64. This is possible, for 31½, 7½, 8½, 16½ added = 64. These should be taken either

	1	2	3	4	5	6	7	8
1	+31½	−30½	+29½	−28½	−27½	+26½	−25½	+24½
2	−23½	+22½	−21½	+20½	+19½	−18½	+17½	−16½
3	−15½	+14½	−13½	+12½	+11½	−10½	+9½	−8½
4	+7½	−6½	+5½	−4½	−3½	+2½	−1½	+½
5	−½	+1½	−2½	+3½	+4½	−5½	+6½	−7½
6	+8½	−9½	+10½	−11½	−12½	+13½	−14½	+15½
7	+16½	−17½	+18½	−19½	−20½	+21½	−22½	+23½
8	−24½	+25½	−26½	+27½	+28½	−29½	+30½	−31½

FIG. 3.

all plus or all minus. Assume them all plus. Then 23½, 15½, ½, 24½ should be all minus (in order to make the total of column zero as it should be), and these fit in with the signs previously assumed in the first four rows.

Having thus fixed the signs of the first four rows and of the first column, the signs of the remaining numbers of the square must be taken as the opposite of the same numbers in rows 1, 2, 3, 4. By adding 32½ to each number, we get the magic square.

As the numbers in Figs. 1 or 2 appear to be symmetrically placed, I think a rule (if required) might be deduced for writing them down at once, commencing with the number 1.

I should mention that the clue to the above square was got by operating on and slightly transposing a known symmetrical arrangement of a four square.

Mr. Barrett, in his letter (32798), intimates it would be interesting to explain construction of 6 square in 32755. I may state I knew of nothing to guide me except that in Fig. 2 of that letter the sum of each row and of each column should be zero, and the rows be made to follow, if possible, in reverse order, and with opposite signs in the manner shown. The remainder of process in forming Fig. 2 was made by trial. The square Fig. 1 was then obtained from Fig. 2 by adding 18½ to each number. J. H. Truscott, F.R.S.N.A.

MAGIC SQUARES.

[32884.]—As so much interest seems to be taken in magic squares at present, permit me to state that probably the largest magic square in existence, or that has ever been constructed, is in the possession of the Hartley Institution at Southampton.

It comprises the numbers 1 to 1,024, in 32 lines and columns, and two diagonals, summing up 16,400 each way, and was composed by my eldest son, William Stuart, and by him presented to the Hartley Institution in October last year, he being at that time just turned 17. Wm. H. Daniels.

◆

[32885.]—The square of eight given by W. H. Gates, A.M.I.C.E. (letter 32797), may be derived by a few transpositions from one formed by the following rule:—

Place in the eight rows of the square, alternately in direct and reverse order, the first 64 consecutive numbers. Then reverse in the upper half of the square the several pairs of consecutive columns, so as to obtain the following preliminary arrangement:—

	a	*a*	*b*	*b*	*c*	*c*	*d*	*d*
a *b*	2 15*	1* 16	4 13*	3* 14	6 11*	5* 12	8* 9	7 10*
c *d*	18 31*	17* 32	20* 29	19 30*	22 27*	21* 28	24* 25*	23 26
d' *c'*	33 48	34 47	35 46	36 45	37 44	38 43	39 42	40 41
b' *a'*	49 64	50 63	51 62	52 61	53 60	54 59	55 58	56 57

In each column and diagonal we have already the normal sum of 260. To make the sum normal in each row we have only to exchange one number in each of the pairs of columns marked *a*, *b*, *c*, *d*, with the number vertically below it in the opposite row, here marked with the same marginal letter. Thus, we may exchange either 2 and 64, or 1 and 63, and in the same row either 4 and 62 or 3 and 61, together with 6 and 60 or 5 and 59, and finally 8 with 58 or 7 with 57. In order, however, to retain the normal sum in the diagonals, we must either leave both numbers which lie in the diagonals in each of the rows *a b* unchanged, or we must change them in both, and the same with the rows *c d*. If we exchange as indicated in the above preliminary arrangement, we obtain the following magic square, in which complements are adjacent throughout.

	a	*a'*	*b*	*b'*	*c*	*c'*	*d*	*d'*
a *a'*	2 49	63 16	4 51	61 14	6 53	59 12	58 9	7 56
b *b'*	18 33	47 32	46 29	19 36	22 37	43 28	42 39	23 26
c *c'*	31 48	34 17	35 20	30 45	27 44	38 21	25 24	40 41
d *d'*	15 64	50 1	13 62	52 3	11 60	54 5	55 8	10 57

The reader will see that by varying the mode of making the exchanges and by transposing the rows and columns the above may be made to assume $32^2 \times 8 \times 6 \times 4$, different shapes. One such transformation is here given with complements opposite each other in the rows. The marginal letters explain the changes in the order of the rows and columns.

	c	*b'*	*d*	*a'*	*a*	*d'*	*b*	*c'*
c	27	30	25	34	31	40	35	38
b' *d*	37 11	36 52	39 55	32 50	33 15	26 10	29 13	28 54
a' *a*	53 6	14 61	9 58	16 63	49 2	56 7	51 4	12 59
d' *b*	60 22	3 19	8 42	1 47	64 18	57 23	62 46	5 43
c'	44	45	24	17	48	41	20	21

This method of forming a preliminary arrangement (which may be similarly treated) is only one of a vast number (—). The readers may, for example, form a square from either of the following by making the indicated exchanges, or others which will readily suggest themselves.

4	3*	2	1*	8*	7	6*	5
13* 20*	14 19	15 18*	16* 17	9 24	10* 23*	11 22*	12* 21
29 33	30 34	31* 35	32* 36	25* 37	26* 38	27 39	28 40
48 49	47 50	46 51	45 52	44 53	43 54	42 55	41 56
64	63	62	61	60	59	58	57

3*	1	2*	4	6	8	7	5*
13 20*	15* 17*	16 24	14* 19	12* 18	10 21	9* 23*	11 22*
30 37	31 40	29* 33	26* 38	27* 39	32* 36	25 34	28 35
43 54	42 56	44 55	47 53	46 51	41 49	48 50	45 52
60	58	57	59	61	63	64	62

In this last square the consecutive order disappears. The first row contains the series 1 . 2 . . 8, and the third the series 17 . 18 . . 24 arranged at random. The second row is formed from the first, and the fourth from the third, by adding 8 to each number and reversing the order. The four lower rows contain the complements of the numbers in the upper rows in reverse order. In the finished square, complements are obliquely opposite.

J. Willis.

[32886.]—The suggestion relating to the formation of even magic squares communicated by Mr. Barrett (Sept. 10) contained only one of two leading ideas I had intended to convey. One referred to the mode of constructing the skeleton composed of the four numbers—0, $\frac{n^2}{4}$, $\frac{n^2}{2}$, $\frac{n^2}{4} \times 3$. The other referred to the method of constructing the skeleton composed, in each of its four quarters, of the numbers 1 to $\frac{n^2}{4}$. The latter, owing, probably, to obscurity in my explanation of the meaning of the term "complementary square," was not communicated by Mr. Barrett. The mode of constructing the first skeleton was mainly devised to render possible the substitution of complementary squares for magic squares in the four quarters of the second skeleton, and thus secure uniformity in the mode of constructing "even" and "evenly-even" squares, and furnish a method which would be universal for all even numbers exceeding 2, and independent of any such rules as would be required in the construction of *minor* magic squares.

By "complementary square" is meant a square in which both numbers of each complementary pair are equidistant from the centre of the square, and connected, as it were, by a straight line drawn through it (the centre). The natural square is a complementary square, and, still keeping by the root 6, it is now used for illustration:—

1	2	3	7	8	9
4	5	6	4	5	6
7	8	9	1	2	3
3	2	1	9	8	7
6	5	4	6	5	4
9	8	7	3	2	1

FIG. 1.

A	B	C	D
C	D	A	B
B	A	D	C
D	C	B	A

FIG. 2.

In Fig. 1, four identical complementary squares of the root 3 are used as second skeleton, their relative positions in the four quarters of the square being indicated by Fig. 2.

The number of possible variations in the arrangement thus of the numbers in each quarter, and for any root, would be:—

$$(1 . 2 . 3 . . . x) \times 2^x$$

where, the minor square being even, $x = \frac{n^2}{2}$, and, being odd, $x = \frac{n^2-1}{2}$ the root of the *minor* square being here represented by n.

Previous to superposition on the above skeleton, each number in Mr. Barrett's skeleton has to be diminished by 1 and multiplied by 9. A similar skeleton, thus adjusted, would stand, as in Fig. 3.

0	27	9	18	18	9
9	0	27	18	9	18
27	9	0	9	18	18
27	0	18	27	0	9
0	18	27	9	27	0
18	27	0	0	9	27

FIG. 3.

Readers are referred to his letter for the manner of construction. The construction, however, might be effected with one operation; but this is a detail.

J. C.

STAND PHOTOGRAPHIC ENLARGEMENTS.

[32887.]—There is a manner of enlarging which, of course, is in no wise comparable with the bromide process, but, nevertheless, is capable of affording, if not a means of admiration, certainly of amusement.

The process, which is very simple, is as follows:—By means of a magic-lantern throw an image of the negative, preferably a portrait, upon a screen, and, of course, accurately focus the same. Now pin with four drawing-pins a sheet of paper upon the screen, preferably of a yellowish or neutral tint, and with a camel-hair brush commence with a weak solution of Indian ink to wash over the whole of the illuminated space; afterwards with a somewhat stronger solution go over the half-tones, finally finishing up the high lights with a solution of much darker hue. What should be aimed at in the picture is the production of an equal tint all over the sheet, so that no image or irregularity is discernible. This scrupulously carried out would, it is plain, result in a perfect enlargement. It is surprising, however, in what a short time (say ten minutes) a person totally devoid of artistic capabilities can produce a portrait, the truthfulness of which is irresistible. We all know how difficult it is to draw the sketch of a person's face in which is any real expression at all, let alone the correct one; but by this process, which is no more difficult than the copying of pictures by means of a child's transparent slate, a positive and immediately recognisable portrait can be produced. It need hardly be said that it is well to have two different-sized brushes, the larger for the washes, and the smaller for details. **Albert E. Bennett.**

CATGUT FOR CLOCKS.

[32888.]—In the articles on Clockmaking which have appeared in your journal lately I notice that catgut is recommended for weight-cords, &c. This, from my experience, does not seem a good material.

When I was in India I had a Vienna regulator, which went very well indeed until the rains came on, when it stopped, and, though cleaned and oiled, it still refused to go. At last it struck me that the catgut might be at fault, so I dried and oiled it: then the clock went all right.

It seems to me that with damp catgut becomes, to a certain extent, elastic, and at each beat the pull of the weight was taken up by the elasticity of the catgut instead of being communicated to the clock, as though, in fact, the weight were hanging by an indiarubber string. Now, if this were sufficient in India to stop the clock, there must, one would think, always be some effect in damp weather here—enough to cause the pull of the weight to vary somewhat.

As soon as I could get it, I substituted fisherman's gimp for the catgut. After that, the damp made no difference to the clock.

I do not know how gimp would answer in place of catgut for the spring fusee clock described; but I should advise anyone who does not care to buy chains to try it. It is immensely strong, and would not be so liable to chafe and cut as catgut, and it is cheap. **Gimp.**

TECHNICAL GAS ANALYSIS.

[32889.]—Some time ago the writer presented a review of researches made by many chemists on improvements in analytical processes employed in gas analysis. Since then Profs. Lunge and Lewes have made valuable contributions to the subject, which may be of interest to many readers of the "E. M."

Examination of Pyrites Burner Gases.—In the manufacture of sulphuric acid, it is important to test the gases coming from the Pyrites burners. This has usually been done by ascertaining the volume of gas required to decolorise a definite quantity of iodine representing a definite quantity of SO_2. This, as was well known, is not very satisfactory, because the gases contain SO_3. Prof. Lunge has, therefore, proposed to pass the gases through standard caustic soda, using phenolphthalein as indicator, which indicates neutrality at the formation of Na_2SO_3. Further details are given in the *Journal Society Chemical Industry* for Nov., 1890.

Estimation of SO_2 and SH_2 in the Chance Process.—Mr. Crowther, of Messrs. Chance, uses the peroxide process. He passes the gases through standard iodine and hydrogen peroxide, when

$$1.\quad \begin{array}{l} H_2O_2 + SO_2 = H_2SO_4 \\ H_2O_2 + SH_2 = 2H_2O + S \end{array}$$

Then, by titrating by standard soda, we get the sulphur dioxide. The reactions with iodine are—

$$2.\quad \begin{array}{l} H_2S + 2I = 2HI + S \\ SO_2 + 2I + 2H_2O = 2HI + H_2SO_4 \end{array}$$

In this way we get the sulphur in two forms; by substituting that in 1 we get the SH_2.

Chamber Exits.—Chamber exits are usually tested for acidity, and occasionally for nitric oxide. This is done by passing the gas through a sulphuric acid solution of potassium permanganate; suffice it to say that no better method has been found for this purpose, the chief improvement being in the use of absorption apparatus, those of Emmerling and Mayers being preferred, the former having been in use for a long time in my laboratory, with the most excellent results; it may be used very well in place of the usual tube for estimating ammonia in coal-gas. The distinguished author of the handbook on Sulphuric Acid and Alkali has also rendered great service by his improvement of the gas volumetric processes of estimating "bleach" manganese ore, &c., and by the introduction of his apparatus for reducing the gases to N.T.P. Prof. V. B. Lewes, in a paper before the London Section, Society Chemical Industry, reviewed existing methods for the separation of a mixture such as CO, CO_2, O_2, CnH_2nCH_4N, and has shown that the estimation, the correct estimation of even the simpler gases, is not so easy as is generally supposed. Prof. Lewes also tried new absorbents, such as alcohol and paraffin, for CNH_3N. Prof. Lewes's results have shown the following is the best method of procedure: CO_2 and SH_2 are absorbed by 50 per cent. NaO_4, allowing ten minutes for absorption. Oxygen is absorbed by alkaline pyro., which must not be too new or too old, nor it must not be employed too often. Unsaturated hydrocarbons must now be absorbed by bromine in potassic bromide, allowing 15 minutes. Carbon monoxide is absorbed by acid Cu_2Cl_2, which must not be used too often, and 15 minutes must be allowed. The saturated hydrocarbons must now be partly absorbed by paraffin oil, and the remainder then exploded with excess of oxygen. The gases then submitted to absorption by caustic soda, and then pyrogallate, whence the marsh-gas, and by difference the nitrogen, is found. Prof. Lewes takes another portion of gas and explodes by the spark after mixture with oxygen, then submitting to the action of caustic potash and pyrogallate, which gives the nitrogen—a very important factor in coal-gas—and which analyses are often found containing nitrogen, which cannot possibly be present, and which is due to faulty methods of analysis. Whilst not agreeing with all Prof. Lewes's conclusions, thanks are due to him for calling attention to this subject, and still more for formulating a scheme for the estimation of carbon monoxide in gaseous mixtures. I have for a long time employed palladium asbestos for burning CO and hydrogen, and believe that nothing better can be desired, and if coupled with the usual absorption methods, is nearly all that can be desired. However, a good method for the estimation of benzine vapour in mixture with gases is still a desideratum.

J. A. Wilson.

Tottington Mills, near Bury, Oct. 26.

REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[74424 and 75328.]—**Midland Engines.**—No. 1870 is one of the Midland Company's fine new class of express engines, built at Derby from the designs of Mr. S. W. Johnson, and employed to work the most important main-line traffic. No. 1870 is similar to No. 1853, which was sent to the Paris Exhibition of 1889, and which has been illustrated in your columns. Clement E. Stretton.

[75000.]—**American Organ.**—The "Practical Organ Builder" seems to wish to hide his reply to my question as to where those shilling-a-set pallet-springs are made (p. 201), by appending it to the reply which appears under another number on p. 226. He says there definitely that these shilling-a-set springs are used in the "best American-made organs," and I can only reply that they are not. The cost of manufacture may be only a shilling; but a set of 61 good pallet-springs cannot be bought for a shilling retail, and the statement made shows how much practical knowledge this organ-builder has. He can easily settle the matter by offering to supply them at the price. That would be conclusive.

Etienne.

[75273.]—**American Organ.**—See reply to query No. 75705, in this week's issue.

Practical Organ Builder.

[75276.]—**Carbonising Wool.**—As one who has during the past few years had numerous opportunities of thoroughly studying the various processes now carried on by large flock dealers for the carbonising of wool, rags, &c., and judging of their merits in a commercial point of view, I should strongly advise "Fibre" to write to J. Illingworth, flock manufacturer, Whitelee, Batley, Yorkshire, who would undoubtedly put him in the right way to accomplish his object in a satisfactory manner, and would show him, if necessary, his latest patented machine in operation. I may add that the materials to be carbonised, rags, wool, woollen waste, &c., which may contain cotton-seeds, straw, or any other vegetable matter, are fed into his machine, and are carried forward by mechanism through the apparatus, during which time they are being thoroughly impregnated with an acid gas, which destroys all vegetable matter, leaving the animal fibres practically uninjured. The mechanism of the machine is automatic and continuous, and may be so regulated that the material to be carbonised can be passed through the machine in any given time. H. L.

[75353.]—**Retouching.** — This querist should read Johnson's "Art of Retouching" (Marion), and try what he can do by rubbing over fine pumice powder; but if he must have a "medium," it is better to buy those sold by the dealers.

Stub.

[75355.]—**Galanty Shows.**—I do not think there is any book, cheap or otherwise, devoted to the manufacture of figures for galanty shows, but there is some information about them in back volumes. The figures might be cut out of thin brass or tin-plate as easily as out of cardboard; but perhaps some render knows of a descriptive article on the subject. M. T.

[75366.]—**Decomposition of Iron and Steel.**—Iron decomposes more rapidly than steel according to their respective qualities. Steel is really iron; but neither cast iron nor wrought iron is steel, and steel itself varies. J. L. R.

[75370.]—**Tainted Beer.**—The beer can be filtered and bottled off with a grain or two of rice in each bottle, and after standing some time will probably lose the "musty" taste; but is that really due to a tap imperfectly cleaned, and not to the beer itself? A Cellarman.

[75375.]—**Strasburg Turpentine.** — Probably it is only another name for Venice turpentine, or, perhaps, Bordeaux turpentine. Turpentine, so far as its name goes, is rather an indefinite quantity, as it is distilled from the oleo-resins of various species of Pinus, Picea, Abies, and Larix, and varies with their peculiarities and the methods of preparation.

S. R.

[75377.]—**Gas Generator.**—There are many forms of this, the general principle being that air is blown through a chamber containing benzoline or gasoline, the evaporating surface of which is increased by filling the chamber with cloth screens, lumps of pumice, or other equivalent methods. The blowers used are similar to gas-meters, the only practical difference being that the drum of the meter is driven by a weight and pulley. 999.

[75383.]—**Water-Motor.** — Any of the small water-motors in the market will suit Mr. Walker, provided he has enough pressure in his supply. He says "a very fair pressure," but that is indefinite. He can find suitable water-motors illustrated in back volumes. R. S. T.

[75384.]—**Etching.** — Copper plates can be "etched" to the depth ($\frac{3}{16}$in.) required; but for what purpose such deep "eating away" can be wanted is a puzzle. Will not engraving suit the purpose of the querist who calls himself "A Reader," but can scarcely have read many numbers of the "E. M."? A copper plate of any thickness can be cut right through by means of acid, protecting the sides of the "cut" with varnish as the work proceeds; but *Cui bono?* Nun. Dor.

[75393.]—**Silicate of Soda.**—Silicate of soda on dry or porous substances dries readily. I think there is nothing that will hasten its drying, and if there were, it could scarcely improve the silicate, which practically forms a sort of glassy film on the surfaces to which it is applied. "Tommy Hawk" should make experiments himself, as he knows his own object, which he carefully does not mention when seeking information. Perhaps his woodwork was not dry itself when he tried to "prime" it with silicate of soda, which, by the way, does not readily take to wood. Nun. Dor.

[75398.]—**Freezing Machine.** — There are freezing machines which will answer in Queensland or elsewhere, but they mean considerable expenditure for plant. The querist's brother seems to have tried the ordinary hand-machines, and I can only recommend him to read up the subject in back volumes. Freezing powders are useful only on the small scale; and all the machines which work on the small scale are rather expensive and troublesome. A rather costly plant must be put down to work the freezing process with success if it is wanted to freeze sheep or other perishable matters.

S. I.

[75405.]—**Force Pump.**—All that is necessary for this pump of $\frac{1}{4}$in. bore and 1in. stroke is a cylinder of iron of the required bore and a plunger to fit it. Whether it will be capable of pumping up to two tons on the square inch remains to be seen, and depends on the "prime mover" at the outside end of the handle. I think that probably the querist could find what he wants in the articles on Model Locomotive Making, for such a pump is a very small affair, though strongly made would be powerful enough for anything, provided the "power" is applied at the pumping end.

Archi.

[75436.]—**Nasik Squares.**—I am sorry to confess that, inadvertently, I made a careless blunder in my last reply, p. 225. The smallest numbers for making a nasik square of 10 are *not* as I stated, but are, very obviously, the numbers 1 to 10, with 11 substituted for 10. And the lowest summation of a nasik square of 10 will, accordingly, be 562.

T. S. B.

[75436.]—**Nasik Squares.**—I wonder to whom we are indebted for the curious substitution of the words "the *surface* of 6" for "the *square* of 6" at the end of my reply, p. 225? It would be a remarkable slip for me to make, and also a remarkable misreading of the compositor (if I did not write it), as my MS. is always legible. "Arithmetic" is surely misinformed, if he thinks the word "nasik" may only be applied to magic squares consisting of consecutive numbers. Rev. H. A. Frost, the inventor of the word, did not so limit it, as may be seen from his contribution on the subject to the *Quarterly Journal of Mathematics*, in which he actually indicates, roughly, the method of making oddly-even nasik squares by leaving out some of the central numbers of the progression.

T. S. B.

[75436.]—**Nasik Squares.**—As the magic summation of a 6-square composed of the natural numbers, beginning with 1, is odd, and as there are 18 odd numbers in such a square, "Arithmetic," if he tries to arrange 18 units in a square of 36 cells, so as to produce odd summations in rows, columns, and diagonals, may be able to prove that a Nasik square of the first 36 numbers is impossible. His square was Nasik, except as to two columns, one of which summed 102 and the other 120. In the following square, which is the nearest possible approximation to a Nasik square, within the limits prescribed by "Arithmetic," one of the abnormal columns (the third) sums 110, and the other (the sixth) sums 112, each summation differing only 1 from the normal, 111:—

1	14	27	36	23	10
32	35	18	5	2	19
21	6	11	16	31	26
4	15	25	33	22	12
29	34	20	8	3	17
24	7	9	13	30	28

If the numbers 18 and 19 are mutually transposed, the summations of the columns become normal, and those of two diagonals in each direction are correspondingly perturbed. The square possesses many additional points of interest, chief among them being that the summations are alike of all batches of nine numbers lying between the same diagonal parallels, and which are contained in rhomboidal spaces having perpendicular sides. There are 72 such spaces in the square (repeated where required). One half of them sum 166, and the other half, 167. Although I have always been of "Arithmetic's" opinion, as regards magic squares at all events, that they ought to consist of consecutive numbers from 1 upwards, consecrated (if I may so speak) as they have been to these numbers for thousands of years; still, the fact cannot be ignored that the Nasik square of 9, given in the current edition of the "Encyclopædia Britannica," by the Rev. A. H. Frost, who, though not the inventor of Nasik squares, yet nevertheless was (or is —Is he still living?) the author of the term, is not (if I remember rightly) composed of consecutive numbers, though, of course, it might have been. Should "Arithmetic" care for such, I could give what I term a kaleidoscopic square of 36 cells, consisting of the numbers of the natural square of 7, *minus* those in its middle row and middle column. In addition to being "Nasik," it is "4-ply," "9-ply," and "16-ply." It also contains symmetrically and uniformly disposed aggregations of any number from 2 upwards, whose summations are equal to one another for all combinations containing the same number of numbers.

J. C.

[75488.]—**Press Screws.**—The reason that the threads of press screws are fuller at the top than at the bottom, is rather difficult to grasp; but I will endeavour to explain the cause in as practical a manner as possible. First, suppose, for example, we turn a piece of round steel, and then turn a series of grooves round the circumference of the steel with a parting tool, see Fig. 1. Now if you calip grooves, A A A, and also calip the rings B B, you will find them perfectly square. Secondly, now suppose we get another piece of round steel the same as before, but instead of turning grooves on the circumference, suppose we plane four grooves on this piece of steel longitudinally, with a square-nosed tool, see Fig. 2. Now you can see in this case, without the aid of calipers, I mean by looking at the plan, Fig. 2, that you can see plainly that the spaces or grooves made by the tool are perfectly square; but the part marked B, which I propose to represent the thread of a screw, is not square, but very much smaller towards the centre of the steel. Of course Figs. 1 and 2 are the two extremes, one perfectly square and the other very much out of square; but if this is quite clear so far, then I think anyone who will give the question a little reasoning can easily see that the greater the pitch, therefore the greater the inaccuracy, and the smaller the pitch, the more near truth shall be the thread of the screw. This inaccuracy in press screws is the reason why the screws of new presses soon become loose, because the thread comes up to a sharp edge, and of course this same fault is in the nut or box of the press. Add these two together, a screw that shakes very much, see Fig. 3.

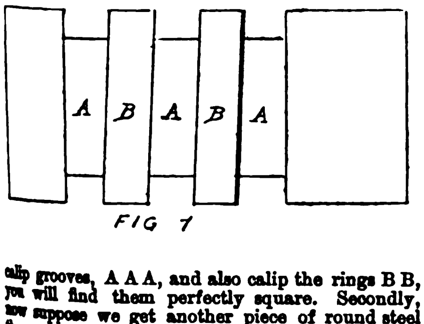


FIG 1

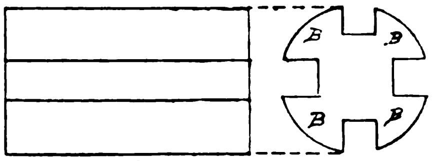
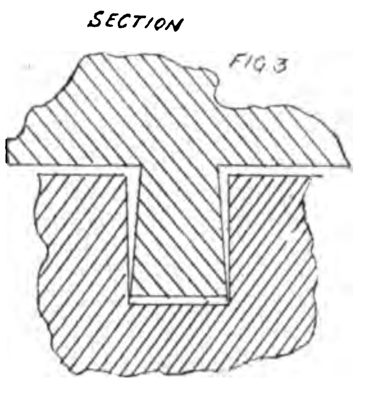


FIG 2



Birmingham. R. B. HODGSON.

[75507.]—**Locomotive Colours.**—Sorry I am unable to tell you what the picking-out and relieving colours of the N.L. Railway are. The number-plate (to the best of my knowledge) is an oblong brass plate, with enamel figures on it. The relieving colours of the G.N.R. and N.E. Railway are both crimson lake, with black and white picking-out lines. I cannot say what the colours of the other railway locos. are.

R. S. BRUCE.

[75524.] — **American Organ.**—On p. 184, "Practical Organ Builder" said that since the instructions, which give a "good insight" into the method of building an American organ were printed in Vol. XXVI., "many great and important improvements have been made." I asked on p. 204 if our friend could give a list of the patents, and he replies on p. 226 that he cannot "enter into any useless controversy on the subject of certain patented improvements." How there can be any controversy about the numbers and dates of patents I do not know; but if "Practical Organ Builder" can improve on those "vague instructions" to which he refers, it is, I suppose, quite open to him to do so, and introduce the "many great and important improvements" into the instructions which he will no doubt write for the benefit of readers of the "E. M."

ORGANON.

[75563.]—**Registering Rain-Gauges.**—If this querist will turn to page 424, vol. V., ENGLISH MECHANIC, he will find an engraving of one of the best revolving dial-gauges I have ever seen. Should he wish to procure the number, it is August 23rd, 1867.

AN A.I.E.E.

[75563.] — **Rain - Gauges, Recording.** — "F.R.Met.Soc." has unconsciously explained why I did not include Yates's or Crosley's (not Crossley) gauges in the articles on "Brit. Rainfall." The articles were on self-recording gauges, and he is correct in saying that they are not self-recording gauges. Very few Crosley gauges ever told the truth, and unless very carefully made and attended to, they are not trustworthy. A description and engraving of Yates's was given in *Meteorological Magazine*, Vol. XI. (1876) p. 153.

G. J. SYMONS.

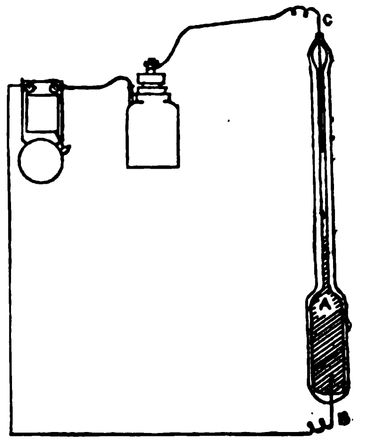
[75605.]—**Incandescent Lamps.**—Yes, lighting one 16c.p. lamp by hand-power is about as much as one man can do comfortably.

H. H. HEADWORTH.

[75610.]—**Electric Fire-Alarm.**—One method is to construct a mercurial thermometer having a platinum wire fused through the bulb, and another wire inserted down the stem, so that the mercury makes contact at any desired temperature.

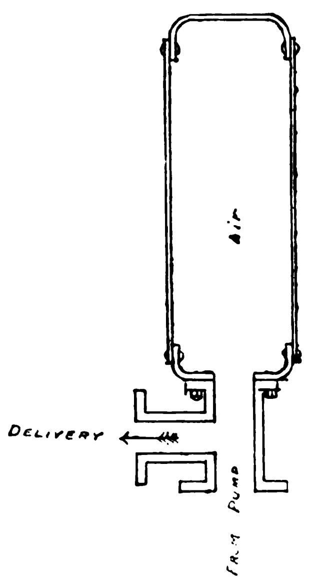
SM.

[75610.]—**Electric Fire-Alarm.**—I send sketch of simple fire-alarm. A is glass tube with bulb, partly filled with mercury; B and C are two platinum wires, the one (B) fused into bulb, and the other into stem; connect with bell as shown; by altering length of wire C you can make alarm to ring at any desired temperature.



Brighton. T. C. SMITH.

[75609.]—**Force Pumps.**—An air chamber fitted as sketch will make the delivery practically constant.



Brighton. T. C. SMITH.

[75612.]—**Interest.**—I doubt whether any of the replies given work out the matter properly, and I doubt whether my way is really absolutely correct. My way is:—

	£	s.	d.
£150 bears int. for three months, 5 p.c. ...	£1	17	6
£108 " " " "	1	7	0
£67 " " " "	0	16	9
£26 " " " "	0	6	6
	£4	7	9

In other words, legitimate 5 per cent. interest only comes to £4 7s. 9d.; but the lender got £50, which is 11·386 times 5 per cent., or within a trifle of 57 per cent. But it will be observed that the lender each quarter had £40 to lend again at the same rate. The risk must be great to justify such results.

Z. Y. X.

[75612.]—**Interest.**—Let A be the number of pounds borrowed, x the rate of interest (per cent. per annum), n number of payment of b pounds, each made at equal periods of m years, and y the amount which £1 becomes with interest added for one period. Now, when the first payment is made, the amount due is Ay; at the second payment the sum due is $(Ay - b)y$; and at the third term $(Ay^2 - by)y$. As the sum due at the last term is b, we therefore get the following general equation: $Ay^n - b(y^{n-1} + y^{n-2} \ldots\ldots y^2 + y + 1) = 0$ and $y = 1 + \frac{mx}{100}$. If "Discere Cupio" will fill in his special values in the first equation, he will find his y come out 1·105. As in his case it is also $= 1 + \frac{x}{400}$, hence $\frac{x}{400} = {\cdot}105$. His rate of interest has therefore been 42 per cent. per annum, assuming it to have been paid quarterly.

TOO MUCH FOR THE WHISTLE.

[75612.]—**Interest.**—I do not think either of the answers given to this query is exact. The following, I think, is correct. If a number of equal payments be made at equal intervals of time, in equity it is the same as if the whole sum be paid down at the end of the mean of the time over which the payments extended. Now the first payment was made at the end of one quarter, the last at the end of five quarters; therefore, the mean $= \frac{1 + 5}{2}$ = three quarters. So £200 paid down at the end of three quarters would be exactly equivalent to the quarterly payments. It follows, therefore, that the borrower pays £50 for the loan of £150 *for nine months*, or 33⅓ per cent. per ¾ annum, or at the rate of 44$\frac{4}{9}$ per cent. per annum, *the interest being paid nine-monthly*. Unless otherwise stated, the interest —when the rate per cent. per annum is required—is supposed to be paid yearly. So the problem resolves itself into this: What is the rate per cent. per annum if the amount of £150 for ¾ year be £200? Which the formula—

$$150 \times \left(\frac{100 + x}{100}\right)^{\frac{3}{4}} = 200 \text{ gives}$$

$$\therefore \log. (100 + x) = \tfrac{4}{3} (\log. 4 - \log 3) + 2,$$

from which $100 + x = 146{\cdot}7523$

$x = 46{\cdot}7523$ is got; being, I think, the true rate per cent. per annum.

Swansea. A. R. MOLISON.

[75614.]—**Electric Lighting.**—You will require two 16c.p. incandescent lamps—or, better still, four 8c.p. lamps—to light your room well; hence a 32c.p. or two-light dynamo, size depending on type and efficiency, will light these. Power required will be ¼H.P., or 2-man (approximately).

H. H. HEADWORTH.

[75618.]—**Tea Urn.**—Oxide of iron put on with a scratch brush. SM.

[75621.]—**Volcanoes in the Moon.**—It does not seem safe to say—in view of the changes that have apparently occurred on the lunar surface from time to time, notably in the case of Linné—that there are absolutely no active volcanoes in the moon now. It is not easy to say either one way or the other. Nevertheless, Sir W. Herschel is generally believed to have been mistaken when he affirmed that he had seen a volcano in a state of eruption on the dark side of the terminator. The crater he probably referred to was Aristarchus, which, as is well known, is the most brilliant crater on the lunar disc. This object can be seen very soon after the first quarter, before the terminator has reached it, as a dazzlingly white spot on the unilluminated portion of the moon's disc, which he fancied might be an active volcano. The illusion was probably not owing to any defect in the construction of the instruments used by that eminent astronomer. AUTOLYCUS.

[75623.]—**Paper Chemically Prepared.**—I do not see how you can get a dry paper to yield a mark from a metal point; but if it be charged with potassium ferrocyanide solution, and an electric current be passed through an iron stylus, you might be more successful. SM.

[75624.]—**Condy's Fluid Stain on Linen.**—Soak in warm hydrochloric acid, and immediately the deposit is dissolved, wash thoroughly to remove the acid, finally neutralising with a little ammonia. SM.

[75629.]—**Battery.**—The zinc dissolved is proportionate to the amount of electricity generated. You must, however, always amalgamate your zincs to prevent local action. SM.

[75629.]—**Battery for Small Motor.**—The best batteries for motors are either the chromic acid or bichromate, the former of which is the better. Keep your zinc plates well amalgamated: perhaps you have too much acid in your cells.

Brighton. T. C. SMITH.

[65629.]—**Battery for Small Motor.**—Why not use a Maquay battery? No trouble in amalgamating zincs. It is a splendid invention, and has been used with great success in various parts of Sherborne, for electric lighting, &c.

E. R. DALE, A.I.E.E.

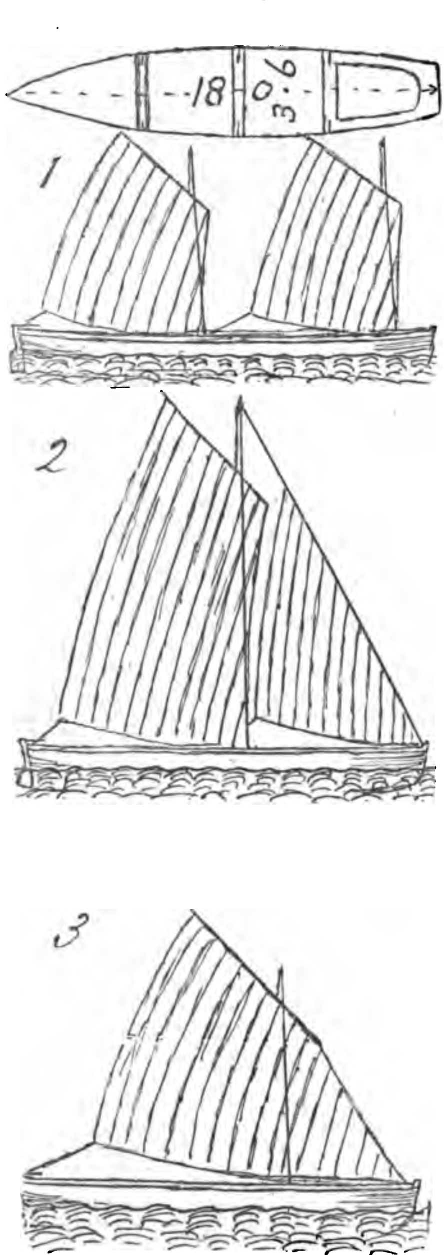
[75629.]—**Battery for Small Motor.**—The best cell for motor-working is the bichromate, using chromic acid for depolariser. The amount of zinc used should be proportionate to the work done. A motor running without load should require hardly any current, as the back E.M.F. generated by the motor opposes the E.M.F. of battery, therefore offering a high resistance, and choking the flow of current. Directly the load is put on the motor slows, the back E.M.F. drops, allowing more current, and burning more zinc. A great deal depends on the efficiency of motor, and small motors are never efficient, requiring a lot of current to do little work. Amalgamating the zincs with mercury will prevent a lot of waste by local action; also the number and size of cells should be arranged to suit the motor, or you will have loss. Battery power is always expensive. H. H. HEADWORTH.

[75632.]—**To "Eos."**—*Justicia paniculata* is the "Kreat" of Malabar, and "Mahateeta" (or "Great Bitter") of Hindoostan, a plant celebrated for centuries as a stomachic bitter, and used by the natives in cholera and dysentery;—many other "Justicias" are also valued by them for medicinal purposes. For more than half a century, French druggists have prepared a famous tincture, called *Drogue amère*, "Kreat" root being the basis. This is a compound of mastic, frankincense, resin, myrrh, and aloes, steeped with the above in brandy for one month. Possibly, a simple infusion of this plant may prove useful in sea-sickness. I need hardly add it has no bad qualities. EOS.

[75639.]—**Model Yacht.**—Use "killed spirits" (chloride of zinc) as a flux. If all the seams fit close and are clean, you should have no difficulty in making the solder run and stay where you want it. The size of propeller will depend to a great extent on the power of your engine; but to get anything like a good speed, you must make it considerably larger in proportion than for a large boat, say about 2½in. or 3in. in diameter.

Brighton. T. C. SMITH.

[75643.]—**Sailing.**—If "F. W. A." has any knowledge of boat-sailing, he will know that 3ft. 6in. beam is very little for stability, and doubtless his boat is very shallow. First thing I should do would be to bolt on a bar of iron 1½in. or 2in. square, according to the thickness of keel, tapering off the fore end to meet the round of the keel. No 1 sketch is capable of giving good satisfactory results in beating to windward, but two persons should attend the sheets, in case of down-puffs from the hills. I have drawn standing lug-sails as being most handy. No. 2 is a lug and foresail for single management; size depends on boat's stability. No. 3 is a dipping lug for long reaches, on one tack only, until shifted on the other side of the mast.

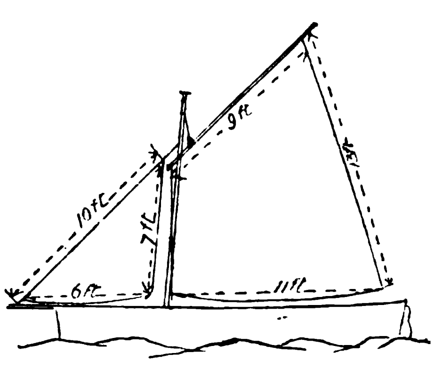


$\frac{1}{8}$" to 1·0 scale

Penryn. WM. HOSKEN.

[75643.]—**Sailing.**—I should advise a lug-sail as the most convenient. This would only require one halyard to hoist it. The mast to be about 10ft. high, placed about 6ft. from bow. The yard 7ft. long, to be fastened to halyard about ¼ of length from end. The peak of the sail would be 12ft. from gunwale of boat. To be able to go to windward, you would have to put on a false keel of about 4in., otherwise your boat would only drift. To fasten the halyard, make a ½in. hole, 6in. from mast, and 1½in. from after side of the seat, and drive in a hard wood peg, so that it projects 2½in. underneath. To fasten the rope, simply pass it round the pin, and jamb it between the seat and the standing rope; this will never give, and yet can be undone on the instant. All our fishing boats use this hitch, and never meet with an accident. Lastly, never sail with the sheet made fast; pass it round a pin placed on the stern, and hold the end in your hand. JERSEY ARTILLERY.

[75643.]—**Sailing.**—I think that the most handy rig for a small boat is the standing lug. 3ft. 6in. is very narrow for a boat 18ft. long, and unless she is very deep I should not make sails larger than shown in sketch.



Brighton. T. C. SMITH.

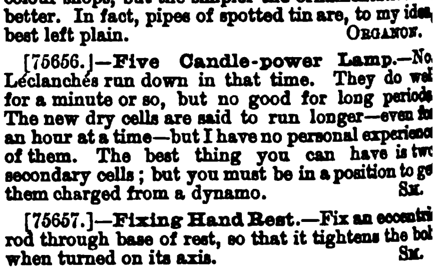
[75646.]—**Surfacing Wood Blocks.**—A mixture of zinc white and gelatine rubbed on with the hand, I believe. SM.

[75353.]—**Paint for Organ Pipe.**—Organ pipes are painted in just the same way as anything else, except that "dead" or "flat" finish is preferred. If the pipes are of wood, paint just as you would for anything of the kind; but if of metal, that must be well cleaned with turps first, and then have, say, two coats in oil, so as to leave a gloss. The final coat should be in turps only, as that treatment seems to give a better flat surface than if all the coats were mixed with equal parts of oil and turps. Suitable stencil designs can be bought at the artists' colour shops, but the simpler the ornamentation the better. In fact, pipes of spotted tin are, to my idea, best left plain. ORGANON.

[75656.]—**Five Candle-power Lamp.**—No. Léclanchés run down in that time. They do well for a minute or so, but no good for long periods. The new dry cells are said to run longer—even for an hour at a time—but I have no personal experience of them. The best thing you can have is two secondary cells; but you must be in a position to get them charged from a dynamo. SM.

[75657.]—**Fixing Hand Rest.**—Fix an eccentric rod through base of rest, so that it tightens the bolt when turned on its axis. SM.

[75657.]—**Fixing Hand-Rest to Lathe.**—I send sketch of a very simple and efficient method as used by the Britannia Co. Sketch will explain itself.



Brighton. T. C. SMITH.

[75659.]—**Plating Solution.**—The fault probably lies with the metal to be plated, which may be of a composition unsuited to the purpose in hand. SM.

[75659.]—**Plating Solution.**—You do not say how you made your solution, so it is difficult to advise you, but the chief causes of "stripping" are

1st, too much cyanide; 2nd, too great or too little battery power; 3rd, improperly prepared work. I think the former is most likely to be the cause of your trouble. Have only a very small excess of cyanide at first; you can always add it if needed. New solutions, unless very carefully worked, deposit an uneven coat of silver which is very liable to "strip." If the surface of the anodes is regulated so as not to rob the solution of silver, and dirt carefully kept out of the vat, a solution that has been worked for several years is far better than a new one. The best cyanide (95 per-cent) is very nearly white and semi-transparent.

Brighton. T. C. SMITH.

[75363.]—**Compressed Air-Engine.**—Exactly the same form as is used in steam-engines will do for compressed-air engines, but in their case it is often absolutely necessary to keep them warm, as the escaping air freezes any moisture in the air. See the Fielding high-speed engine, illustrated in the number for August 28, 1885. I remember seeing the Tower spherical engine at one of the exhibitions held at the Agricultural Hall, but it is impossible to give any lucid explanation of it without many diagrams. The querist should look up the patent specification, or possibly back volumes of the engineering papers. NUN. DOR.

[75668.]—**Dynamo Getting Hot.**—One of the following is most likely the cause of the machine running hot. 1st. The brushes press too hard on the commutator. 2nd. Brushes not adjusted to proper angle, and thus causing excessive sparking.

Brighton. T. C. SMITH.

[75669.]—**Snakes.**—To "AUTOLYCUS."—The best book I know is by Surgeon Nicholson of the Indian Medical Department, published by Higginbotham and Co. R. O. H.

[75669.] — **Snakes.** — "The Thanatophidia of India," by Sir Joseph Fayrer, is a very large and expensive book, with coloured plates, illustrative of each venomous species. The "Reptilia" of Dr. Gunther is a still larger and more costly work. I cannot remember the publishers' names. I recommend all those in search of special literature to visit the Library Catalogue Room of the British Museum, should they reside within easy reach of London.

EOS.

[75670.]—**Gasholder.**—The contents of the gasholder will be about 904·78ft. A. L.

[75670.]—**Contents of Gasholder.**—Contents of gasholder 12ft. diam. by 8ft. high = 904c.ft. A 3H.P. nominal Otto gas-engine will drive the pump referred to. An engine suitably adjusted for "Dowson gas" gives about 10 per cent. less maximum H.P. than with ordinary coal-gas; but this only affects the maximum power, and need not be taken into account for the above pumping. The chief advantage of gas-power is that the Dowson Company guarantee consumption of coal not to exceed 1¼lb. per indicated H.P. per hour. The actual consumption for above engine will be about 1lb. per indicated H.P. per hour. The best steam-engine for the above power cannot consume less than 3lb., and in all probability will require about 5lb. per indicated H.P. per hour in average practical work. W. RIDOUT.

[75670.]—**Cubic Contents.**—301¾ cubic feet.

SM.

[75671.]—**Influence of Light.**—An answer to this query may be given in four letters—"Bosh." Since chisels, &c., are never sold with an edge, it is not easy to see how exposure can blunt them.

SM.

[75672.]—**Modelling Wax.**—The following is a good modelling wax which I use with satisfaction: Beeswax, 8oz.; lead plaster, 8oz.; Burgundy pitch, 4oz. Melt together, and stir in sufficient chalk to form a paste. Form into sticks suitable for use.

FRANK.

[75673.]—**Broken Electric Wire.**—You will require to know resistance of whole line and length when perfect first; then proceed as follows:—Say, for instance, on a large scale the line is 50 miles long, and resistance 675 ohms; the resistance of line to broken part when tested shows 135 ohms. Therefore—

$$\frac{675 \text{ ohms}}{50 \text{ miles}} = 13{\cdot}5 \text{ ohm per mile,}$$

and—

$$\frac{135 \text{ ohms}}{13{\cdot}5 \text{ ohm}} = 10 \text{ miles,}$$

approximate distance of broken wire. MICK.

[75674.]—**Gas-Engine.**—From my experience, I should say keep to the iron ignition-tubes. Supposing you used platinum—which is now almost the price of gold—it would take a very long time indeed to use such a supply of iron tubes that would equal in value the platinum; then there is the probability of the bore gradually filling up with carbon from each explosion or ignition. I have found the bore of iron tubes so small that an ordinary sewing-needle could not be passed into it. The gas-engine I use is a 2-horse Crossley. In this the ignition-tube is changed every forty-five hours. The tubes are home-made; these last longer than those which were supplied with the engine.

S. ROBERT BONNEY.

[75675.]—**Phonograph.**—The edge of the cutting stylus should be very slightly curved, in fact a straight-edge with the corners rounded off. The number of rings in the armature are about twelve, or the rings are each $\frac{1}{24}$in. in thickness. To drive the phonograph by hand is possible, but in doing so a moderately heavy flywheel must be used to smooth down any irregularities of pressure which the hand may give on the driving crank or handle.

W. GILLETT.

[75679.]—**Canoe Building.**—The best book I know is "Canoe and Boat Building," "Forest and Stream" series, procurable from Norris and Wilson, Minories. It has with it a number of drawings in an envelope, which are valuable—and, indeed, indispensable—to an amateur. The price is, I think, 7s. 6d. or 8s. GOLDEN SLIPPERS.

[75680.]—**Falling Bodies.**—Let G denote the *variable* accelerating force, g its initial and minimum value, h the space described by a particle in the time t, and v its velocity due to G at the end of t. Then, m being some given constant, we have (as I understand the question) $G = mh + g$. Hence it follows from dynamics that—

$$\frac{d^2h}{dt^2} = mh + g,$$

a differential equation of the second order. Multiply both sides by $2\frac{dh}{dt}$, and integrate. We then get—

$$\left(\frac{dh}{dt}\right)^2 = mh^2 + 2gh + C.$$

But $\frac{dh}{dt} = v$, and $v = o$ when $h = o$. $\therefore C = o$, and therefore, taking the square root of the reciprocal of each side, we have—

$$\frac{dt}{dh} = \frac{1}{\sqrt{mh^2 + 2gh}}.$$

Integrating again from $h = o$ (and $\therefore t = o$), we finally obtain—

$$t = \frac{1}{\sqrt{m}} \cdot \log.\left(\frac{hm + g + \sqrt{m^2h^2 + 2gmh}}{g}\right)$$

Also—

$$v = \sqrt{mh^2 + 2gh}.$$

If, in this value for v, we put $m = o$, we have $v = \sqrt{2gh}$, a formula which corresponds to the ordinary equation to gravity at the earth's surface. The above expressions for t and v do not admit of simplification, and to find an expression for t like that suggested by "W. S." seems to me impossible.

Charing, Kent. J. R. C.

[75681.]—"**Faust.**"—The quotation will be found about 130 lines after the conclusion of the "Prologue in Heaven," in 1st part of "Faust" (Anster's translation). C. E. MUNCHEN.

[75684.]—**Dynamo.**—To MR. BOTTONE.—The punchings should extend the whole length of tunnel, if the bearings are of such a shape and size as to admit the wire which protrudes. Put 18oz. No. 24 silk-covered wire on the field-magnets, and between 2½ and 3oz. of the same wire on the armature, and you will be able to light one or two 20-volt lamps. Size of spindle, $\frac{3}{16}$, steel.

S. BOTTONE.

[75685.]—**Limelight.**—To MR. BOTTONE.—You will need about 2lb. 5oz. of chlorate of potash, mixed with about 2oz. of black oxide of manganese, to produce ten cubic feet of oxygen.

S. BOTTONE.

[75685.]—**Limelight.**—To make 10ft. of oxygen gas, you will require to mix together 2lb. of chlorate of potash with ½lb. of black peroxide of manganese. Roll up the gas-bag from the thick end, with the back full open, so as to exclude all air before filling with gas from retort.

Sunderland. C. J. H.

[75685.]—**Limelight.**—The materials required are chlorate of potash 36½oz., and manganese dioxide 7 or 8oz. (avoir.) for 10c.ft. of gas. These are the theoretical quantities, but in practice the maximum yield is seldom obtained. You can, however, use these, and find how much you do get when a simple calculation will put you right for future guidance. Grind the two substances together in a mortar to a granular consistency before putting into the retort. As you say nothing about the capacity of the latter, no advice can be given, but I find it more economical to use small quantities, as if retort is too full, very often the heat does not reach the heart of the mass, and the full yield is not obtained. JOHN FOGGIE.

[75689.]—**Accumulators.**—To MR. BOTTONE.—With plates of the size you mention you would get about four ampère hours. You can charge them from the series dynamo; but you must mind and cut off connection before you slow down your dynamo, otherwise you will surely reverse it. The right dynamo for charging is a shunt-wound machine, with ring or drum armature.

S. BOTTONE.

[75693.]—**Winding Dynamo for Two 4v. Lamps.**—To MR. BOTTONE.—Put 2oz. No. 24 silk-covered wire on the armature, and 12oz. of the same gauge of wire on the fields. Connect up in shunt with brushes. S. BOTTONE.

[75695.]—**Sediment in Nickel-Plating Bath.**—Have you tried the double chloride? Keep the solution just neutral or very slightly alkaline by occasional additions of ammonia, which it loses during action, and becomes acid when it does not work well. Specific gravity, 1·03, and use low E.M.F. A. D. SOUTHAM.

[75695.]—**Sediment in Nickel-Plating Bath.**—Filter through calico, to rid the bath of this sediment. What is your idea of adding borax to the solution? Dissolve the double salts of nickel and ammonia in hot water, 12oz. of the salt to one gallon of water—distilled water is the best—or, if not obtainable, well-boiled ordinary water filtered. After having dissolved the salts, filter the whole solution through calico. A bath made after this manner from pure salts should not, if carefully worked, give any trouble. The "Electroplater's Handbook" gives full particulars on nickel-plating.

S. ROBERT BONNEY, Electroplater, &c.

[75696.]—**A Stopping for Electro-Silvering.**—When it is desired to prevent deposit occurring on any part of the surface, it can be protected by copal varnish. A. D. SOUTHAM.

[75696.]—**A Stopping for Electro-Silvering.**—Beeswax, 3 parts; clear resin, 5 parts; red sealing-wax, 2 parts; and rouge 1½. For hot solutions the best copal varnish with a little rouge mixed; melt together.

S. ROBERT BONNEY, Electroplater.

[75700.]—**Hardening Potatoes.**—I heard once that they could be hardened by boiling in a strong sulphuric-acid solution. MICK.

[75702.] — **American Organ.** — This query is addressed to me personally. I think it might have said "and other readers," because some who can give useful information are deterred when a query is addressed to a special correspondent. However, I can tell "R. M." that if there is room to introduce the second manual, there need be no difficulty about the slowness of speech. If the reeds are properly voiced they will speak promptly enough if put on a separate wind-chest as suggested. When as many as six rows are placed in one block, the upper rows are often said to be rather sluggish, but it requires a cute ear to detect any important difference. If "R. M's" case is large enough, the reeds belonging to the second manual may be inclosed in a swell-box posited in the upper part of the case, their wind-chest being connected by a "trunk" to the main wind-chest or sound-board. I assume that "eight sets" means four rows, as eight complete sets cannot well be wanted in a one-manual instrument. It is often convenient to place the cavity-board for the upper manual in a vertical position at the back; but it is a fact that it is never advisable to add to organs that have not been planned out with an eye to future additions. As a rule there is more trouble and expense than is compensated for by the result. ORGANON.

[75704.]—**Balloon.**—Presuming hydrogen is the gas used,

$$D = \sqrt{25{\cdot}5W} \qquad W = {\cdot}0392D^2$$

Where D = diameter of balloon, W = weight to be raised (including balloon). The buoyancy of hydrogen is about 13·3 to a pound. A. D. SOUTHAM.

[75705.]—**Reed-Voicing.**—This querist wants to know, first, how reeds are properly voiced. In reply to that question, I may safely say that proper "voicing" is accomplished by artists or skilled men, who devote the whole of their time to that part of the business. Voicing reeds is, therefore, an "art," and requires considerable practice and experience, and it is impossible to teach anyone how to voice reeds by writing instructions on voicing, and theory is no earthly good, unless practical experience is combined with the theory of knowing exactly what form the tongue has to take to produce a certain quality of tone. Second, as regards the space required for an octave coupler, the best plan is for the querist to purchase one (they are cheap enough, and can be had for 5s.), and he will then see exactly what the smallest space required for an octave coupler will be. Third, cavity boards are cut out by special machinery, and as these boards can be bought so cheap, it would really be worse than useless to advise the making of such a part of an organ by hand. Fourth, make the mutes of best, and well seasoned, yellow pine. This kind of wood answers well for mutes. The querist evidently wants me to write out instructions on building American organs. I have not the time to spare just now to do that; but I am quite willing to answer any reasonable question on the subject.

PRACTICAL ORGAN BUILDER.

[75706.]—**Thermopile.**—Not having tried the experiment, I cannot say; but I should think that the influence of the dripping water on the outside would most likely set up a current of its own, and thus vitiate all the results. About ½ to 1 ampère would be as much as you could expect under the conditions you name. S. BOTTONE.

[75708.]—**Magnetic Iron Oxide.**—If "Magnetite" will advertise his address I shall be pleased to give him all information he requires.
GEO. G. BLACKWELL.
Mineral Merchant, Liverpool.

[75711.]—**Saponifying Eucalyptus Oil.**—This could easily be done by the addition of a little common washing soda. The latter query I am unable to answer. S. BOTTONE.

[75711.]—**Eucalyptus Oil.**—Is much used in baths, &c. It has a most agreeable and fragrant odour, and is very refreshing. Besides this, it has most valuable antiseptic properties. Mixed with spirit, it is easily incorporated with water.
X. Y. Z.

[75714.]—**Dynamo Brushes.**—One reason is that the resistance of aluminium has nearly twice that of copper, while platinum has 16 times the resistance of copper. A. D. S.

[75714.]—**Dynamo Brushes.**—In some small motors I have the brushes are tipped with platinum, which becomes unsoldered if the current is too strong; but, of course, other means of fastening might be used. E. R. DALE, A.I.E.E.

[75714.]—**Dynamo Brushes.**—Neither of the metals mentioned is such a good conductor as copper, and, consequently, is not so well adapted. Nothing beats a brush made of copper gauze.
S. BOTTONE.

[75715.]—**Electric Light with Small Gas-Engine.**—Providing your gas-engine runs steadily, and you have a good heavy balance-wheel on dynamo shaft to take up any irregularity in driving, you can do without accumulators. With your ¼H.P. engine, you would be able to light well three lamps, each of 10c.p., taking about 25 volts, and 1·5 ampère, and might even light four.
S. BOTTONE.

[75717.]—**Galvanometer Mirror and Scale.—Correction.**—In my query (p. 230) feet should be inches. The lens used had a focal length of 4in. (not feet), and the only place that an image of the slit could be found was 6in. (not feet) from the mirror. STUDENT.

[75718.] — **Adjustable Resistance.** — Wind some German-silver wire on a round ruler in a spiral manner, the coils about ⅛in. apart, and having a piece of brass tube to slide up and down; you can then vary the resistance to a nicety.
MICK.

[75718.] — **Adjustable Resistance.** — Presuming you do not want any great degree of accuracy, the following, known as the Wirt, may serve your purpose: Make a stout cylinder of cardboard, about 1/16in. thick, 6in. in. diameter, and 6in. high. Wind this like a Gramme armature, with one continuous layer of silk-covered German silver wire, of such a gauge that the entire length gives the highest resistance you will be likely to need. Leave the starting end free, the other fasten down inside the cylinder. Now dip the whole in hot melted paraffin-wax. When cold, scrape the insulation off the wires, in a band about an inch in diameter, all round the cylinder, so as to bare the wire. Mount the cylinder on a central wooden hub with a metal spindle, supported below by a board with terminal connected to spindle, and above by a cross-piece. Let the free wire be connected to spindle, and let a copper "brush" press against the bared band. This brush must also have a terminal. S. BOTTONE.

[75719.]—**Gilding 9c. Chain.**—Give a good boiling in caustic potash, rinse in clean water, scratch-brush with powdered pumice or bath-brick (brass wire scratch-brush); give the chain a thorough doing between links—do not miss any part; now another swill in potash; rinse well in clean water; gild right away; rinse in clean hot water, and dry off in clean boxwood sawdust. Read Watt's book, 9s.
S. R. BONNEY, Electroplater, &c.

[75722.]—**Siemens Drum Armature Winding.**—For full details, with illustrations as to mode of winding and connecting up a Siemens drum armature, I must refer you to my article at p. 506, Vol. LII. of the ENGLISH MECHANIC; or, if you cannot refer, you will find the same subject fully treated in my book, "The Dynamo: How Made," last edition. The series dynamo has one F.M. wire connected to one brush, the other F.M. wire and other brush being connected to the other circuit. The shunt machine has both F.M. wires connected to the brushes, and the current for the outer circuit is shunted off from these brushes also.
S. BOTTONE.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75180.	Expense of Mail Steamers, p. 21.
75183.	Electric Tramway, 22.
75188.	Induction Coil, 22.
75190.	Detecting Oil in Jute, 22.
75205.	Kola and Cocoa Manufacture, 22.
75207.	Peroxide of Hydrogen, 22.
75210.	Harp Making, 22.
75218.	Galvanometer, 22.
75219.	Rope Gear.

75359.	Windmill, p. 118.
75374.	Calculating Power, 119.
75385.	L. & N. W. Locos, 119.
75395.	Vaucanson's Endless Chain, 119.
75396.	Stereographs of Non-Planar Vibrations, 119.
75400.	Buzzer, 119.

QUERIES.

[75727.]—**To "Sm."**—An electrified drop of water supported on a non-conductor evaporates. Assuming that the vapour is not electrified, what change of potential will the drop undergo?—FRICTIONAL.

[75728.]—**Wheel-Making.**—I am at present engaged in making some wheels for a model; they are of the ordinary cart-pattern, being intended for a model fire-engine, the dimensions of the wheels being 9¾in. the fore, and 13½in. in the rear in diameter. I find that chiselling out the holes in the hubs for the spokes to fit into a very long process. How are they done in the trade?—I presume by a machine. If that is so, could I get mine done for me by machinery, or would the size be too small. I shall be much obliged to any correspondent who will help me.—GROSBY.

[75729.]—**L. and N.W. Loco.**—Can any of our readers give me a description of L. and N.W.R. loco, 3,093? It runs between Broad-street and Mansion House. —J. H. P.

[75730.]—**Electric Organ.**—Can any of "ours" say how the couplers of an electric organ are arranged? I cannot see how it is done so that the coupled manual shall not work the one from which it is coupled backwards, unless each coupler has a separate contact at the key, which I believe is not the case, the coupler being a simple slide with contacts on it. A diagram would oblige.—ORGANIST.

[75731.]—**Motion for Equatoreal.** — Possessing an excellent portable equatoreal mounting by Cooke, of York (cost about £25 without pillar), which carries a 5¼in. telescope, and wishing to apply clockwork, I wrote to the makers, who replied that for this they must have the instrument sent them. As I happen to be many thousands of miles from England, it would not be worth while going to the risk and expense involved. In these circumstances I should be quite satisfied with any form of motion capable of driving the telescope roughly, something sufficient to keep an object a short time in the field and leave the hands free for notes, or taking a rough measurement. Can any of your readers kindly help me with practical advice? I am aware that in the earlier vols. of "E. M." various devices were described, but my copies have disappeared long ago, and the numbers are out of print. If an ordinary clock, or other mechanical means, can be adapted to the squared end of the tangent screw, I hope any reader who is kind enough to advise will give full working details.—A. S. F.

[75732.]—**Silvering Mirror.**—Are accidents owing to production of fulminate of silver at all common in silvering by Brashear's process?—F.

[75733.]—**Boiler for Launch Engine.**—As I am making a 3¼ by 3½ launch engine, will any reader kindly inform me what size vertical boiler, propeller, and dimensions of boat I should require for a speed of 8 to 10 miles an hour?—A YOUNG MECHANIC.

[75734.]—**Alabaster.**—How to work it into vases and other objects of art? Can it be worked in the lathe—wet or dry? What tools are necessary? Is the dust from it injurious to the running parts of the lathe? How is it polished? Is there any book published on the subject?—R. N. GRAYS.

[75735.]—**Galvanometer.**—To MR. BOTTONE.—I have purchased all the parts of a Latimer Clark's linesman's quantity and intensity galvanometer, but cannot think out the way to wind and connect up the wires. There are two brass bobbins, one each side of the needle. The commencement of the fine wire on each coil is soldered to the bobbin (the fine wire is about No. 42 B.W.G.), which is screwed on to the back of the brass scale-plate. The thick wire is about No. 22 B.W.G. Would you kindly state the way to wind the wires, and also which to connect.—GALVO.

[75736.]—**Henley's Quadrant Electrometer.**—To MR. BOTTONE.—I wish to construct a Peltier electroscope and a Henley's quadrant electrometer. Will you please tell me if the brass pillar, ring, and ball for the first named, and the pillar and ball for the latter must necessarily be solid?—HAGAR.

[75737.]—**Arches.**—In a book I am reading on "Arches," I find the expression 30 − 10 × 2. Does this mean that 10 is to be multiplied by 2, and subtracted from 30 −, or does it mean that 10 is to be subtracted from 30 and the remainder multiplied by 2? The results are as follows:—

1st. 30 − 20 = 10
2nd. 20 × 2 = 40

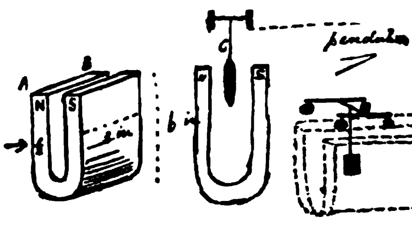
—PUZZLED.

[75738.]—**Testing Rennet.**—Will some one of your numerous readers kindly suggest the best instrument for testing and gauging rennet used for curd making in cheese, &c.?—ENQUIRER.

[75739.]—**Fan.**—I have a fan to fix to drive more air into gas-pipes for heating purposes for ovens, and should like some information as to what speed the fan ought to run, and the best way of fixing the piping from fan to the ovens: whether it would do to fix in the main pipe or at separate pipes close to the ovens. Any help will oblige.—J. C.

[75740.]—**Bath Heater.**—I am wishing to make a bath heater, and shall be glad if any of your readers will be good enough to give me the benefit of their experience. I have an ordinary Bunsen burner, which I could utilise; the next thing is a copper coil of suitable size; how to fix it up inside an outer casing to make the water heat quickly.—IONA.

[75741.]—**Magnetic Attraction.**—Can a reader help me in forming an idea as to the pull that would be exerted on the pendulum *c*, swinging between the poles of magnet N.S., and working by means of clockwork between A and B. Pendulum *c* to be made either solid or hollow. Would the pull be at right angles to line of progression?—ELECTRA.



[75742.]—**Dry Battery.**—In your issue of Sept. 18 No. 75288, Mr. Bottone gives instructions for making "Dry Battery." As I am unable to procure "graphite," I wish to know if it would not do to substitute broken carbon—say pieces of arc-light carbons broken small. Also, would the change alter the proportions given—viz., 5 parts to 90?—J. C. M.

[75743.]—**Value of One Second of Longitude.** —Will "F.R.A.S." or others give me the value in feet of one second of time in longitude on the parallel of latitude 42° 53'?—A. B. C. D.

[75744.]—**Engine Flywheel.**—Will anyone kindly say what diameter and weight iron flywheel to put on engine (vertical), 1¼in. bore, 2in. stroke? Also what power it will give at 100 revolutions with 30lb pressure? —W. D. G.

[75745.]—**Wood Bending.**—I wish to get an apparatus for steaming and bending wood. Can you give me any general information on wood bending—viz., pressure of steam required, if gas would raise sufficient pressure of steam, and nature of appliances used for bending? Also probable cost of whole? An oblong iron chest about 5ft. long by 18in. by 18in. would be large enough for steaming the wood.—BENT.

[75746.]—**Electric Alarum.**—As I have to be up early all through the winter, I should like to fit up a small alarm timepiece, so that when the alarm ran down it would light a small incandescent lamp for, say, about ten minutes every morning. I should like the battery in a box, with the lamp fixed in front, and the timepiece to stand on the top.—EARLY RISER.

[75747.]—**Single-Needle Telegraph.**—To MR. BOTTONE OR OTHERS.—I shall be glad if you can give me a diagram showing connections of one of these instruments. It is the kind with "tappers" instead of a handle, and in the case is a single-stroke bell. There is also a switch outside for putting "bell" or "needle" in use. There are four terminals. I want to connect it up properly, as it is not right at present, and shall be glad of help to do so.—A. W. G.

[75748.]—**German-Silver Wire.**—(1) Supposing German-silver wire of 1-16th of an inch diameter required to be flattened, and of course hardened at the same time, what would be the most expeditious and inexpensive way of doing it?—INVENTOR.

[75749.]—**Nickel Plating.**—How should I prepare the surface of iron, both wrought and cast, and steel, to receive deposit. How to make solutions, and what amount of battery power in proportion to surface to be plated? My largest job will be 60sq.in. What battery is the best?—I have Daniell's, Bunsen's, and Smee's.—WOULD-BE PLATER.

[75750.]—**Tests for Tin.**—Will some chemical friend give me the most delicate tests, both qualitative and quantitative, for tin in a solution of water? Also how test solutions may be prepared.—CHEMICAL STUDENT.

[75751.]—**Boiler.**—I have a 4HP. boiler about 20 yards from my office, in which I wish to fit a spare pressure-gauge (Bourdon's). What size pipe should I use, and will a fall of 2ft. between boiler and gauge matter, the latter being lowest? And should I have a cock near gauge to run condensed water off, or will the water act on the gauge the same as steam? Will some reader kindly give me information?—BOILER.

[75752.]—**Puzzle 48.**—The square, when this puzzle is put together, contains 45 (forty-five) square inches. Could someone kindly inform me what is the exact measurement of one of its sides? The square root of 45 will not come out exactly in decimals. I don't know how to do it in vulgar fractions.—PROPOSITION.

[75753.]—**To Mr. Bottone.**—In your interesting work on "Electrical-Instrument Making" you suggest "papyroxyline" for electrophore. Could you kindly tell me if any particular proportions of nitric and sulphuric acid are advisable? and also whether, by using thick millboard, you might in any way use "papyroxyline" for electrical machines of the Holtz type?—A. L. B. T.

[75754.]—**Ancient Navigation.**—Would some one of our readers describe the "Astrolabe," and how used on board ship? Also the "cross-staff," which was substituted for the astrolabe? I suppose that Columbus and the navigators of his time could, by either of these instruments and astronomical tables, get their latitude only?—L.

[75755.]—**Preserving Water Colours.**—Could anyone give a process for preserving the above, so as to be always ready to hand, like there is with oil colours? I have tried the process of putting the dry paint into a glass jar with a screwed lid to it, and putting some water into the jar and screwing it air-tight. I left it to soak; in a short time, on looking at it, I found it turning mouldy.—J. A. Bellringer.

[75756.]—**Self-Acting Railway Carriage Coupling.**—Can any of "ours" explain, perhaps also by sketch, the coupling inventend by Mr. Pietro Prada, which is said to be most perfect in action?—M.

[75757.]—**Motive Power.**—Which is the most economical—all things considered—a 60H.P. gas engine operated by Dowson water-gas, or a modern high-class expansion steam-engine giving off the same amount of power? Result from actual existing plant preferred.—M.

[75758.]—**Telephones.**—To Mr. Bottone.—In "Electric Instrument Making," article Telephones, you say the bobbin is to be 1in. diameter, 1in. broad in the groove, and wound with one drachm 36 silk-covered wire. I cannot make one drachm of that size wire fill a 1in. bobbin half in the groove. The wire and magnets I had from you some year or so ago. Is there any error, or does it not matter if bobbin is half-empty?—Golden Slippers.

[75759.]—**Question in Arithmetic.**—Ash saplings after five years' growth are worth 1s. 3d., and increase in value 1s. 3d. each year afterwards. They each require for their growth twice as many square yards as the number of years they are intended to grow before cutting. A plantation is arranged so that each year the same number may be ready for cutting. Find the greatest annual income which can be obtained per acre, allowing 20 per cent. for expenses. Answer, £7 11s. 3d. How is it arrived at?—A. B. C.

[75760.]—**Law.**—A. lent B., 31 years ago, a sum of money at five per cent. interest against deed of mortgage on land and house property, for paying off a previous mortgage. B. is since dead, and the property passed, presumably by succession, to C. (brother), and after C.'s death to D. (nephew), and then to widow of D., E., likewise now deceased. No interest has ever been paid to A. E sold the property, some seven years ago, to F., and seemingly without any reservation as to the claim of A., and certainly without knowledge and consent of the latter. A. now wishes to recover loan and interest, and the question is, can he do so as against F., or by claiming possession, and what kind of claim can he make, and especially as to arrears of interest, if on the basis of simple or compound interest, and for how many years back? Are the rights of A. in anywise damaged by neglecting to proceed earlier, or must he show proof of acknowledgment of claim on the part of E. (the last holder by right of succession) within a given period, and for what period? Could E. legally sell to F. without producing deeds antecedent to A.'s mortgage showing B.'s original right of proprietorship, and which deeds are in possession of A.? How can A. proceed, either to make good his claim as against F., or in way of taking possession of the property? The subscribing witnesses to the signature (mark) of B. are either dead or otherwise unreachable. Does not the fact of their having so subscribed on deed suffice as proof in full of the mortgage having been duly executed by B.?—X.

[75761.]—**Throat.**—I am troubled with what a throat specialist called "catarrh of the throat." My means prevent my consulting him again. Can "B.Sc., Plymouth," or anyone else help me, as I have a family depending on me? All bodily habits, such as eating, sleeping, &c., good; active disposition, rise early, live carefully and regularly; non-smoker, no stimulants worth naming. Symptoms: Sore feeling when swallowing; voice inclined to be rough after much speaking; no cough, but on clearing throat a white phlegm is expectorated; rather worse in cold weather. Diet: Breakfast, brown bread, one cup of coffee; dinner, meat, two vegetables, milk pudding, stewed fruit; tea time, tea and brown bread. I shall be thankful for any information from anyone experienced that is likely to be of use.—Troubled Throat.

[75762].—**Stone from Signet Ring.**—Will anyone kindly inform me the best and simplest manner of taking the stone out of a signet ring without injuring either the stone or the gold setting?—Amateur Jeweller.

[75763].—**Screw-Cutting.**—Having purchased an 5in. centre screw-cutting lathe, there is some of the change wheels missing which I shall have to replace. As I have not been used to this sort of lathe, I should like to know if I could get a book for instructing, with illustrations, for working the change wheels.—Young Blacksmith.

[75764].—**Batteries.**—Will Mr. Bottone kindly advise me what to do as regards two batteries which I have? I think they must want recharging, as neither of them will ring a small bell. They are made out of blocks of wood, hollowed out 4½in. deep, 2in. wide, lined with pitch, and charged with some pink substance like plaster of Paris, but smells somewhat like ammonia. Tied round the carbon in a piece of linen is some stuff resembling magnesium, and sealed over with pitch. Would you advise me to recharge the same, as answer given to "Dry Batteries" in recent back number? If so, will you kindly say what is graphite, the price of a small incandescent lamp about 2c.p., and where I could get one in London? Also, will you tell me how many volts I could get from two medium size ordinary Leclanché batteries and two ditto agglomerate? And could I get more power by using larger zincs than those generally used in Leclanché batteries?—Perplexity.

[75765.]—**New G.W.R. Single Locos.**—Would anyone tell me the length of stroke and dimensions of the new G.W.R. singles, date 1891?—C. N.

[75766.]—**Paint for Boiler.**—Will any kind reader recommend querist a suitable paint for a model boiler that will stand the great heat without blistering? Or can any reader recommend a japan, such as they use for stoves, or bicycle enamel?—Loco. Boiler.

[75767.]—**Dry-Plate Developer.**—Will any kind reader give formula for a so-called Mayfield's single-fluid transparent dry-plate developer, which has been in use six or seven years?—Loco. Boiler.

[75768.]—**Hysteresis.**—To "Sigma."—"In one experimental case which he (Prof. Ewing) quotes in a complete cycle of magnetisations in alternate directions, the loss from hysteresis that would have taken place is very nearly extinguished when a powerful current is passed through the body operated on." Meaning, I presume, the iron core. Could "Sigma" tell us anything on this subject? The extract is from the *Iron and Coal Trades Review*, on a "new" theory of magnetism.—Chas. Provis.

[75769.]—**Dynamo.**—Will Mr. Bottone kindly say if it matters at all in a dynamo the F.M.'s of which contain correct weight of wire, but on which number of turns are few? For instance, take F.M.'s 8in. high, 16in. wide, and 2½in. thick, and each wound with 38lb. No. 16 wire, about seven or eight coils deep would take the 38lb. What I want to know is whether it would improve efficiency of dynamo to curtail wire space on F.M.'s to, say, 4in. high, 16in. wide, and 2½in. thick, so as to give same amount of wire more turns and leave other part of F.M.'s bare?—F. M.

[75770.]—**Magnetised Watches.**—Is it true that watches are affected on electrical railways? I mean watches carried in passengers' pockets on electrical railways worked by current from the rails on which the coaches run.—T. L. G.

[75771.]—**Influenza.**—To the "Lydney Dispenser."—I am subject to the above distressing complaint. Nearly every day I am troubled more or less with it. Sometimes I begin to sneeze violently, and clear water will run down my nose until it is very sore. I have only just recovered from a fortnight's illness, brought on by influenza and sneezing. A cure or preventive for above will oblige—Sufferer.

[75772].—**Leclanche.**—Could any reader enlighten me as to the following: (1) A Leclanché battery is only required two months in twelve. Would it be advisable to take cell and zinc rod out of solution? Would battery last longer than if kept continually in the solution? (2) Two Leclanchés of same power: one is frequently used to ring a bell, the other only occasionally; cells and rods continually in the solution. Would one battery be expected to last as long as the other?—G. Haynes, Stockwell.

[75773.]—**Violin.**—Would Mr. W. Pickering kindly tell me if a piece of Scotch fir with scarcely any fibre would be suitable for violin belly? It is very old, but perfectly sound. I have a splendid piece of birdseye maple for back, but I have had to join it across the back. Will that make any difference to the strength?—Fiddler.

[75774.]—**Cheese-Making.**—Can any of "Ours" give practical instructions, or name book giving such fully in every detail?—W. R.

[75775.]—**Voltmeter.**—To Mr. Bottone.—Much obliged for answers; the reply describing voltmeter was 75523. 2. Why is it a coil giving so high an E.M.F. is not fatal to animal life; has not the extremely small amount of current something to do with this? 3. Through what length of No. 20 B.W.G. copper wire would a bichro. battery force 1 ampère?—G. M. S.

[75776.]—**Formula.**—I should like to be able to work out formulæ such as are needed by horologists. Having no knowledge of formulæ, I should like to know if there is any book for self-teaching, and should I require a knowledge of algebra? Any hints will oblige.—Simpleton.

[75777.]—**To Mr. Bottone or Mr. Allsop.**—Is it possible to use a microphone with the Bell magnet-telephone, and if so, is there any advantage gained by doing so? What gauge of wire would the bobbins round the permanent magnet require? Also, is the insulation of the silk covering sufficient, or should paraffin-wax or shellac be used?—G. M.

[75778.]—**Cement.**—Will any correspondent kindly give me formula for making an excellent cement or harmless composition for adhering to wooden surface? It must be capable of standing great friction without fracturing, although applied thinly, say, 3-16ths of an inch thick.—Brake.

[75779.]—**Atomic and Molecular Volumes.**—What facts are there in support of the theory that in a gaseous element the atomic volume is one-half the molecular volume?—Enquirer.

[75780.]—**Electrical.**—Each of n Leyden jars of capacity k is charged to potential v, and outer coating of No. 1 connected to inner coating of No. 2, and outer coating of No. 2 to inner of No. 3 and so on. If the n jars be insulated, what is the capacity and potential of the series? Details wanted.—Enquirer.

[75781.]—**Horological History.**—At what period was the cutting of the teeth in clocks and watches by hand superseded by the machine; and what was the mode of procedure adopted in dividing and in forming the teeth by the primitive method?—Detent.

[75782.]—**Electro-plating Bath.**—My bath worked well, but stood idle about a year and partly evaporated; now it will not work. Will some reader kindly tell me the probable cause? At first there was about 2½ gallons. Can I recover the silver?—W. M.

[75783.]—**Frictionless Pendulum Gear.**—Wanted—a frictionless gear to work a pendulum on a wall 10ft. away from the clock; must be reliable, being for a public clock.—W. M.

[75784.]—**To Mr. Bottone.**—I have a nice soft wrought-iron ring, size 2⅝in. outside, 1⅝in. inside, 1½in. wide, which I should like to use for armature of small dynamo. Would you kindly give me full particulars for making suitable field-magnets and cores, &c., with sizes and quantity of wire for armature and magnet cores, and number of sections on armature, for best results and probable output of such a machine? I have some of your No. 26 s.c. wire, which I thought might do for armature. I shall be thankful for particulars.—Mono.

[75785.]—**Sun Transits.**—I am anxious to know whether any of your correspondent are troubled with a difficulty, such as I nearly always experience in taking transits of the sun. My instrument is a small but good one by Fayrer, its focal length is 22·5in., and its aperture 1·8. It has two horizontal and five vertical wires, the latter, as the sun's preceding limb approaches them, become involved in a mist, and the contact with each becomes very difficult. With the following limb this is not the case, the wires being projected on the sun's disc are perfectly distinct and the contact easy. Can any of your readers furnish me with a solution and a remedy for this inconvenience?—G. W.

[75786.]—**Cart-Grease.**—Would any of your correspondents give me the information of the ingredients of common "cart grease" and mode of manufacture?—H. W.

[75787.]—**Curves.**—Will any reader of the "E. M." kindly give me the curves for a 3½in. achromatic object-glass of about 3ft. focus, for Chance's hard crown and heavy flint, of second quality, and oblige?—Lenses.

[75788.]—**English Lever Watch.**—Would any reader of the "E.M." give a few hints how to correct an English lever watch which varies in position—goes faster when lying on its back than when hung up?—Watch.

[75789.]—**Heating Room.**—Kindly tell me the best and most economical way to heat a large room over boiler by means of 2in. pipes, the boiler working at 60lb. pressure? What size inlet—what size outlet? Is a steam-trap required? Should steam and condensed water flow back into boiler?—King.

[75790.]—**To "F.R.A.S." or Mr. Linscott.**—I have a 3in. telescope 42in focus, which does not show a planet or star as I think it should. The fault is that the field round any bright star has an appearance of being flooded with a misty light, though the star is perfectly round. Should not field appear black up to edge of a planet or star? What, please, is the cause of this? Is it a misty atmosphere or a defective object-glass? If the latter, for how much could I get a first-rate 3in. o.g., and are they sold separate from tube, &c.? In reply to "F.R.A.S.," p. 217, No. 1388, I may say I tried ϵ^1 and ϵ^2 Lyræ with a very good 2¼in., 36in. focus, 60 power; but could make nothing of it under a power of 120, which just split the lower pair in field of telescope.—M. D.

[75791.]—**Cycle Brazing.**—I am making a Safety during spare time and would be grateful for a few hints on brazing the same. I have the use of small smith's hearth. I should be glad to hear of any good books on metal brazing.—Cyclist.

[75792].—**Workshop Floor.**—I am building an addition to workshop (brick). Solid clay is within 12in. of surface. What is a good cheap thing for solid floor? I wish it to be warm to the feet. I have any amount of broken brick and clay, and could get some broken asphalte. Has anyone had any experience with burnt clay?—Cyrus.

[75793.]—**Heating Room from Fire Below.**—My room is above the kitchen, which has always a good fire and lean-to boiler. Any suggestions as to heating it from the kitchen fire, either by air (preferred) or water, would much oblige. It seems strange that so much heat must pass up the chimney and not be able to use it on its way outside.—Cyrus.

[75794].—**Cleaning Sand, &c., from Gunmetal Castings.**—What is the best way of doing this? The castings are complex.—Cyrus.

[75795].—**Grinding and Cutting Gunmetal.**—Can anyone give his experience of use of emery stones and milling cutters in gunmetal? If I grind to shape roughly would the emery stick in and then dull the milling cutter?—Cyrus.

[75796.]—**Sizing Worsted Yarns.**—Will any brother subscribers give me, through the "E.M.," a suitable size for sizing worsted yarns which will not easily come off with friction?—J. H. F. A.

[75797.]—**Violin Queries.**—I shall be glad if some one who really knows will tell me the following:—1. Is it at all usual for violinists to use a pad on the chest to help support the violin? If not, how do they contrive to hold the instrument at right angles without the use of the left hand, as I have seen done? 2. When music is marked to be played on one string, how far must that be observed? In my copy of Raff's Cavatina, parts are marked to be played on the 4th, 3rd, and 2nd strings respectively; but I don't understand how far those marks are binding. They are evidently not meant to be observed until the next mark occurs. Is there any rule? 3. What book contains the fullest directions for acquiring a proper style of playing?—C. R.

[75798.]—**Induction Coil.**—Will some of the readers of the "E. M." please tell me where I am wrong? I have made an induction coil of the following dimensions, but it wont work:—Core of iron wire 2¾in. long, ⅜in. dia.; bobbin, 2in. between flanges; primary, two layers No. 24 silk-covered; secondary, 3½oz. No. 36 silk-covered; battery, one of the smallest size bottle bichromate, entirely new. I think it is the primary not being long enough; wire is continuous, no breaks.—R. T. Paisley.

[75799.]—**Repousse Work.**—I want some panels done in this—or perhaps I could use thin brass castings. Can any of our readers help me? See address column.—Cabinet Maker.

Kiernan's Fire-Escape.—A useful form of fire-escape, which is about to be patented, has been invented by Mr. M. F. H. Kiernan, of Thornton Heath. It consists mainly of a strong, steel framework, carrying a net and mattress, which can be readily attached to a couple of prepared ladders, and be so placed that persons can jump from a window without injury. In one corner of the net there is a sort of cylindrical folding "shoot," with a rope in the centre, and a platform at the bottom, on which escaping persons can stand, and be easily rescued by those who ascend the ladder. The ladders themselves could be used for other purposes, and need but few fittings to adapt them to receive the "escape." An escape of this sort might be kept at every country house.

ANSWERS TO CORRESPONDENTS.

\. *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

\. Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above. which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, November 4, and unacknowledged elsewhere:—

W. and R., Limited.—C. I., Ohm.—Phono.—Kent.—Ernalf Par.—Norfolk Amateur.—Mechanic.—A. Cape.—Mosses and Mitchell.—J. and H. Grace.—B. Smith. The Lydney. Dispenser. — Motor. — Glengall.—H. — T. C. Smith, Brighton.—Surrey Lad.—Inquisitive.—Geo. Whittle.—R. Tudsbury and Son.—A Fellow of the Royal Astronomical Society. — A. D. Southam. — Chas. A. Parker.—C. V. V. F. B.

G. E. Seeley. (All the information needed about dynamos can be found in back volumes, and even, in the present case, in recent back numbers.)—Illingworth. (Probably you mean Jupiter, although you say star. Maps of the heavens showing the positions of the chief stars can now be obtained at a cheap rate, and our Astronomical Notes will guide you to the rest.)—E. S. Franklyn. (Almost all textbooks of astronomy contain much information about Jupiter. There must be some mistake in the work which states that the planet revolves round the sun in 666 days. Approximately you may take the revolution period at the easily remembered figures 4,333 days. As you have Mudie's Library to help you, all the best works will be available; but if we must suggest one, it would be the volume of Chambers's "Handbook of Astronomy" relating to the Sun, Planets, and Comets. It is published by the Clarendon Press, Oxford.)—J. Geary. (Any bookseller can show you works on microscopy, or at least a list of them. Dr. Lardner's "The Microscope," Lockwood and Son; and Dr. E. Lankester's "Half-hours with the Microscope," Allen, are low-priced works.)—W. H. (Answered many times. Dissolve 1lb. of good glue in as little water as possible; add 4lb. of glycerine; stir in while warm as much whiting as will thicken and colour the mixture and pour into shallow trays, removing bubbles with the edge of a card).—Chloride. (We scarcely understand what you mean. The coils can be used separately if suitable means are provided for connecting and disconnecting, but what could be the object? There is a diagram of the connections in the No. for Jan. 9, 1891, and others in back volumes.)—Ben Mahmoud. (It would occupy too much space. Refer to the articles in the encyclopædias on "Alphabets.") Amen-Ra. (Alcohol is produced in beer during the process of fermentation. It is distilled from various substances, and in the watery state is known as "spirits." See such a work as "Payen's Industrial Chemistry.")—Thin Hair. (There are many recipes for baldness which "any chemist can make up," and there are several in back volumes. Have you tried paraffin-oil?—it is very useful. But look through the indices.)—Nicotine. (It is against the law to cure tobacco in this country except under special permit. The leaves are sweated and dried, and are then packed. "Essential flavouring oils" are not used. See the description of the methods adopted which were given at the time the attempts were made recently in this country to grow tobacco.)—H. A. J. (The cement for an aquarium which you give might possibly do, but it is not recommended. Several recipes are to be found in back volumes, but perhaps this will do:—Take three parts each of litharge, white sand, and plaster of Paris, all in fine powder, and thoroughly dry; mix with one part of powdered rosin, and then make into a paste with boiled linseed oil to which some terebene or driers has been added. The mixture must be well beaten up and worked together, and allowed to stand for a few hours; but it should be used the same day as made. It is the cement generally employed at the aquariums in places of public resort.)—Casenhem. (The tables issued by the Post Office Department will be a guide; but obviously something depends on the medical report as to the value of the life. Any of the insurance offices will answer the question. 2. The price of the work referred to is advertised by Messrs. Cooke and Sons, Buckingham Works, York, at 5s. See front page last week.)—J. H. B (Yes, we believe so, and it was found that the air simply rose in bubbles to the surface and had little effect, so far as moving the boat was concerned.)—J. Sawford. (Mr. Allsop's articles on the expiration of the microphone patents commenced on p. 1 of this volume. All the numbers of this volume are still in print.)-New Reader, Norwich. (The articles on "How to Make a Violin" commenced in No. 1 of this volume. There are several notes on putting pedals to pianos in back volumes—some in recent numbers.)—Paralysis. (There are several works of the kind. Perhaps "Electricity in the Treatment of Disease," by James R. Tunmer, E. W. Allen, may suit; but see what has been said on the subject in back volumes.)—Socrates. (The cause is mainly unsuitable diet, although necessarily the germs must find access. Dr. Cobbold's remedy was a purgative. followed by an enema of salt and water. They are very troublesome, but do not appear to be very injurious to otherwise healthy persons. Put the question to Dr. Allinson through the *Weekly Times and Echo.*)—Lamp. (No more space at present for replies to such a long string of questions about paraffin-oil lamps. Any dealer can show you the different patterns; the merits of the various materials have been discussed in back volumes, and Messrs. Jones and Co., of Viaduct-street, E., will send a little leaflet explaining the differences in the oils, and the safe way of burning paraffin or petroleum oils.)—Loco. No. 2. (The number can be had direct from this office for five halfpenny stamps, and you can then show it to the Manchester bookseller who was unable to procure it. It is the number for Aug. 22, 1890. At one of the free libraries in your city you can, we think, see all the more recent volumes, and probably find drawings of the engines you require. They have no doubt all been illustrated.)—Lindum. (We gave the figures as we had them; but Prof. Pettenkofer's paper will no doubt be published in full shortly. Perhaps there is some misunderstanding as to the meaning of the word "fresh water." 2. Please see "Hints" above. It will probably be freely discussed and advertised.)—W. (Certainly. The stones or other material must be clean; the pitch must be boiled to remove the moisture; and the path must be covered with sand. It is usual to coat the stones first, lay them down level, and then fill in with thin hot pitch, thinned if necessary with coal oil. 2. They are more cheaply bought, and are made in great variety of size.)—No Mathematician. (Space is too much in demand just now for such abstruse questions.)—One in Difficulty. (Your recipe will do as well as anything for the so called storm-glass; but the proportions usually given are—camphor, 2 drachms; nitre, 1½ drachm; salammoniac, 1 drachm; proof spirit, 2½fl.oz.)—A Subscriber. (We do not know that it is made for sale; but see "Hints" above.)—J. G. (You could find much information about electric lighting in our back numbers. As you want a book, perhaps "Electrical Engineering," by Slingo and Brooker, published by Longmans, will suit you.)—Inquirer. (Your question has been answered many times. The electric light can be worked by means of suitable batteries; but that method is both very troublesome and very expensive. Leclanché cells are not fit for the work.)—Coffee. (We think you will have to keep that expensive coffee-pot as an ornament. It is doubtful whether any cement would stand long under the conditions.)—Numis. (Apparently issued by the Venetian Republic for circulation in Dalmatia and Albania.)—Shamrock. (Lists of patentees, of the subject-matter of the patents, and abridgments of the specifications are published by the Patent Office. They can be seen at the library of the Patent Office in Southampton-buildings, Chancery-lane, E.C. The library is free, and is open from 10 in the morning until 10 at night.)—C. S. B. (We doubt it. See Dr. Allinson, the Medical Editor of the *Weekly Times and Echo.* His treatment of rupture is economical and based on common sense, and if he does you no good, he will, at least, do you no harm, and it will cost you little.)—W. T. Haydon. (In type.)

The New Rupture Appliances. — Sufferers should lose no time in making themselves acquainted with the merits of Mr. Harness' improved hernia appliances. Relief guaranteed. Consultation and examination free. Those who cannot call should write at once to the Medical Battery Company, Limited, 52, Oxford-street, London, W., for Mr. Harness' descriptive pamphlet and copies of convincing testimonials.

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The address is included as part of the Advertisement, and charged for.

Advertisements must reach the Office by 1 p.m. on Wednesday to insure insertion in the following Friday's number.

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PAYABLE IN ADVANCE.

5s. 6d. for Six Months and 11s. for Twelve Months, post free to any part of the United Kingdom. For the United States, 13s., or 3dol. 25c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (viâ Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

The remittance should be made by Post Office Order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 4d. each to cover extra postage.

Messrs. James W. Queen and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 3d. each copy, to cover extra postage.

Vols. XXIV., XXX., XXXII., XXXVI., XXXIX., XL., XLII., XLIII., XLIV., XLV., XLVI., XLVIII., XLIX., L., LI., LII., and LIII., bound in cloth, 7s. each. Post free, 7s. 9d.

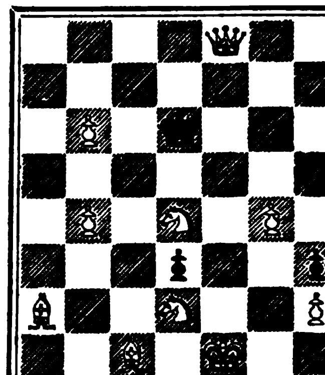
All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post free from the office (except index numbers, which are 3d. each, or post free, 3½d.)

CHESS.

All communications for this column to be sent to the Chess Editor, at the office, 332, Strand.

PROBLEM MCCLXXIX.—By E. B. Schwann.

Black.



White. [10 + 7

White to play and mate in two moves.

Solution to 1277.

White.	*Black.*
1. R-K 6.	1. Kt or P moves.
2. Q, R, or Kt mates.	

NOTICES TO CORRESPONDENTS.

Correct solutions to 1277 by W. T. Hurley, W. L. Martin, Stortford, W. Jay, T. Guest, and Biene; to 1276 by Biene (second solution), T. H. Billington (ditto), J. Johnston (ditto), W. L. Martin, Chas. S. Bright, W. Jay (two solutions), T. Guest (ditto), F. H. Guest (ditto); to 1275 by T. H. Billington (one dual and one triple), J. Johnston (ditto), W. L. Martin, Chas. S. Bright.

F. H. Guest.—You have evidently left out P on Q 4 in 1276.

T. Guest.—There are only two solutions to 1276.

James Kistruck.—1277 cannot be solved by B-B sq.

W. T. Hualey.—Solution to 1275 duly received.

Names Received for New Tourney.—W. L. Martin, T. Guest, and F. H. Guest.

Microscopic Mounting.—A useful little work giving "Practical Hints on Microscopic Mounting" has been issued by Mr. R. G. Mason, of Clapham Park-road, S.W. It is intended expressly for beginners, and will be of much help to any intelligent young worker who wishes to make his own slides.

Holloway's Ointment and Pills exercise priceless power over Lumbago, all pains of the muscles, nerves, and joints, and quickly reduce all swellings caused by accidental injuries, weakness, or hereditary taints. The intelligible instructions enveloping Holloway's medicine give full counsel for using it most advantageously for regaining health, strength, and mobility.

OUR EXCHANGE COLUMN.

The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.

Wanted, to exchange small **Donkey Pump**, with ½in. ram, suitable for small boiler, for smallest size inspirator.—Paice, Hampton Wick.

12¼in. excellent **Glass Speculum**, 1¼in. thick, turned edge, unsilvered. Trial. Offers.—T. W. B. Willey, Old Hall, Broseley, Shropshire.

The Chenies-street Exchange offers best value in cash or instruments for scientific appliances and tools of all kinds.—Caplatzi, Chenies-street.

New **Ediswan Lamps**, brass holders, switches, &c., bought, cash or exchange.—G. Bowron, 93, Praed-street, London, W.

Ariston Organette, with tunes, nearly new, cost over £4. Broadwood Grand Piano. Exchange.—Stuart, 36, Russell-square, W.C.

Plate Electrical Machine, in box, complete, 30s., or offers in exchange.—W. Sawdon, Bridge-street, Whitby.

Two splendid pairs **Archangel Pigeons**, winners numerous prizes. Exhibition birds. Cards sent. Value 45s. Exchange Watch, Dynamo, Electrical Books, Motor, &c.—Phillips, Stokefields, Guildford.

Horizontal Engine, 1in. bore, 2in. stroke, and Copper Boiler. Exchange Electrical Light, Set Electrical Instruments, or Lathe.—Dawson, Plumber, Northorpe, Mirfield.

I have in addition to a complete set of "**English Mechanics**," a quantity of the early numbers, about 1cwt. Some volumes complete. What offers?—Harper, Engineer, Jersey.

Model brass **Swivel Gun**, brass mountings, or vertical tubular Boiler, 6in. Exchange Screw Engine for 3ft. boat.—Shorrocks, Keppel-road, Chorlton-cum-Hardy.

A genuine **Violin** (property of a late professional), by Wolff. Original price £8. Exchange to value £6.—King, 139, Queens-road, Finsbury-park, London.

Silver English **Lever Watch**, nearly new, in perfect order. Will exchange for Cuttriss' Electro-Motor.—W. E. Jackson, 64, Norton-street, Grantham.

"**Amateur Work**," first five volumes, cost £1 15s. Want Microscope, Objectives, Apparatus, good Microscopic Literature, or offers.—Whiting, Chaworth-road, Colwick, Nottingham.

Light vertical and **Eccentric Cutting Instruments**, by good maker, both graduated, equal new. Wanted, good four-jaw Chuck (⅝in. nose).—Craven, Pontefract.

Compound Engine, 4in. and 7 cylinders, nearly finished; also 2H.P. Horizontal Engine. Wanted, 4in. Screw-cutting Lathe, or other exchanges.—J. Allsopp, C.E., Worksop.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, NOVEMBER 13, 1891.

PRACTICAL ELECTRIC-LIGHT FITTING.—IX.

By F. C. Allsop.

Author of "Practical Electric-Bell Fitting," "Telephones: their Construction and Fitting," "Electric-Bell Construction," &c.

WE now come to the actual fittings, of which a very large variety exists. They can be comprised under three distinct heads, viz., "pendants," "electroliers," and "wall brackets," with perhaps a fourth heading, under which may be placed "ceiling fittings," "shop-window fittings," and "reading lamps." Although the word *fittings* is not unfrequently used to designate the whole of the accessories of an electric-light installation, such as switches, ceiling roses, cut-outs, &c., nevertheless in its more general application it is understood to mean only the actual lamp-fittings or supports, and this is the rendering that will be given to it in these articles. Like gas chandeliers and brackets, electric-light fittings are made in brass, copper, and wrought iron, either of one metal only, or of a combination of two or three, according to the style and design of the fitting. The electric light, however, lends itself much more readily to artistic adaptation than gas; indeed some of the ten or twelve electroliers now in the market are, it must be admitted, a masterpiece of elegance and artistic design. Perhaps the most noticeable difference between gas-fittings and those for electric light is that in the former all burners must be directed upwards, whereas in the latter they are directed downwards, thus obviating all shadows, and an obscured, or partially obscured, light. In an electric-light fitting also a great reduction in the thickness of the metal can be effected, doing away with that heavy appearance that is so unsightly in many gas-fittings.

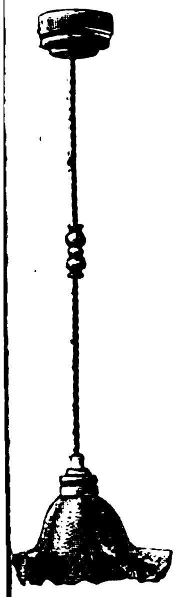


FIG. 56.

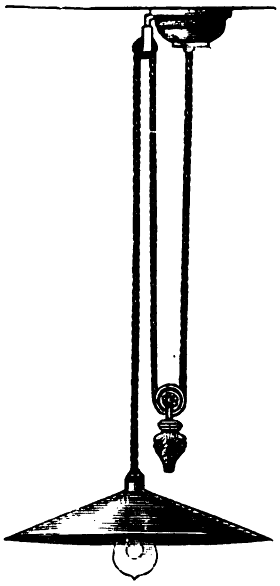


FIG. 57.

The simplest electric-light fitting (if so it may be called) consists of a lamp and holder hanging at the end of a flexible cord, the other end passing through a hole in the lid of the casing, and being directly attached to the conducting wires. This form of fitting, however, though simple and cheap, is not recommended where it is desired to make a good job of the work. A rather better form is one similar to that shown in Fig. 56, except that it has a conical shade as Fig. 57, and no bead on the flexible cord. It is a fitting much used for mill and factory lighting, and indeed in all places where a plain and cheap fitting is required. It consists of a ceiling-rose, 3ft. of 35-40 flexible cord, a shade-carrier, holder, and a conical shade—this latter being either of opal glass or, what is perhaps preferable in many places owing to its being practically unbreakable, enamelled iron. If the fitting is for a private house or shop window, something more artistic will generally be required, so some such form as shown in Fig. 56 can be employed. This has a fancy shade and a glass or brass bead half-way between the ceiling-rose and shade, which somewhat relieves its plainness.

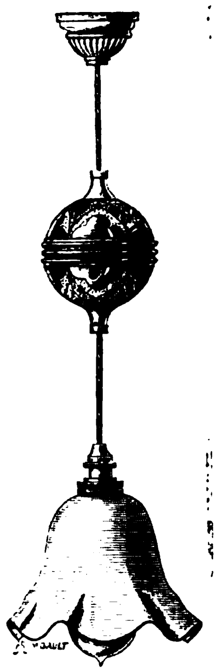


FIG. 58.

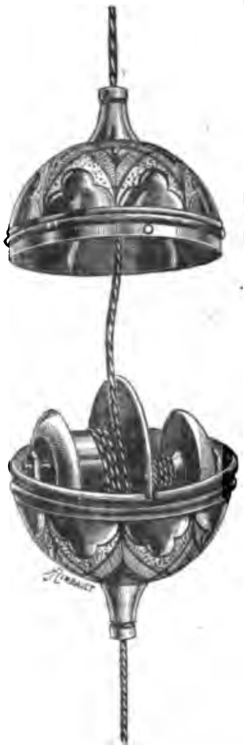


FIG. 59.

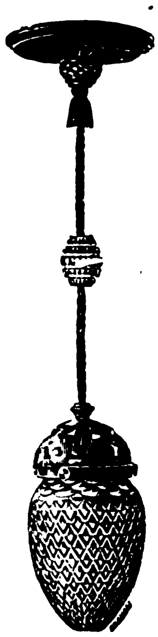


FIG. 60.

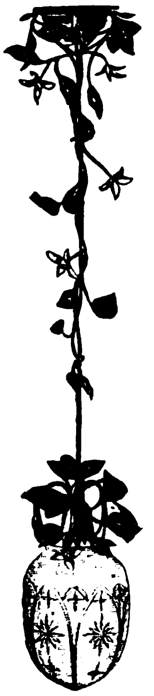


FIG. 61.

A very convenient form of fitting is that shown in Fig. 57, which is known as the "adjustable pendant." It consists of a ceiling-rose of the form shown in Fig. 41, Article VII., and about 9ft. of flexible cord, at the bottom of which is the holder, lamp, and shade. The ceiling-rose is fixed on the ceiling, and the flexible cord threaded through as shown in the figure, so that the lamp and shade can be raised or lowered to any position. The counterweight is hollow, and must be filled with shot until a balance is obtained, so that the lamp will remain in any position in which it is put. These adjustable pendants are made in a great variety of forms up to five and six lights, with fancy silk shades and massive counterweights.

Numerous attempts have been made by various inventors to devise a compact form of the adjustable pendant, and one of the most successful (the Bradner) we illustrate in Figs. 58 and 59. Fig. 58 shows the fitting complete, and Fig. 59 the counterweight, with cover removed, showing the interior construction. It is ingeniously arranged so that only one cord is necessary, and the brass ball or counterweight appears to be merely an ornament to break the line of the long straight cord. It acts by the coiling and uncoiling of the flexible cord on two drums of different diameters, and fixed on a common spindle, so that when the lamp is pushed up the counterweight descends, winding up the slack cord on one side of the drum and unwinding from the other. The pulley is so weighted as to balance any ordinary lamp-shade, but where these are unusually heavy the balance can be readjusted by inserting lead discs inside the drum. In erecting the fitting a thin cord should be used, so as to obtain an easy movement. Fix one end to the ceiling rose and pass the other down through the shell with the bearings, and through the hole in the drum from the smaller side to the larger; then wind the larger drum with as much cord as it will hold without crowding. The pivot at the larger end of the drum must be in the longer bearing. This fitting has a smooth movement, and the lamp remains in any desired position without the slightest difficulty.

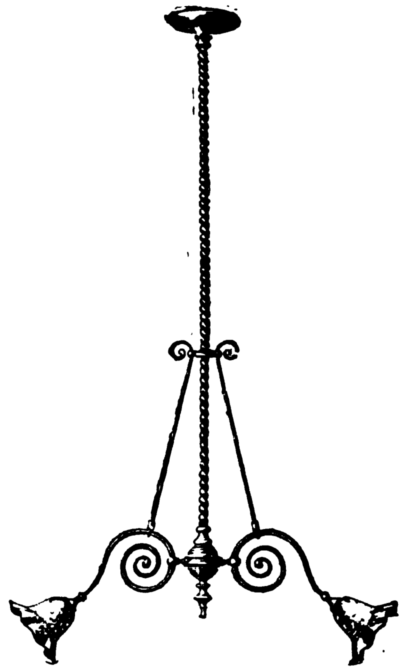


FIG. 62.

It might be supposed that in all these adjustable pendant fittings the wear and tear is excessive; but owing to the pulleys being made of porcelain or ebonite, and running easily, the wear on the cord is inappreciable. A very handsome form of the ordinary pendant is shown in Fig. 60. It has a cut-glass ceiling plate, thick suspension cord, and massive cut-glass globe, supported by a brass gallery. The lamp is carried by a plain holder inside the globe, and the effect of a high candle-power lamp inside the globe is very fine. Another excellent form is shown in Fig. 61. The cut-glass globe containing the lamp is supported by a thin flexible cord, round which twines an imitation creeper, the leaves being of wrought iron and the flowers of beaten copper.

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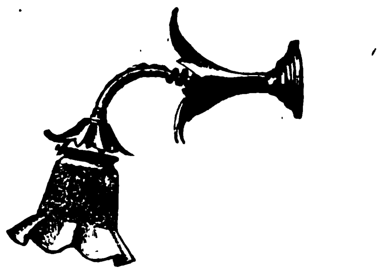


FIG. 63.

Electroliers are made in a large number of shapes and sizes, from the plain 2-light to the massive and imposing 30 or 40-light, the sizes in most general use, however, being the 3, 5, and 12-light. A small 2-light electrolier is shown in Fig. 62, consisting of an upright twisted stem and two ornamental arms, at the end of which are the holders carrying the shades. The stem and arms are made from brass tube, and the wires to the lamps are passed down the stem and through the arms to the holders.

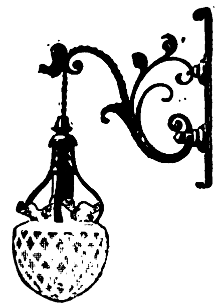


FIG. 64.

Wall brackets are generally either 1 or 2-light, the 3-light not being very much used. As their name implies, they are fixed against the wall for lighting the room from the side—a method preferred by many to centre lighting. The simplest wall bracket consists of a plain tube fitted at one end with a back-plate, and at the other turned down at right angles. This end is fitted with a thread to suit the holder, which may be with or without shade-carrier, according to whether a shaded light is required or not.

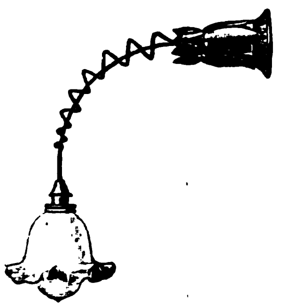


FIG. 65.

A very neat form of wall-bracket is shown in Fig. 63. The tube and back plate are of polished brass, and the leaves of beaten copper. Another rather favourite form is shown in Fig. 64. It is of wrought iron throughout, and makes a capital hall or library fitting. Fig. 65 shows a very light bracket, which will be found very effective in many places. The lamp and shade hang on the end of the flexible cord, which is kept to a graceful curve by the spiral brass wire surrounding it. Fig. 67 is a ceiling-fitting in polished copper for centre lighting, and more especially for low-pitched ceiling. A high candle-power lamp is generally employed in such a fitting, which makes it very effective. Figs. 68 and 69 show two small fittings such as are used for shop-window lighting. The form in Fig. 67 consists of a china shade in the form of a shell leaf, inside which is fixed the lamp. The shade is suspended from the ceiling by a flexible cord, and the lamp adjusted so that the light is thrown on to the goods, and shell-leaf shade screens the eyes. Fig. 69 is a similar fitting, but is fixed on the wall so as to throw a light from the side of the window. The shell-leaf reflector in this fitting is of metal, silver-plated, the holder and stem being likewise plated to match.

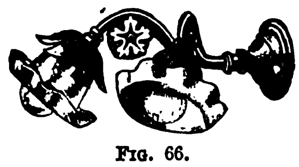


FIG. 66.

Reading-lamps are lamps made to stand on the table or mantelshelf, in order to get a concentrated light for reading, writing letters, &c. They are connected to the conducting wires in the walls by means of the wall-plugs described in Article VII., a length of about 6 yards of flexible cord being employed. A simple and very useful form is shown in Fig. 70, consisting of a polished brass standard with the lamp at the top, and a conical shade to throw the light down. The flexible connecting-wire passes in through a hole in the stand of the lamp. A very ingenious and convenient form of reading-lamp is shown in Fig. 71. It is a combined reading-lamp and wall-bracket, and can be used as either at will. It consists of a polished brass standard, the upper end of which finishes off in a Y-shaped branch. Between the two projecting prongs is pivoted the lamp-holder, the bottom of which is weighted so that the force of gravity always keeps the lamps upright. The end of the flexible cord (which cord is not shown in the figure) enters to the lamp through the bottom of the holder, and the holder is, it will be noticed, fitted with a switch. In the position shown in the figure the lamp is in use as a wall-bracket, it being supported by the lug seen at the top of the base. When required as a reading-lamp, the fitting is lifted off the nail in the wall, and stood on its base, when the lamp immediately swings into the upright position.

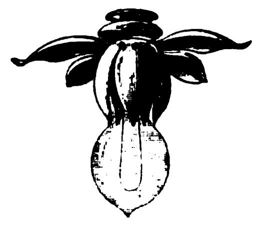


FIG. 67.

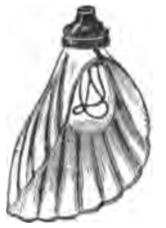


FIG. 68.

As regards the selection and arrangement of fittings for different rooms and buildings, no hard and fast rule can, of course, be laid down. The selection and proper disposing of the lamps and fittings to get the most effective lighting and pleasing appearance is no easy matter, and a qualification—judging by the eyesores to be met with every day—not possessed by every electric-light engineer. One comes across dining-rooms, reception-rooms, &c., equipped with fittings that are more suitable for a barn or workshop; shops with the lamps so badly arranged that it is impossible to properly inspect the goods owing to the glare in one's eyes, and theatres, music-halls, and other public buildings so inadequately lighted that quite a gloom is cast over the place. No doubt, in many instances, the proprietors of the buildings are themselves to blame, as many insist on having the lamps arranged to their own notions, irrespective whether it harmonises with the style of decoration and arrangement of the building. In the majority of cases, however, it is only too evident that bad lighting is caused by carelessness or want of judgment on the part of the contractor. Seeing that nothing lends itself so readily to artistic adaptation as the electric light, this is much to be regretted.

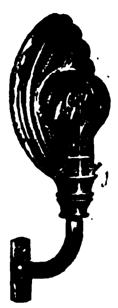


FIG. 69.

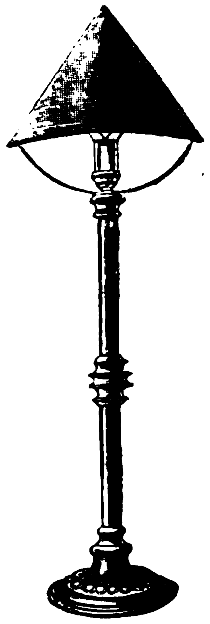


FIG. 70.

For factory or mill-lighting, it is very doubtful if anything better than the ordinary plain pendant, similar to Fig. 56, with enamelled iron shade, can be employed, or if a side light is desired, a plain wall-bracket. Hand-lamps connected to the wall-socket with flexible cord will also be found very convenient for inspecting different parts of machinery, &c. For hall and entrance lights of private houses, a ceiling-fitting, with two or three lights, according to the space to be lighted, will be found very suitable. In the reception rooms, electroliers, or wall-lamps, are used according to the size, style, and

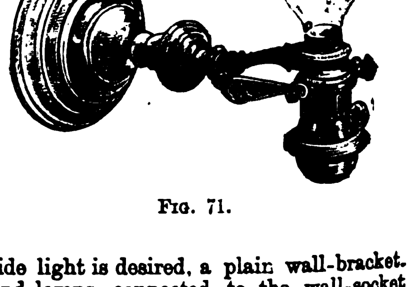


FIG. 71.

arrangement of the rooms. Wrought-iron fittings are a favourite fitting with many persons, and look very well with carved oak decorations. In the library, wrought-iron wall-brackets will be found very effective as a general light, adjustable pendants, with large silk shades being used to get a concentrated light for reading. Billiard-rooms, of course, require a special fitting. Generally, this very much resembles the ordinary gas billiard-table light, with the large paper shades, though a very good way is to drop down six pendants from the ceiling over the table, each pendant being fitted with a large opal shade. In the bedrooms, plain pendants, or wall-brackets, are generally used, different colour shades being employed, according to taste and style of decoration. In the kitchen and adjoining offices nothing better can be employed than the simple pendant, with enamelled iron shade, and a portable lamp, for use over the cooking-range, will be found very convenient. As regards reading-lamps, it will be found very convenient to have a wall-socket in all the reception-rooms and principal bedrooms; there need not be a lamp for each room, as if there are one or two, they can be carried from room to room, as desired. In shop-window lighting, the lamps require to be carefully placed, the great point being to conceal the light from the eyes, and concentrate it on the goods. In some windows, the goods are placed close to the glass, and in such cases it is useless to try and get good effects from inside lighting. Shaded lights (specially protected against the weather) must then be employed outside, which can be done more effectually than by gas, and at the same time so as not to appear unsightly.

(*To be continued.*)

GEOLOGY FOR STUDENTS.

By Edward Aveling, D.Sc. Lond., Fellow of University College, London.

Chapter XVIII.—Classification of Plants and Animals.

ALL the rest of the geological systems that we have to study, from the Silurian up to the Recent, are fossiliferous, contain remains or traces of living beings. There are no longer doubtful questions of Eozoons, but unmistakable organic remains. D. Palæontology, in our plan (p. 81) has hitherto been almost wholly ignored. There has been nothing to say under that head, with one dubious exception. But, henceforth, in our study of the various systems, their palæontology will play a very important part The next two chapters will, therefore, be devoted to a few notes on fossils generally, and to an outline of the classification of plants and animals.

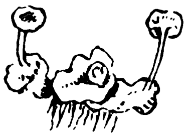


Fig. 67.

A fossil may be the result of the actual preservation in the rocks of some living thing, or of some part of a living thing; or it may be the result of the petrifaction of the whole or of part of an organism. In some few cases conditions have been favourable, and the whole of a plant or animal has been preserved in the rock. But this very rarely occurs. Much more frequently parts of the plant (the cones of pines, e.g.) or parts of the animal (the shells or bones, e.g.) are preserved. Most frequently, however, fossils are the result of petrifaction. *Petra*, a stone; *facio*, I make. In these cases the plant or animal loses more or less of its organic structure and composition, and takes on the structure and composition of a mineral. As a result we may find perfect models of plants or animals in stone. And sometimes these mineral fossils, if I may use the phrase, take the form of casts or moulds of the exterior or of the interior of the organism. The actual substance and the petrifactions of the actual substance are more common in clays and limestones. Casts and footprints are more common in sandstones, through which water can percolate freely, and carry away the actual substance of the organism.

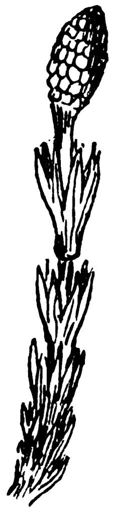


Fig. 68.

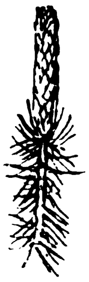


Fig. 69.

The student must not imagine, for a moment, that traces will be found in the crust of the earth of all the living beings that have existed in the past. The geological record is very imperfect.

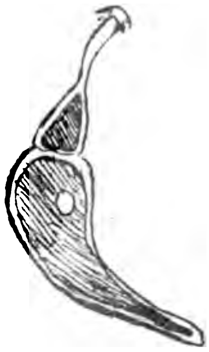


Fig. 70.

For, in the first place, very many plants and animals could not be preserved. Soft and delicate structures cannot, as a rule, become fossils. In the table of classification of animals given below, the names of the classes entirely unrepresented palæontologically are printed in small type.

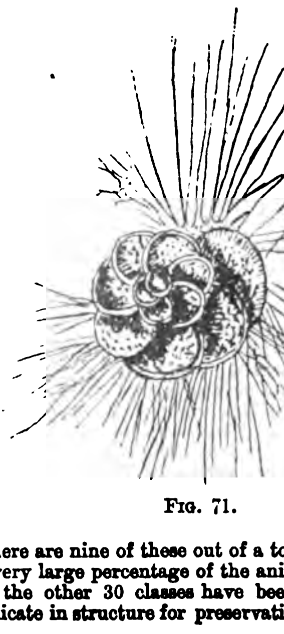


Fig. 71.

There are nine of these out of a total of 39. But a very large percentage of the animals belonging to the other 30 classes have been too soft and delicate in structure for preservation in the rocks. With plants, the intrinsic possibilities of preservation are even less than with animals.

Besides the necessary intrinsic conditions, the firmess and durability of the organism, there are necessary extrinsic conditions. A plant or animal in itself capable of preservation will only be preserved when the external surroundings are favourable. Myriads upon myriads of organisms have perished and decayed away, without any sedimentary rocks being deposited upon them to envelop them as fossils.

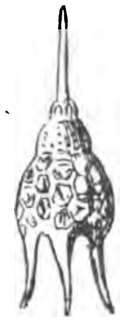


Fig. 72.

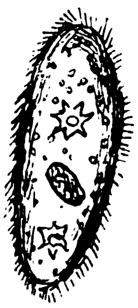


Fig. 73.

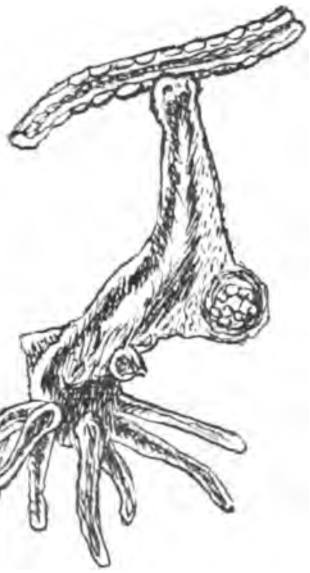


Fig. 74.

Yet again, even supposing a plant or animal to have been intrinsically and extrinsically in favourable conditions for preservation, after-changes, especially of an igneous nature, have in countless instances destroyed the fossil. And again let us bear in mind that vast regions of the earth's surface have not been explored geologically.

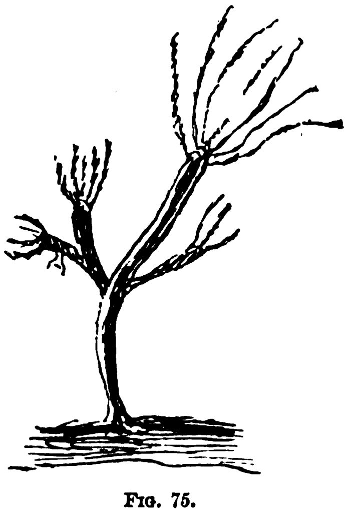


Fig. 75.

Keeping these facts in mind, the student will realise to some extent the imperfection of the geological record as far as palæontology is concerned. The fraction of the organisms that have existed on the earth, represented in any form in the fossils of the crust, is infinitely small.

In Table I., p. 66, it was shown that palæontology has two divisions; palæophytology (fossil botany), and palæozoology (fossil zoology). The subjoined Table shows the chief divisions of the Kingdom Vegetabilia, to which reference will be made in our study of palæophytology.

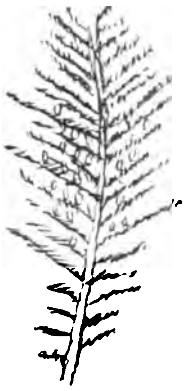


FIG. 76.

TABLE X.

Kingdom.	Sub-Kingdom.	Class.	Division.	Examples.
Vegetabilia.	Cryptogamia.			Algæ.
				Fungi.
				Musci.
				Hepaticæ.
				Filices.
				Equisetaceæ.
				Lycopodiaceæ.
	Phœnogamia.	Monocotyledones.		Grass.
				Arum.
				Hyacinth.
		Dicotyledones.	Gymnospermæ	Pines.
				Cycads.
			Angiospermæ.	Hazel.
				Deadnettle.
				Rose.
				Buttercup.

The lower of the sub-kingdoms, into which the artificial kingdom Vegetabilia is artificially divided, comprises plants that have no flowers. As the reproductive organs of these plants are microscopic, and not visible to the naked eye, the sub-kingdom is known as that of the Cryptogamia. κρυπτος (kruptos), hidden; γαμος (gamos), marriage. This sub-kingdom includes Algæ or seaweeds, Fungi or mushrooms, Musci or mosses, Hepaticæ or Liverworts, Filices or ferns, Equisetaceæ or horsetails, Lycopodiaceæ (lycopods and club-mosses). Of these, the only classes not familiar to the reader are the Hepaticæ (*hepar*, a liver), Equisetaceæ (*equus*, a horse), and Lycopodiaceæ. Figs. 67, 68, 69 respectively represent a liverwort, a horsetail, a club-moss.

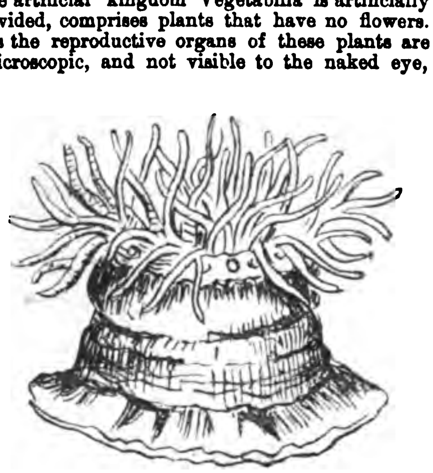


FIG. 77.

The second sub-kingdom comprises plants that have flowers. As the reproductive organs of these plants are not microscopic, but are visible to the naked eye, the sub-kingdom is known as that of the Phænogamia or Phanerogamia. φαινω (phaino), I appear; φανερος (phaneros), evident. This sub-kingdom has two classes. The lower, whose plants have generally an adventitious root—i.e., a root with no main dominant axis—irregular wood, leaves with parallel veins, the parts of the flower in threes, and only one cotyledon or embryo leaf in the seed, is called the class Monocotyledones. *adventitius*, accidental; κοτυληδων (kotuledon), a plant; μονος (monos), single. The higher, whose plants have generally a root with a main, dominant axis, their wood arranged in rings, the leaves with netted veins, the parts of the flower in twos or fives, and two cotyledons, is called Dicotyledones. δις (dis), twice.

The Dicotyledones present two divisions. One, represented by the pines and firs, has naked seeds—i.e., seeds not inclosed in ovaries or seed-cases. It is named Gymnospermæ. γυμνος (gumnos), naked; σπερμα (sperma), seed. The other, represented by most of our trees and flowers, has seeds inclosed within ovaries. It is named Angiospermæ. αγγος (angos), a vessel.

Table XI. shows the chief divisions of the kingdom Animalia. I give all the sub-kingdoms and classes, printing in *italics* the names of those classes of which no fossil forms are known.

TABLE XI.

Kingdom.	Sub-Kingdom.	Division.	Class.	Example.
ANIMALIA.	Protozoa		*Gregarinida.*	Gregarina.
			Rhizopoda.	Rotalia.
			Infusoria.	Paramœcium.
	Porifera.		Plethospongiæ.	Spongilla.
			Calcispongiæ.	Grantia.
	Cœlenterata.		Hydrozoa.	Hydra, Sertularia.
			Actinozoa.	Actinia, coral.
	Echinodermata.	Echinozoa.	Echinoidea.	Echinus.
			Asteroidea.	Starfish.
			Ophiuroidea.	Brittle star.
			Holothuroidea.	Sea cucumber.
		Pelmatozoa.	Crinoidea.	Pentacrinus.
			Cystoidea.	Hemicosmites.
			Blastoidea.	Pentremites.
	Annulosa.	Scolecida.	*Platyelmia.*	Tape worm.
			Nematelmia.	Round worm.
			Rotifera.	Wheel animalcule.
		Anarthropida.	*Gephyrea.*	Spoon worm.
			Myzostomida.	Myzostoma.
			Annelida.	Earthworm.
			Chætognatha.	Sagitta.
		Arthropida.	Crustacea.	Lobster.
			Arachnida.	Spider.
			Myriapoda.	Centipede.
			Insecta.	Cockroach.
	Molluscoida.		Polyzoa.	Entalophora.
			Brachiopoda.	Rhynconella.
			Tunicata.	Ascidia.
	Mollusca.		Lamellibranchiata	Oyster.
			Gastropoda.	Snail.
			Polyplachophora.	Chiton.
			Scaphopoda.	Dentalium.
			Cephalopoda.	Cuttlefish.
	Vertebrata.		*Leptocardia.*	Amphioxus.
			Pisces.	Salmon.
			Amphibia.	Frog.
			Reptilia.	Lizard.
			Aves.	Fowl.
			Mammalia.	Cat.

PROTOZOA. πρωτος (protos), first; ζωον (zoon), animal. Very lowly organised beings, with protoplasmic microscopic bodies; generally aquatic.

Class. 1. *Gregarinida*. Internal mouthless parasites. Fig. 70 represents the gregarina found inside earthworms and cockroaches. The name of the genus and of the class is from *gregarius*, living in flocks, as the gregarines always occur in colonies, not singly. Never occurring as fossils.

Class 2. *Rhizopoda*. ριζα (rhiza), root; πους, ποδος (pous, podos), foot. Aquatic, mouthless, sending out extensions of their protoplasmic bodies, that are used to secure food particles and also in the movements of the rhizopod. Most of the class have the power of forming around their protoplasmic bodies shells of calcium carbonate (Fig. 71) or silicon dioxide (Fig. 72). In Fig. 71 (Rotalia) the many protoplasmic segments of the body are seen invested by the many-chambered shell, through the perforated walls of which the protoplasmic extensions or pseudopodia protrude. ψευδος (pseudos), false.

Class 3. *Infusoria*. Microscopic animals, living in vegetable infusions—hence the name of the class; with mouths, without pseudopodia, but with minute hair-like cilia (*cilium*, eyelash) on the exterior. Fig. 73 represents a very common form, Paramœcium. Not occurring as fossils.

FIG. 78.

PORIFERA—*porus*, a passage; *fero*, I bear. The sub-kingdom of the sponges. The ordinary sponge, as known to us, is only the skeleton of the living sponge. In life, the many canals running through this skeleton and their dilatations are lined with protoplasmic masses, each of which is, virtually, a single rhizopod.

Class 4. *Plethospongiæ*. πληθος (plethos), a great number. The name comes from the fact stated in the preceding paragraph. Our ordinary sponge is a representative of this class. The skeletons are horny or silicious.

Class 5. *Calcispongiæ*.—The skeleton is of calcium carbonate; *calx*, *calcis*, chalk.

CŒLENTERATA. — κοιλος (koilos), hollow; εντερον (enteron), intestine. Bag-like, aquatic animals, with body walls no longer protoplasmic, but with at least two layers.

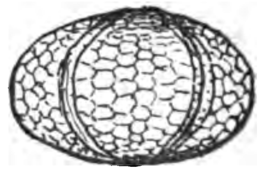


FIG. 79.

Class 6. *Hydrozoa*. — Hydra animals. Thus named from the type of the class—the Hydra, or fresh-water polyp (Fig. 74), the simple bag-like animal often found hanging mouth and feelers downwards from duckweed. The Hydra, like all its class, has only a single, undivided internal cavity.

Much more important than the Hydra, palæontologically, are its compound derivatives. In Fig. 75 is shown a hydra giving out buds which after a time become detached and live as separate individuals. Many of the allies of the Hydra, however, give out similar buds which do not become detached. Hence a colony results, as in Sertularia, Fig. 76. The small eminences represent individual hydræ, connected by a branched, common structure, originally of living matter, later on of hard material.

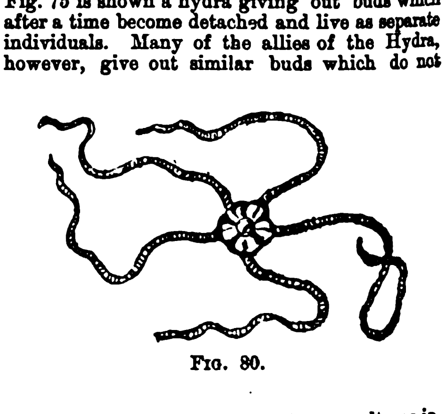


FIG. 80.

Class 7. *Actinozoa*.—Actinia animals. Actinia is the technical name of the sea-anemone, Fig. 77. ἀκτις (aktis), a ray. The name comes from the radiating appearance of the tentacles or feelers of the sea-anemone. The body cavities of the sea anemone and of all its allies are divided into at least two chambers. Just as the Hydra forms buds which afterwards become detached and separate individuals, so the sea-anemones are reproduced by this process of budding; and in some of the Actinozoa, as in some of the Hydrozoa, buds are given out that do not become detached. Hence a colony results, the members of which are connected by a branched common structure, originally of living matter, later on of hard material. These colonies of Actinozoa form coral. In Fig. 78 is shown a piece of branched coral. Most of it is only the hard persistent dead coral; but to the left is seen a portion of the soft, living substance investing the hard coral, and having imbedded in it the small bodies of the sea-anemone-like animals.

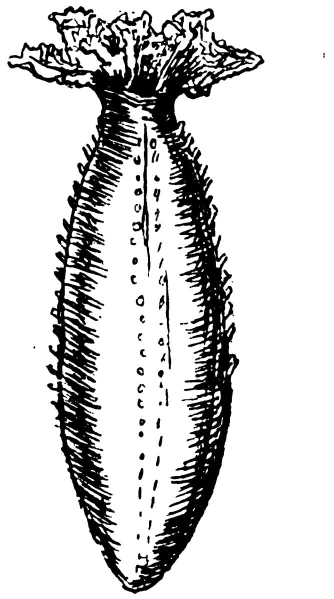


Fig. 81.

Echinodermata—εχινος (echinos), sea-urchin or hedgehog; δερμα (derma), skin. On account of the spines or sharp prominences met with on the bodies of most members of the sub-kingdom.

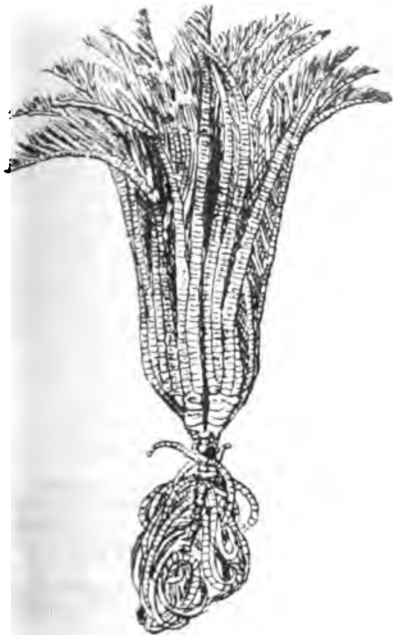


Fig. 82.

The first division is Echinozoa or sea-urchin animals; the second, Pelmatozoa. πελμα (pelma), a stalk (see Fig. 82).

Class 8. *Echinoidea.* ειδος (eidos), likeness; sea-urchins (Fig. 79) and their allies. With a globular body surrounded by a calcareous shell, of many plates, perforated and covered with bosses and spines.

Class 9. *Asteroidea.* ἀστηρ (aster), a star. The starfish and its allies. A central body with radiating arms, into which extend prolongations of the alimentary canal.

Class 10. *Ophiuroidea.* ὀφις (ophis), a snake; οὐρα (oura), a tail. The brittle-stars (Fig. 80) and their allies. The radiating arms in this class are sharply marked off from the central body, and do not contain any extensions of the alimentary canal.

Class 11. *Holothuroidea.* ὁλοθουριον (holothourion), the sea-cucumber (Fig. 81). Elongated, leathery, with no shell, but with calcareous, microscopic bodies immersed in the integument.

Of the division Pelmatozoa, Class 12, is the *Crinoidea.* κρινον (krinon), a lily. The sea-lilies (Fig. 82) and their allies. Long-jointed stalks, carrying above a central body, with radiating, jointed arms.

Class 13. *Cystoidea.* κυστις, (kustis), a bladder. A spherical body, covered by irregularly arranged calcareous plates (Fig. 83). Extinct.

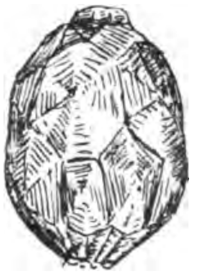


Fig. 83.

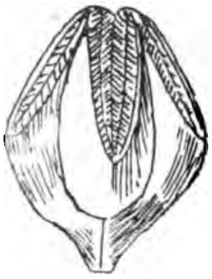


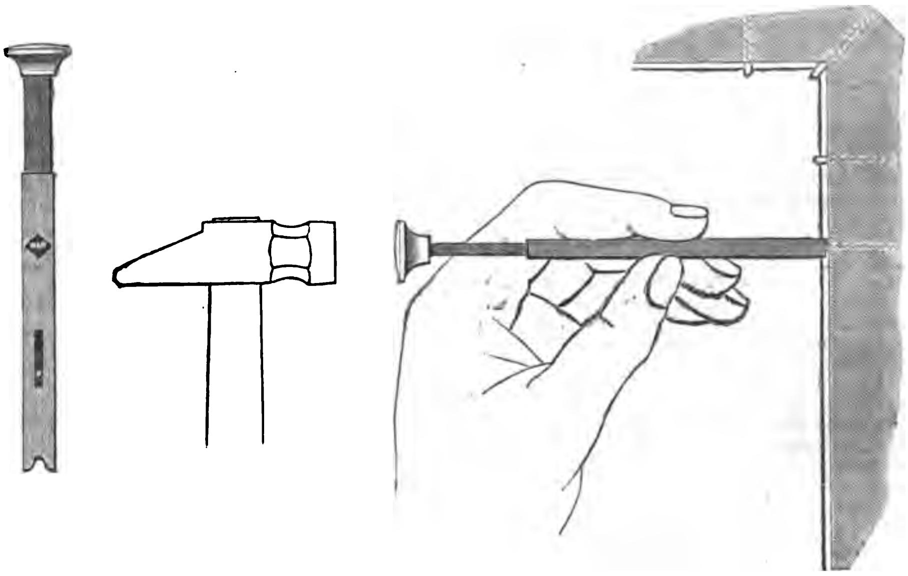
Fig. 84.

Class 14. *Blastoidea.* βλαστος (blastos), a sprout or shoot. Pear-shaped body with shell (Fig. 84). Extinct.

In the next chapter we shall consider and illustrate the remaining classes of the kingdom Animalia. Then the systems presenting fossils will be studied.

"W. AND R." PATENT STAPLE DRIVER.

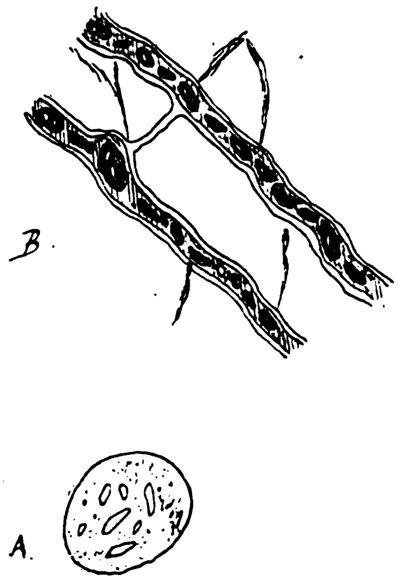
THOSE who have had much experience in running bell wires, have often wished for some easy method of holding staples in position without using one's own fingers for the purpose. We illustrate a simple little instrument, which has been designed with this end in view. It holds the staples in position until they have penetrated far enough to be driven home with the hammer. The tool consists of a rectangular tube of a size suitable for the staples being used, in which is a plunger with a movement of about ¼in. The staple is placed in the end of the tube, where it is held, and the projecting points are placed over the wire, which is being run; a blow is given to the opposite end of the plunger, after which the tool is removed and the staple driven home. It will be found very handy for those who are in the habit of running wires overhead, or in other places where it is inconvenient to hold the staples in the fingers. Messrs. Woodhouse and Rawson United, Limited, are the makers.



PRACTICAL MICROSCOPY FOR STUDENTS.—VI.

By Frederick Davis, B.Sc.

WE have now arrived at a simple cell. Every form of plant-life is composed of an immense number of simple cells modified in certain particulars. The student will remember, in examining the fern-stem, he found the form of cells known as parenchyma. If we take one of these cells, and view it with the ¼in. objective, we shall see it to be composed of an outer portion, or cell wall, with an inner semi-fluid substance, called the protoplasm, in th centre of which may be observed the nucleus. At first the protoplasm entirely fills the cell; but as the cell-wall enlarges—that is, grows, the protoplasm is insufficient to fill it. Spaces, therefore, occur, which are termed vacuoles. These vacuoles are filled with a watery fluid called the cell-sap.

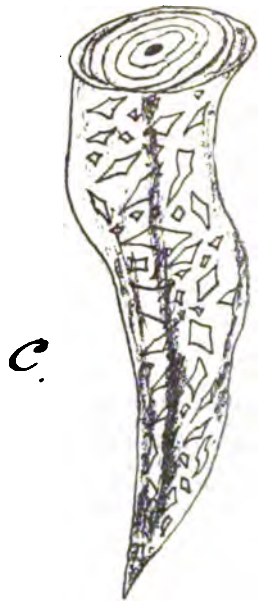


A, Chlorophyll Granule; B, Protoplasm of cells, showing Chlorophyll and Starch-granules contained therein.

It must be remembered it is the protoplasm which constitutes the whole vitality of the cell, and from this substance all the cell contents are directly formed.

During the growing state of the cell, its contents are constantly in motion. In some plants this may be observed to better advantage than in others. The best plant for the microscopist to examine is that bearing the name of Vallisneria spiralis: in its cells the circulation is very beautiful. The student may have attended one of the many soirées connected with a microscopical society: it is generally this plant which is shown at such to demonstrate this phenomonon.

Many hairs from the nettles and potato plants show the same circulating character of the cell contents. The shape of the cell is modified according to the equal or unequal pressure brought to bear upon it, any so-called secondary deposits being developed as the cell requires such to strengthen and support it according to its surroundings. In the various forms of cells which the student will examine, he will observe in some the protoplasm to be transparent, in other opaque, again of the consistency of dough, or quite hard and easily broken. Generally speaking, however, it is of a pale fawn or greyish colour. Sachs is of opinion that only the transparent variety should be considered protoplasm in the true sense of the word; it will be remembered that, in a previous chapter, we stained the protoplasm of a cell with iodine solution, but that the sac or cell-wall was unaffected; if now we substitute a solution of sugar and dilute sulphuric acid in place of the iodine solution, we shall find a pink coloration developed. This of itself should be sufficient to prove the presence protoplasm as such, whether opaque or transparent.



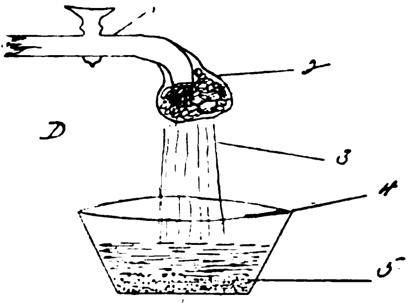
C, Raphides existing in cell walls (Oxalate of Calcium) highly magnified.

The nucleus appears to be modified or thickened protoplasm, whilst the cell-sap does not appear to be developed from the protoplasm until the vacuoles are formed ready for its reception. After the thickening of the protoplasm, it deposits itself upon the inner portion of the cell-wall, and is then termed the primordial utricle. As the protoplasm thickens or becomes elaborated, other substances are thrown out or separated from it; these assume various forms, and are termed chlorophyll, raphides, aleurone grains, starch, &c., according to their respective compositions.

Chlorophyll is developed only under the influence of light, and in the presence of iron: chemically it is assumed to consist of two bodies, one blue in colour termed phyllocyanin, the other yellow, termed phylloxanthin; these, in combination of course, produce a green colour; the student should not, however, accept definitely this theory, as probably before long it may be proven to be fallacious.

At present all other colours developed in flowers are assumed to be produced by a modified form of phylloxanthin, termed phylloxanthein, in combination with phyllocyanin in different proportions. Starch is produced in and from the chlorophyll granules in the first instance; in its primary state, however, it is transferred from the chlorophyll to the cell-sap, where apparently further changes occur, and the matured starch granules result; these are stored in various parts of the plant for its future nourishment. Before it can be assimilated by the plant it is converted from the insoluble to the soluble state by conversion into—firstly dextrin, and then sugar; it is then ready for purposes of nutrition.

A starch granule has specific points according to the plant it is developed in; the microscopist may, therefore, use his instrument to advantage in detecting adulterations or otherwise.



D, Apparatus for obtaining Starch from Potato. 1, Tap; 2, Muslin bag, containing a pulped Potato; 3, Gentle stream of water; 4, Receptacle; 5, Deposit of Starch granules.

The starch of potato, for instance, shows a marked difference to that of wheat, whilst rice starch is smaller and of a totally different shape. The little black spot to be observed in a starch granule is termed the "hilum," and, according to the position of this point and the relative position of the striæ, so we can refer a starch to its source, not omitting to take notice of its size, because, as in the case of tous-les-mois and the starch of potato, very little difference is perceptible excepting in size.

It frequently happens wheaten flour is adulterated with starches of an inferior or cheaper kind, such as rice or potato starch: the microscope is of great value in such cases.

The chief characteristics of the starches may be enumerated as follows:—Wheat starch is always very irregular in size. The large granules have a well-defined hilum and faint striæ; the smaller granules will present under the ⅛in. objective an angular formation. The granules vary in size from ·0011 to ·0001 of an inch.

Rye Starch varies greatly in size; the chief feature, however, is the *stellate* hilum.

Barley Starch resembles wheaten starch, with the exception that the striæ are more distinct.

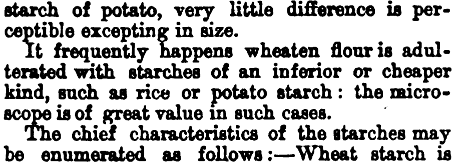
Oat Starch.—The granules are polygonal, small, and regular, and in very few is the hilum perceptible.

Rice Starch.—Very small indeed, polygonal, about ·0001 to ·0003 inch in diameter.

Arrowroot is a term employed to designate any, or every, form of pure starch. Originally, however, it was intended to refer to the starch obtained from the Maranta arundinacea. At the present time, all forms of starch obtained respectively from species of Curcuma and Smilax, Canna edulis, Tacca oceanica, are termed arrowroot, frequently largely adulterated with potato starch.

Potato Starch.—The granules vary in size, are either circular or oyster-shaped, have well-defined striæ and small hila.

The student will only obtain satisfaction and be able to recognise these starches by practice. He should, in every case, obtain a typical specimen by separating the starch for himself, carefully mount, and preserve for reference.



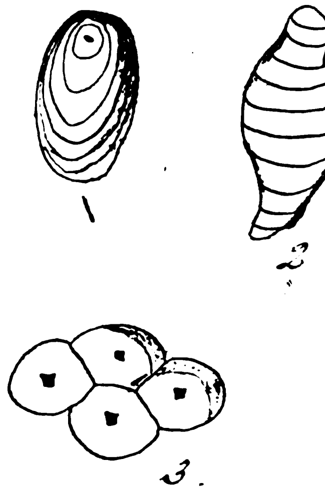
E, Parenchymatous cells, containing—1, Crystalloid; 4, Nucleus.

To obtain the starch from, say, "potato," the following method may be adopted:—Scrape the potato into a pulpy mass after peeling; place this pulp in a fine-meshed muslin bag; fasten the bag safely to an ordinary tap, and allow a *gentle* stream of water to slowly pass through it, being careful to place beneath it a basin or other receptacle to catch the fluid after it has passed through the bag and its contents. In this basin or receptable a thin film will be found to exist, eventually becoming deposited upon the bottom of the vessel. The supernatant fluid may be carefully poured or siphoned off, the film or powdery substance dried between folds of blotting-paper, and examined with the ¼in. objective, when it will be found to be pure starch. The substance remaining in the muslin bag is gluten. The starch may be separated with greater facility from the scraped potato by kneading with the fingers as the water passes through the bag.

Starch granules may be obtained in the same way from anything containing them.

Great care should be exercised in obtaining typical specimens, as upon this hangs the whole of the microscopist's power in detecting adulterations. In speaking of the starches, it may be well to mention they are seen to better advantage by means of "polarised light," the striæ becoming more apparent, and every detail of the granule better defined.

Polarised light may be obtained, as far as the microscope is concerned, by aid of the little instrument called the "polariscope"; this consists of two parts, one called the "analyser," the other the "polariser." The analyser is generally fixed above the objective within the tube of the microscope, the "polariser" beneath the stage of the instrument, a selenite plate intervening. There are various modifications of this arrangement, but the principle of the phenomena may be summed up in a few words.



1 and 2, Starch-granules from Potato; 3, Starch-granule from Smilax officinale.

If a ray of light falls on a glass plate at an angle of 56° 45′, the portion of the ray which suffers reflection will have acquired properties unpossessed previously; for if it be thrown at the same angle on a second glass plate, it will be observed the planes of incidence are at right angles to one another. This causes refraction in place of reflection, hence "Polarised Light" is refracted light.

I give the above explanation because polarisation is seldom explained in a concise form in text-books treating upon optics.

The starches should be examined under varying circumstances—for instance, mounted in water, then in glycerine and water, oil of turpentine, or oil of cloves, and their respective appearances compared.

Raphides are devoloped from the cell-sap, and consist of inorganic substances discharged or crystallised out from this substance. They generally consist of carbonate or oxalate of calcium, combined with water in varying proportions, the quantity of water materially affecting the shape of the crystal. Raphide really means a needle, but frequently they are not acicular in shape, but massed together in various forms. They are then termed conglomerate. In many plants a vast number of raphides are present, more especially in the order Cactaceæ. In Turkey-rhubarb root we find from 30 to 40 per cent., but in the English variety none. By chewing a little rhubarb, therefore, we can tell by its gritty character between the teeth whether it be English or not.

Raphides are most lovely objects for the polariscope.

In addition to raphides, we have, formed in the cell, other bodies of a crystalline character, termed crystalloids. These appear to be modified protein, not true crystals. This may be proved by soaking in solution of potash, which will cause them to swell; a true crystal would, of course, not do this. Between these crystalloids are found aleurone grains—really a modified form of protein, an albuminoid body.

The examination of the simple cell should be of the greatest interest to the microscopist.

FIRE EXTINGUISHER.

THE old fashioned form of fire extinguisher or "extincteur," as it is called, has been improved upon by Messrs. G. Dickson, and D. A. Jones of Toronto, Canada. A mixture of water and liquefied carbon dioxide upon being discharged through pipes at high pressure causes the rapid expansion of the gas and converts the mixture into spray more or less frozen, and portions of the liquid carbon dioxide are frozen, owing to its rapid expansion, and are thus thrown upon the fire in a solid state, where said frozen carbon dioxide in its further expansion not only acts to put out the fire, but cools the surface upon which it falls, and thus tends to prevent reignition. A represents a receptacle sufficiently strong to stand a pressure of not less than a thousand pounds to the square inch. B B water receptacles. In the drawings the patentees show two receptacles B and only one receptacle A; but they do not confine themselves to any particular number, nor to the horizontal position in which the receptacles are shown. C is a pipe leading from the receptacle A to a point at or near the bottom of the receptacle B. F is a pipe through which the mixture of water and liquefied gas from the receptacle B is forced by the expansion of liquefied gas, the pipe taking the mixture from the bottom of the receptacle. To use the apparatus, open the stopcock D in the pipe C, leading to one of the receptacles B, whereupon, owing to the lower pressure in the cylinder B, the liquid carbon dioxide expands and rises to the top of the cylinder A and forces the liquid carbon dioxide into the cylinder B, the same as the superior steam of a boiler forces the water of the boiler out when the same is tapped below the surface of the liquid. Now upon opening the tap H, this superior gas forces out the mixture of water and liquid carbon dioxide, which suddenly expanding causes portions of the globules of liquefied gas to be frozen, and these, being protected by a rapidly evaporating portion of the liquefied gas, are thrown on the fire in solid particles. At the same time the water is blown into a spray, which is more or less frozen. The fire is thus rapidly extinguished by the vaporisation of the carbon dioxide and water spray.

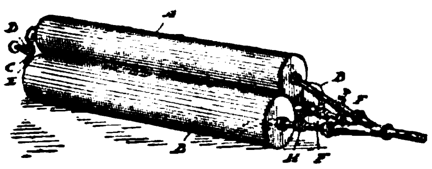


Fig. 1

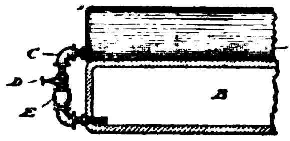


Fig. 2

THE LANTERN MICROSCOPE.*

By W. I. Chadwick.

IN lantern microscope projection three things are essential: the first is brilliant illumination, the second large amplification, and the third clear display of detail. But brilliant illumination does not mean a dazzling display of light upon a large white screen, showing the dark, patchy outline of an object without detail. Objects shown in this way are far inferior to enlarged woodcuts. The light must be made to enter the object so as to present all the details of its structure to the eye of the observer; but no amount of light will bring out this detail if its dimensions are too small for the crystalline lens to form an image of it upon the retina. With high power objectives the light on the screen must, in the very nature of things, be greatly subdued. Still, a large image, moderately but properly lighted, can often be far better observed than a small one many times brighter. An object may, in fact, be too powerfully illuminated. If rays of great angle are too powerfully converged upon an object, the image becomes almost as bright as the other parts of the screen, which represent nothing but clear glass, and in this case the image appears "flat," and without contrast—like an over-exposed photograph. The image may, therefore, be too bright for the screen, or it may be too dark, and the best results are those obtained with the mean, showing all detail without destroying contrast. A lantern microscope, to be of any satisfactory use, must define, for instance, such objects as stellar hairs of deutsia, the minute, lace-like structure of spine of echinus, the matted structure of the hairs of reindeer, the lancet of male flea, its sucking tube, &c. The stomata of leaves are very easy to show. Foraminifera of the smallest sizes should be exhibited to from 7in. to 10in. diameter with all their varied beauty of form and shading. The tongue of the bee should have all its structure clearly displayed to audiences of three or four hundred people. For this purpose it must be magnified to about 20ft. long, then the bulb at the tip of the fleshy cone should be shown with the hairs standing out from the trunk and circling round it apparently marking off its various parts as if they were joined to each other in telescopic articulations; the muscles of the trunk, and the apparently, and no doubt, really central air tube connected with the trachia, ought all to be well defined; and what has been said regarding these objects, applies equally to all kinds of animal and vegetable structure. It is not claimed for the lantern microscope that every object, however delicate, can be shown as perfectly as in the ordinary table microscope, or that photo micrographs are henceforth unnecessary. But it is, notwithstanding, absolutely certain that the lantern microscope now takes rank amongst the scientific instruments of the day, and can no more be dispensed with than the optical lantern itself. It is claimed that by the Leach lantern microscope all we have said can be done, and a very great deal more, though to say that anybody can do it perfectly on a first trial, would be as wild a statement as to say that anybody who buys a camera and lens can at once produce beautiful photographs, or to guarantee the man who buys a piano to be able to play it to the best advantage. The Leach microscope can be applied to any oxy-hydrogen lantern. It is screwed on the front in place of the ordinary lantern objective, the size of flange required being $2\frac{1}{4}$in. When the lantern objective flange is larger than this, an adaptor must be provided, and when the draw-tube of the lantern is "ricketty," a rigid lengthening tube may be adapted. The lantern condenser should be about 4in. or $4\frac{1}{2}$in. diameter, and of the triple form. Ordinary lantern condensers are usually of the double form; then a third lens can be supplied for a few shillings. The stage of the microscope is open at both sides, and at the top also, and serves for all classes of objects, whether ordinary microscopic slides or polariscope crystals, shown with either narrow angle rays or by the convergent system of lenses. The stage being so constructed, it is extremely accessible for the introduction of sub-condensers with which the instrument is provided, and permits, with the greatest convenience, the introduction and manipulation of the polarising prism, which latter may be entirely rotated, so that all the phenomena of polarised light may be exhibited to the greatest perfection. The object holder is quite a novel idea; the principal mechanism of it is placed under the stage (to be out of the way), two arms passing through slots in the bottom of the stage, actuated by a spring and manipulated by a milled head, serve to hold the objects flat against the inside surface of the front of the stage. The diaphragms, or compound wheel of diaphragms, and the mechanism in connection with it, is unique. The wheel of diaphragms is rotative on a pivot attached to the plate arm in such a manner that the whole may be raised out of the field altogether and dropped into it again in an instant, or just as required, and when the compound wheel of diaphragms is raised a spring catch holds it in position and prevents it dropping by its own weight. When in this position the whole field of the microscope can be utilised for showing objects up to $1\frac{1}{2}$in. in diameter; thus, this compound wheel of diaphragms of $2\frac{1}{4}$in. in diameter yields just as large a field as can be obtained by one of the ordinary form of 5in. in diameter. When, as in using polarised light, it is desired not to be incommoded with the diaphragms, the detachable plate carrying the compound wheel can be instantly removed from the stage, and when again required it can be as quickly restored. The arms of the object-holder projecting through the bottom of the stage have sufficient lateral movement to admit any zoophite trough or wooden frame, or combination of wooden frames, up to 1in. in thickness. Thus the advantages of this arrangement are clearly manifest. The two sub-condensers with which the instrument is provided are found to give the utmost satisfaction with all objectives of from $2\frac{1}{2}$in. to $\frac{1}{10}$in. focus, and the simplicity with which these sub-condensers are changed is another feature of novelty in the instrument. All that is necessary to make the change is to take out one and push the other in its place; thus the exhibition or demonstration may proceed without a moment's delay, neither object, objective, nor diaphragm being disturbed. When the light has been properly concentrated, as is the case with Leach's microscope, high powers can be used, and with ample illumination for showing all necessary detail, either for classroom instruction or lecture-hall demonstrations. It should also be observed that when high powers are used the front lens of the objective is open to the view of the manipulator—a great convenience when inserting the object, by enabling it to be immediately adjusted within the area of the lens, so that its image may at once be seen in the field without the tiresome "groping" for it—a method which is usually resorted to with other lantern microscopes. The advantages of this arrangement will be at once apparent, especially when using, say, a $\frac{1}{8}$in. or higher power for photo-micrography. When polarised light is to be used, the polarising prism must be pushed into the rotating tube of the instrument by removing the concave lens at the back, and after inserting the prism this concave lens may be replaced in an instant. To do this when ordinary lanterns are used, the usual draw tube carrying the microscope must be removed for the purpose; but with a Chadwick optical lantern the microscope need not be disturbed. All that is necessary is to disconnect the bellows attached to the lantern front, and the back of the microscope is at once accessible for the removal of the concave lens, and insertion of the prism, &c., and this may be done in less time than it takes to describe the operation; thus the change from common to polarised light can be made in a few seconds. The rotating tube will be found an immense advantage over fixed tubes, as the polarising prism can, by this arrangement, be placed in any desired azimuth which best suits the object, tha analyser, or the screen. The convergent system of lenses for use with polarised light in transmitting rays through biaxial crystals is a system of lenses worked out by Mr. Leach with great patience. It gives powerful illuminations, and includes an angle of 170°. The front-focussing arrangement was introduced by Mr. Leach in 1883. Before that time several supplementary lenses had to be kept in readiness for use, as different classes of crystals were placed in the polariscope. Mr. Leach discovered how these supplementary lenses might be dispensed with, and fitted up his system accordingly, and now all makers of first-class polariscopes attach to their instruments this great improvement. The concave field-lens with which the instrument is provided is absolutely necessary when the polarising prism is in use. It is useful also with low powers when using common light. With all powers it enlarges the field and equalises the distribution of illumination; but when a small field only is desired, with the illumination in the centre, it may be used or dispensed with at pleasure. The three objective adaptors with which the instrument is provided admit of any microscope power with the standard screw. They are made to slide in the front tube of the microscope, which is provided with a rack and pinion, and also with a fine screw movement capable of the most delicate adjustment. Thus, by having the various powers already screwed into the adaptors, one may be changed for another almost instantaneously; and into the front or tube portion of these adaptors the tube of the amplifier is made to slide. Amplifiers usually supplied with lantern microscopes are simply uncorrected lenses perfectly worthless for the purpose for which they are intended. The amplifier with which Leach's microscopes is provided is a Barlow lens, and, being achromatic, it not only does not destroy, but very much enhances the aplanatic qualities of the objective, and is far superior to so-called "projection eyepieces." It has been inconsistently asserted by persons who ought to know better, "that high power cannot be used in the lantern microscope—that it is unable to exhibit fine detail upon the screen, and that no alum-trough is required." No doubt this is all true, so far as applied to inefficient and "jimcrack" arrangements. But the microscope now before us *does* require an alum-trough, because where great light is concentrated from the oxy-hydrogen luminant, great heat must, from the very nature of the means employed, be concentrated with it, and the alum-trough is the only practical thing which can be used to absorb the heat rays. Of course, where there is no light there is no heat, and, therefore, no necessity for an alum-trough, and instruments which do not require one are self-condemned. The alum-trough provided for the

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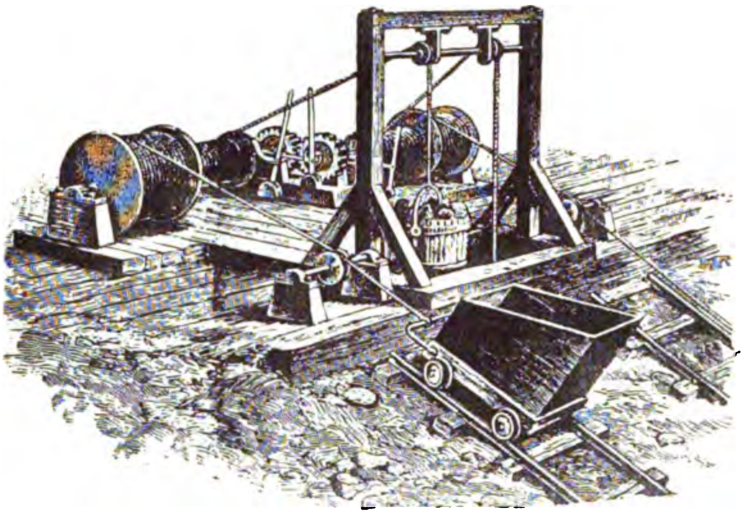
* Read at the Royal Microscopical Society, Oct. 31.

Leach microscope is of large size, and is used in the ordinary slide-stage of the lantern.

At the conclusion of the paper, a demonstration was given by common and polarised light.

A SIMPLE AND EFFICIENT GRAVITY HOIST.

THE apparatus shown in the illustration is especially adapted for use in sinking deep wells and shafts, and may be employed in elevating and disposing of material taken from mines, and for many similar uses. It has been patented by Mr. W J. C. Doyle Aspen, Col. The drums or windlasses of the apparatus are carried by two shafts geared together at their inner ends, each shaft carrying two drums, one of which is larger than the other. On the smaller drums are wound the hoisting ropes, which pass over pulleys on a shaft in a suitably constructed frame, and are connected with the buckets travelling in the well or shaft, the arrangement being such that when one bucket descends the other one rises, and *vice versâ*. On the larger drums are wound cables connected with cars travelling in opposite directions on inclined tracks, the cables and the hoisting ropes being so arranged, relatively to each other, that when an empty car is at the upper end of the incline a filled bucket will also be at the top of the shaft, in position to be conveniently emptied into the car, the downward travel of each filled car along the inclined road exerting a pull on one of the ropes on the large drums to cause a filled bucket to be raised, while at the same time an empty car is drawn up and an empty bucket let down. A brake band is provided for each shaft, operated by a lever conveniently arranged, and, that the two shafts may be readily disconnected, for lengthening or shortening the cables or other purposes, their inner bearings are fitted to slide, and are each connected by a link with a lever pivoted on the frame, by means of which the bearings may be moved to disengage the gear wheels. The construction is very simple, and the hoisting work is all the time under the control of the operator.



LESSONS IN THE DIFFERENTIAL CALCULUS.—I.

By Richard A. Proctor, B.A., F.R.A.S.

Author of "Other Worlds than Ours," "Sunviews of the Earth," &c., &c.

[The "Lessons in the Differential Calculus," by the late R. A. Proctor, which appeared in Vol XII., are, by the request of several correspondents, reproduced, the numbers containing them having run out of print.]

IN promising to place before the readers of the English Mechanic a popular account of the differential calculus, I have undertaken, perhaps, a somewhat difficult task. The differential calculus has a reputation for complexity and difficulty; and in one sense, too, it merits the reputation. One can carry the study of the differential calculus into regions so far removed from ordinary mathematics as to be barely even conceivable by those who have not followed the whole course. But there really seems no reason why so useful a calculus should be regarded as—in its entirety—removed from the range of all save the profound mathematician. Yet, as hitherto presented in our books, this is undoubtedly the case. One must read far on into the subject before one begins to see what its general scope may be. One must carry with one a knowledge of co-ordinate geometry, conic sections, exponential functions, and many other matters, or else one is not allowed even to start.

Now all this seems to me as unreasonable as though before studying the elements of trigonometry or algebra one should be forced to become familiar with every branch of inquiry to which trigonometry or algebra can by any possibility be applied. The differential calculus has its elementary as well as its more recondite department; and by starting with some of the simpler applications the student learns to feel the power of the calculus and to proceed with more confidence to such further examination of its principles as he may have occasion for.

But I am entering, so far as I am aware, on an unexplored field, and I must invite my readers to be patient with me. I may not succeed in making everything so simple as I could wish, but I shall do my best.

The differential calculus is the science which deals with the rate at which variable quantities increase or diminish. Now when we say that a quantity is variable we infer that it varies as some other quantity changes. For example, the velocity of a train is variable. It varies with the *time* which has elapsed since the train started—it varies with the *distance traversed*—with the *steam power* employed—with the *state of the rails*—and so on. But the differential calculus deals only with those quantities which vary according to some definite law.

For example, when a body is let fall from rest the distance it traverses varies, according to a known law, with the time elapsed since the fall began. Now the differential calculus is able to deal with such a case as this. Again, the sine of an angle varies according to a known law as the angle changes; and the differential calculus is therefore able to deal with this case also.

Now we can at once see the importance of a calculus which will deal with variable quantities. Algebra and geometry and trigonometry deal with absolute quantities. But it is often very necessary to learn something about the variations of quantities—to know when a variable quantity attains its greatest value, when it is increasing, when diminishing, when it changes fastest, and so on. Now, whenever its variations take place according to a known law, this is precisely what the differential calculus will do for us. And its great advantage is that it will solve our problems systematically. An ingenious application of algebra or geometry or trigonometry will often enable us to solve problems which belong especially to the differential calculus. But we require ingenuity for the purpose, whereas the differential calculus solves such problems with certainty, even if we have not a particle of ingenuity, so long only as we follow the proper rules. Even where it fails it teaches us that we are trying to solve an insoluble problem.

The first matter the calculus attends to is the choice of a convenient expression for the rate at which a variable quantity changes. This expression is called a *differential coefficient*. I prefer to illustrate rather than to define it. I wish also to illustrate it in such a way as to remove at the outset the chief stumbling-block of the student of this special department of mathematics.

When a body is let fall from rest, we know that as it falls its velocity continually increases. Now this varying velocity affords a very good illustration of a differential coefficient. The velocity of a body may be described as the rate with which the space it has traversed is increasing as the time elapsed increases. When we change the time we change the space traversed. But unless the velocity is uniform the change of space is not proportional to the change of time. In the case of a falling body the velocity is not uniform; so that if we consider one instant, the rate at which the space traversed would change for any given interval of time would be different from the corresponding rate at some other instant. Regarding the matter as illustrating the differential calculus, the first thing to be found is a general expression for the rate of change.

Consider now the following way of dealing with the problem.

At the end of t seconds the body has fallen a space represented by

$$\tfrac{1}{2} g t^2,$$

where g represents the accelerating force of gravity (or numerically, a foot being taken as the unit of length, and a second as the unit of time, $g = 32{\cdot}2$). A second later the body has fallen altogether a space represented by

$$\tfrac{1}{2} g (t+1)^2,$$

so that in the course of that second the space actually traversed by the body is

$$\tfrac{1}{2} g (t+1)^2 - \tfrac{1}{2} g t^2$$
$$= g.t + \frac{g}{2}.$$

And if during that second the body moved with uniform velocity, we should at once know what that velocity is. For when a body moves uniformly over s units of length in t units of time it moves over $\frac{s}{t}$ units of length in one unit of time, and $\frac{s}{t}$ therefore represents its velocity. So that the velocity of our falling body would be

$$\left(g\,t + \frac{g}{t}\right) \div 1$$

if the body had moved uniformly during the second. But this is not the case. The body moves faster and faster as the second of time is passing; and its velocity at time t is therefore *not* obtained by the above process. We should clearly get a better result if we took a shorter interval of time. Suppose we take a very short interval indeed, as a thousandth part of a second. Then we have, as before, the space fallen in t seconds

$$= \tfrac{1}{2} g t^2,$$

the space traversed one thousandth of a second later

$$= \tfrac{1}{2} g \left(t + \frac{1}{1000}\right)^2$$

and the space traversed in the interval

$$= \frac{g\,t}{1000} + \frac{g}{2\,(1000)^2}.$$

So that on the false supposition of uniform velocity during this minute interval, we get for this velocity,

$$\left[\frac{g\,t}{1000} + \frac{g}{2\,(1000)^2}\right] \div \frac{1}{1000},$$

or

$$g\,t + \frac{g}{2000}.$$

This is clearly nearer the truth, because in so short an interval as a thousandth part of a second the change of velocity is exceedingly minute. But still we have not the exact velocity.

If we had taken a yet smaller interval as the millionth part of a second, we should have deduced for the velocity

$$g\,t + \frac{g}{2\,(1000000)},$$

which is yet nearer the truth.

And the minuter the interval the minuter the second fraction becomes, the first remaining unaltered. Also, the minuter the interval the nearer we get to the true value.

But there is nothing to prevent us from conceiving that the interval is taken infinitely minute, in which case the second fraction disappears, and also we get infinitely near to the true value. This value then is

$$g\,t,$$

and as a matter of fact we know independently that this *is* the velocity acquired by a falling body in the time t.

Now the reader will not need to be told that I have not gone through these processes merely for the sake of deducing this special result. I want him to convince himself of the reasonableness of the above method, and also I wish him to note that though the reasoning has introduced the conception of *infinitely minute quantities*, and though the result itself is a *limiting* value, yet that result is none the less *exact*. The velocity a body has at the end of any specified time is real, and not a mere mathematical fiction or approximation. Prepared then to see that a real and exact value can be deduced by a seemingly approximate method, let him consider the following way of treating the very same problem.

Let s represent the space traversed in time t, $s + \Delta s$ the space traversed in time $t + \Delta t$ (where Δs and Δt are to be looked upon as simple quantities, which may be read, if we please, *increment* *of the space* and *increment of the time;* or else, for convenience, simply *delta-space* and *delta-time*). Then

$$s = \tfrac{1}{2} g t^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (i.)$$
$$s + \Delta s = \tfrac{1}{2} g (t + \Delta t)^2 \ldots\ldots\ldots\ldots (ii.)$$

and therefore, subtracting (i.) from (ii.),

$$\Delta s = g t \Delta t + \frac{g}{2} (\Delta t)^2$$

so that if the velocity of the body during the interval Δt were uniform, this velocity, or $\frac{\Delta s}{\Delta t}$, would be

$$= g t + \frac{g}{2} \Delta t.$$

This result, however, will not be true unless Δt is infinitely minute. Let Δt be supposed to be made infinitely minute, in which condition call it dt; then Δs also becomes infinitely minute, and is to be called ds; and we get

$$\frac{ds}{dt} = g t + \frac{g}{2} dt$$

$= gt$, since dt is infinitely minute or nought.

Now this quantity $\frac{ds}{dt}$, for which we have thus obtained a definite value (although ds and dt are each evanescent), is called *the differential coefficient of s* (the space traversed) *with respect to t* (the time). It is really *the rate at which the space is increasing at the time t.*

But the reader is now to consider the differential coefficients in a general way. The above illustration has shown him how a differential coefficient is deduced in a special case; and also that a differential coefficient, though made up of seemingly evanescent parts, may have an exact value, and (what is yet more to the purpose) *has always a real* significance. The $\frac{ds}{dt}$ of our illustration is that real and familiar relation the velocity of a falling body. And so the differential coefficients we have to deal with as we proceed are real matters, not mathematical fictions.

The plan just adopted gave us the differential coefficient of the expression $\tfrac{1}{2} g t^2$ with respect to the variable t. A similar plan will give us the differential coefficient of many other variable expressions.

Suppose, for instance, that

$$x = a y - y^2 \ldots\ldots\ldots\ldots\ldots\ldots (i.)$$

and increase x by Δx and y by Δy; then

$$x + \Delta x = a (y + \Delta y) - (y^2 \quad 2 y \Delta y + \overline{\Delta y|}^2) \ldots\ldots\ldots\ldots\ldots (ii.)$$

so that subtracting (i.) from (ii.)

$$\Delta x = a \Delta y - 2 y \Delta y - \overline{\Delta y|}^2$$

$$\text{and } \frac{\Delta x}{\Delta y} = a - 2 y - \Delta y.$$

Now make Δx and Δy infinitely small, calling them dx and dy. Then we get

$$\frac{dx}{dy} = a - 2 y - dy = a - 2 y.$$

But this process would be very cumbrous if applied to complex expressions. Therefore, the first matter considered in treatises on the differential calculus is the determination of rules by which a differential coefficient may be readily obtained. In the next paper on the subject I shall give these rules, without dwelling at any great length on the reasoning by which they are established. Much of this reasoning, indeed, would be beyond those for whose special service these papers are written. The advantages derived from the practical application of the differential calculus to problems not easily solved in other ways, will encourage the student to discuss after awhile the reasoning by which the rules of the calculus have been established. The great difficulty has hitherto been that this reasoning, coming before the student has learned the power of the calculus, has, by its length and complexity, prevented many from pursuing the study of the subject.

An artesian well, 3,095ft. deep, is reported as having been successfully sunk by Mr. S. Swanson for the Ashland (Wis.) Iron and Steel Company. The well, says *Engineering News*, was begun June 8th, 1890, and completed September 29th, 1891, at a cost of over 14,000dols. After the first 175ft. the remainder of the well, it is said, passes through brown sandstone. Water rises to the surface.

Statistics published by the French Ministry of Public Instruction show that there are in France 625 learned societies, of which 135 have been officially recognised as of national importance. Of these 625 societies 95 are historical and social, 95 agricultural and horticultural, 57 medical and pharmaceutical, 45 scientific, 41 artistic, 37 geographical, and the rest miscellaneous, including photographic, statistical, and ballooning associations.

SCIENTIFIC NEWS.

THE position of Wolf's comet at Berlin midnight on Nov. 23 will be R.A. 4h. 29m. 31s., S. Dec. 11° 30·7′; brightness 8·80, as compared with unity at time of rediscovery.

Tempel-Swift's periodic comet is in Pegasus, and on Nov. 19 will have the position for Paris midnight R.A. 22h. 31m. 45s., N. Dec. 15° 44·4′; brightness 13·5, as compared with unity at time of rediscovery. About the 23rd inst. it will be near Markab, and is moving north at the rate of about a degree per day.

In *Knowledge* for this month there is an interesting article by Mr. Ranyard on "The Upper Atmosphere," with some reproductions of photographs taken by Mr. C. V. Shadbolt from a balloon. The subject is of especial interest to those who study the composition and character of the celestial bodies.

The death is announced of Capt. William Chimmo, R.N., at the age of sixty-three. He saw some active service in the wars with China and in operations against pirates in Eastern waters; but will be best remembered by his work as an hydrographer. At one time he acted as secretary to the hydrographer of the Admiralty, and subsequently did much useful surveying work in various parts of the world. Capt. Chimmo was a Fellow of the Royal Astronomical, the Royal Geographical, the Linnean, and other learned societies.

General Mayo, formerly director of the Geographical Institute in Florence, and president of the International European Commission on the metrical system, died on Nov. 6.

One of the most distinguished of German botanists died at Giessen the other day in the person of Dr. Heinrich Karl Hermann Hoffmann, who was born in 1819. At first he studied medicine and physiological chemistry, but has been since 1846 exclusively engaged upon botany. In 1853 he was appointed ordinary Prof. of Botany at the University of Giessen, and director of the botanical institution of that place, and continued in those offices to the end of his life. His valuable works on botany were chiefly devoted to the physiology, geography, and climatology of plants, and he did much to establish the position of fungus in connection with fermentation and dry-rot. He was also a pioneer in bacteriological work, and from the botanical side did much to support Darwin's views as to the origin of species by natural selection.

The death is also announced of Mr. John Thornhill Harrison, for many years one of the inspectors of the Local Government Board. In his younger days Mr. Harrison worked under Brunel in the construction of the Great Western Railway, but afterwards relinquished engineering for agriculture. He was a member of the first Rivers Pollution Commission.

Eton has lost another of its science masters in the person of Mr. Frederic Drew, at one time on the Geological Survey, but well known for the work he did as geologist to the Maharajah of Kashmir. Mr. Drew was only fifty-five.

Our readers will regret to hear that Mr. John Mayall, jun., the late secretary of the Royal Microscopical Society, has left his widow and family in serious pecuniary straits. A circular has been issued by an influential and representative committee of microscopists, with the object of raising a Mayall Fund for the benefit of a man who was always ready to exhibit his almost unrivalled skill as a manipulator, and to give information from his stores of knowledge of the optical arrangements of the microscope. Many of our readers, without knowing it, have been indebted to the late Mr. Mayall for his numerous contributions to our columns. Communications should be addressed to Mr. T. Curties, treasurer to the committee, 244, High Holborn, W.C.

The first meeting of the Society of Arts during the present session will be held on Nov. 18, when the opening address will be delivered by the Attorney-General, chairman of the Council. On the following Wednesday evenings previous to Christmas, papers will be read on "The Measurement of Lenses," by Prof. Silvanus P. Thompson; on "The World's Fair at Chicago in 1893," by Mr. James Dredge; on "Secondary Batteries," by Mr. G. H. Robertson; and on "Spontaneous Ignition of Coal and its Prevention," by Prof. Vivian Lewes. The first of a series of Cantor Lectures will be delivered by Mr. A. P. Laurie on "The Pigments and Vehicles of the Old Masters," and will consist of three lectures, commencing Monday evening, November 30. Among the following courses are lectures on "Electrical Distribution," by Prof. Forbes; "The Uses of Petroleum in Prime Movers," by Prof. W. Robinson; "Mine Surveying," by Mr. B. H. Brough; and "The Chemistry and Bacteriology of the Fermentation Industries," by Dr. Percy Frankland. A special course of lectures has also been arranged, under the Howard Bequest, on "The Development and Transmission of Power from Central Stations," by Prof. W. Cawthorne Unwin, F.R.S., commencing shortly after Christmas.

The 13th examination in Technology in connection with the City and Guilds Institute was held in the spring as usual, and the annual report shows a gratifying amount of progress, for there is not only an increase in the number of candidates, but also in the proportion of "passes." The total number of passes is 592, the highest number since the establishment of the examinations. It is expected that with the opening of new polytechnic institutions there will be a large increase in the number of London candidates. A sum of £325 in money prizes was divided over 192 awards.

Recently the Speaker of the House of Commons said that there was danger of the sums granted for technical education being frittered away. What was needed was not the teaching of trades, not the manipulation of an article students might have to deal with in after life, but the principles of science as applicable to the art.

At the meeting of the Oxfordshire County Council last Saturday it was stated that the committee have received the sanction of the authorities at South Kensington to apply money in aid of instruction in dairy work, as well as cookery and domestic economy. An agreement has been entered into with the Oxfordshire Agriculture Society to undertake to furnish instruction in dairy work in the county. Arrangements are also made for cookery classes. Forty science and art scholarships—25 to rural districts and 15 to urban districts—have been provided for, and a grant of £50 is to be given to the Oxfordshire Bee-keepers' Association for a travelling lecturer on the theory and practice of bee-keeping.

At the recent Congress on Tuberculosis M. Arthaud gave an account of some observations he has made on the contagiousness of tuberculosis. He is so far convinced of the truth of his observations that he places the period of incubation at two months. Those who labour in ill-ventilated workshops containing persons suffering from tuberculosis, or ride in closed railway carriages with passengers so suffering, are liable to be affected, especially if predisposed.

Mr. E. Davidson Palmer, Mus.Bac.Oxon., calls the attention of scientific men to an apparently unknown fact in connection with voice production. This fact has to do with the so-called "falsetto" voice. The general opinion about this kind of voice is that it is something altogether unnatural, and that it ought never to be used. According to modern scientific theories, however, it is one of two or more registers, and is supposed to be intended by nature to be used only at the upper extremity of the vocal compass. But it is quite possible to produce this kind of voice at a much lower pitch (at least an octave lower) than that at which singers are ever taught to use it. Produced in this way, it may be so weak and feeble as to be practically useless. Still it is possible so to produce it, as men and singers well know. What they do not know, and what scientific men appear to be totally unaware of, is that it may be developed at this low pitch, and not only developed, but completely transformed. When thus transformed, it loses entirely its unnatural and effeminate character, and becomes a strong, manly voice, which is easily mistaken for what is commonly called "chest-voice," but which, unlike that kind of voice, is capable of bearing throughout its whole compass any strain that may be put upon it.

The American *Engineering News* states that aluminium is to be substituted for cast iron in the tower of the new public buildings in Philadelphia, where it will save 400 tons in weight and avoid the constant expense of painting.

For freight service on the Erie Railway, the

Baldwin Locomotive Works, Philadelphia, have recently completed what is said to be the largest compound locomotive in the world. The weight of the engine alone is 135,000lb. It has three pairs of driving-wheels 62in. in diameter. The weight on the wheels is 107,000lb. Its length is 56ft. It is asserted that this engine can be run at a saving of from 30 to 40 per cent. over the same size single-expansion engine. Several heavier compounds are under construction at the Baldwin works for the same company.

According to the *Mysore Herald*, experiments with dynamite for producing artificial rain are to be attempted in Mysore, according to the American system.

Mr. G. J. Symons, F.R.S., writing about the rainfall, which the "floods" in some parts have brought into notice, says that during the last four months the excess, so far as the metropolis is concerned, occurred during the last three of the period July-October. During the last four months we have had nearly half as much again as our average, and nearly as much as in the wettest corresponding period during 34 years. If to this be added the fact that, out of the 123 days, rain fell on 74, it will be understood that the weather in the metropolis has not been pleasant.

It is calculated that in Switzerland there is sufficient water practically running to waste to supply, by elecctrical or other means, as much as 600,000 effective horse-power.

USEFUL AND SCIENTIFIC NOTES.

A LARGE deposit of meerschaum has been found on the Sapello Creek 25 miles north of Silver City, New Mexico, and near the alum deposits of the Gila River. The principal vein is 8in. wide, and cubical blocks with faces 6in. to 7in. long can be obtained without a flaw. One block 8in. thick by 3ft. wide and 5ft. long has already been sawn from the deposit. "Ricolite," a fine ornamental stone, has also been found in this locality, and arrangements are being made for quarrying it.

Maximum Locomotive Speed.—Most experienced railroad men feel that the possibilities of steam practice are nearly reached, and that much greater speed is not practicable. A maximum of 90 miles an hour, with a running speed of 60 to 70, is all that can be hoped for under the very best conditions. The limitations are numerous, and are well known to all engineers. The maximum speed of which a locomotive is capable has not been materially increased in a number of years. The schedule time has been shortened, principally by reducing gradients, straightening curves, filling up ravines, and replacing wooden structures by permanent ones of iron or stone; by the use of heavy rails, safer switches, improved methods of signalling, the interlocking switch and signal system, the abolition of level crossings; in fact, by improvements in detail and management which permit a higher speed on a more extended section of road because of greater safety and the greater degree of confidence inspired in the engine driver.—*Scientific American.*

Cycling: its Use and Abuse.—Those who believe in the necessity of physical exercise, and we belong to their number, have need also to remember that even so good a thing as this is in excess an evil. The use of the cycle is a form of bodily recreation in itself doubtless wholesome; none the less is it open to the mischievous effects of undue indulgence. Tempted by the ease of movement, combined as a rule with attractive scenery, everyone tries it. Everyone, too, finds he can do something with it; and considerations of weather, constitution, age, and health are apt to be dismissed with summary imprudence. One fruitful source of injury is competition. In this matter not even the strongest rider can afford to ignore his limit of endurance. The record-breaker, who sinks exhausted at his journey's end, has gone a point beyond this. The septuagenarian who tries to rival his juniors by doing and repeating his twenty or thirty miles, perhaps against time, is even less wise. Lady cyclists, too, may bear in mind that their sex is somewhat the weaker. So likewise among men the power of endurance varies greatly; and it is better for some to admit this and be moderate than to labour after the achievements of far more muscular neighbours. In short, whenever prostration beyond mere transient fatigue follows the exercise, or when digestion suffers and weight is markedly lessened, and a pastime which ought to exhilarate becomes an anxious labour, we may be sure that it is being overdone. He that would reap its best results must content himself with much less than this; but unless he can observe such moderation, he had better abstain from it altogether.—*Lancet.*

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> "I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
> —*Montaigne's Essays.*

THE HEIGHT AND LIMIT OF THE ATMOSPHERE—LUNAR ROTATION, AND TIDAL ACTION—THE SUN'S LIGHT—RADIATED AND REFLECTED DARK RAYS OF HEAT—A NOVEL EYEPIECE—JUPITER'S SATELLITES FOR VERIFYING CHRONOMETER—DRIVING CLOCK—ASTRO-PHOTOGRAPHY—JUPITER—RETICLE MICROMETER—PERSONAL EQUATION IN TRANSIT-TAKING—SECTION-CUTTING MACHINE—THE ASTROLABE AND CROSS-STAFF—MISTY OBJECT-GLASS.

[32890.]—I SPOKE, in paragraph two of letter 32846 (p. 216) of the great height of the absorptive terrestrial atmosphere, as indicated by the thermal phenomena observed during lunar eclipses. Prof. Young, in dealing with the height of the atmosphere in his splendid "General Astronomy," says, concerning our atmosphere: "And it cannot be asserted positively that it has *any* definite upper limit;" while Prof. Förster, of Berlin, in a paper read last May before the German Geographical Society (and reproduced in the *Proceedings* of the Royal Geographical Society of London for July, 1891), maintains that a thin air pervades the whole of the Solar system. In an article in your contemporary, *Knowledge*, for this month, its editor combats, as I think successfully, this idea that the terrestrial atmosphere has no definite boundary, and I would recommend such of my brother readers as are interested in the subject, to study the arguments advanced in the article in question.

I think that the best answer I can return to letter 32848, p. 219, is to refer Mr. Peal to Sir R. S. Ball's delightful little book, "Time and Tide," published in "The Romance of Science Series," by the Society for Promoting Christian Knowledge. He will find in it as popular an exposition of the accepted theory of the reciprocal tidal action of the Earth and Moon as such a subject permits of.

I have not seen, so far, either a reproduction of M. Stas's paper (referred to by Mr. Holden in letter 32852, on p. 220), nor any comment on it, in any of the English scientific journals to which I have access. I do not myself regard it as probable that the sun is nothing but a stupendous electric light.

In the absence of any means of reference to Prof. Langley's original work, I regret that I am unable to enlighten "E. P. S." (letter 32853, p. 220) as to the means of distinguishing reflected heat rays from radiated ones of the same refrangibility.

"C. S." (reply 75451, p. 225) might have saved both himself and me much needless trouble had he referred me to the volume and page he now does, in his original query. In the first place, the two plano-convex lenses should be mounted $\frac{11}{16}$in. apart, the 1in. one forming the field lens, the $\frac{5}{8}$in. one the eye-lens, the plane surfaces of both towards the observer's eye. A diaphragm limiting the field of view should be placed between them in the focus of the eye-lens. The concave lens really forms no part of the eyepiece proper at all. It is simply an imperfect "Barlow" lens, and "C. S." had better discard it altogether.

"Shipmaster" (query 75677, p. 229) would need a higher power than could be conveniently employed with a hand-telescope at sea to make anything like an accurate observation of the disappearance in eclipse of one of Jupiter's satellites, the only phenomenon of the slightest use for time purposes. But, added to this, the tables of the satellites are so faulty that Satellite I. is the only one the predictions of the times of whose eclipses are moderately trustworthy. Under the most favourable circumstances he might get Greenwich time from an eclipse of the Ist satellite to about half a minute; but I should be very sorry myself to trust the safety of a vessel to it.

Like "Regulus" (query 75683, p. 229), I have no access to any library in which illustrations of driving-clocks are to be found. Some of our professional horologists, or instrument makers, may be able to supply the needed drawing.

Nor can I answer Mr. Slade (query 75713, p. 230), as I am not myself a practical astro-photographer. We certainly number some among our brother readers, from whom he will probably obtain the information he seeks.

Certainly "Eta Argûs" (query 75721, p. 230) ought to see the red spot on Jupiter well with his 6in. mirror; inasmuch as its remarkable colour, which for some few years has so notably faded, is again intensifying. As to the times at which it will be favourably situated for observation, I know of no ephemeris of its passage over the central meridian of the planet, nor can I lay my hand upon any recent observations of such transits. Under these circumstances I have done a little sum. The last trustworthy record of a transit I can find is on p. 116, Vol. I., of the *Journal* of the British Astronomical Association, where our well-known zenographer, Mr. Stanley Williams, states that the red spot was on Jupiter's central meridian at 5h. 12m. 36s. p.m. on November 1, 1890. Its rotation period he gives as 9h. 55m. 40·6s., so that it ought to be centrally placed on Jupiter's disc at 11h. 29m. 43s. on the night of November 13, having thus completed exactly 912 revolutions. At any rate, this should enable my querist to pick it up. Having once noted the time of its passage over the central meridian of the planet, the instants of its future transits will be multiples of 9h. 55m. 40·6s.

In answer to the question about the reticulated micrometer, it would scarcely be of any service whatever in measuring double stars. It would be mainly useful for approximately mapping fields of stars or the positions of sun-spots.

The mention of Jupiter suggests to me to recommend all students of zenography to obtain the supplementary number of the *Monthly Notices* of the Royal Astronomical Society, for the sake of a paper by Mr. E. E. Barnard, of the Lick Observatory, on observations of Jupiter made there during 1890 with the 12in. equatoreal. He would appear to have mapped and catalogued a very considerable amount of detail upon the surface of the planet, including half-a-dozen remarkable little black spots, like tiny shadows of satellites. These spots, by the way, though black at first, later on became of a dark reddish colour. Curious white spots, too, were seen, which melted away like a cumulus cloud does towards evening. An oblong dark spot south of the great red one was seen to overtake and pass the latter. The familiar phenomenon of the dark transits of Satellites III. and IV. was, of course, observed several times. The remarkable apparent duplication of Satellite I. is also described in detail, and sketches given of its appearance. Mr. Barnard was at first disposed to attribute this surprising effect to a white belt in the satellite parallel to those on Jupiter, but now inclines to the idea that the satellite is actually double! Mr. Barnard's chief illustration is a really beautiful drawing of the planet as seen on July 30th, 1890. His paper deserves careful study from beginning to end.

M. Paul Stroobant, the well-known Belgian astronomer, has recently published the results of a series of experiments on personal equation in transit-taking, made by him in the Paris Observatory during the first half of the present year, which are of very considerable interest to observers. As M. Stroobant merely mentions in his introductory paragraph that the apparatus he employed is that described by M. Wolf in the *Annales de l'Observatoire*, to which I have no access, I can only gather that the artificial star was carried on a slide, and that each series of measures was composed of four sets of transits, two to the right and two to the left, over the five wires of the instrument. By the aid of a small prism placed over the eyepiece the direction of motion of the star was apparently reversed. Beginning with the observation of a star proper (as contradistinguished from a planet or other object having a measurable disc), as registered electrically, he found, from the mean of 23 series, that when it travelled from right to left he observed its passage 0·023sec. too late, and (from the mean of 14 series) when it travelled from left to right 0·048sec. too soon. By the eye and ear method the mean of a series of ten observations of a star moving from right to left was 0·041sec. too soon, and of another of nine from left to right 0·079sec. too soon. It will be noted how M. Stroobant's tendency is to observe transits too soon when the usual direction of the apparent motion of the star across the field is reversed. The sentence with which M. Stroobant concludes his account of this second series of experiments is worth quoting textually: for, speaking of the eye and ear method, he says: "Mes expériences tendent, d'ailleurs, à prouver que cette dernière méthode n'est guère inférieure à l'enregistrement électrique." Truly encouraging to those who, like myself, have never gone to the cost of a chronograph. No very marked influence seemed to be exerted on the personal equation of the observer by differing degrees of illumination of the field. By the aid of discs subtending the same angular diameters as those of the moon and planets, M. Stroobant arrived at some very interesting results. Without extracting a mass of tabular matter, it may suffice to select two or three illustrations. In the case of the moon, the motion being direct (i.e.) from right to left, the first limb was observed to pass the wires 0·125sec. too soon, the second limb 0·025sec. too late. The movement being reversed, the first limb came 0·169sec. too soon on to the wires, and the second 0·016sec. too late—and so on with the planets, the mean of the whole series of observations of the moon and planets giving the result that the first limb arrived at the wire 0·1405sec. too soon, and the second 0·0325sec. too late. Hence we learn that personal equation is very different, according as we observe the preceding or following limb of a body presenting a sensible disc. That personal equation is a variable quantity goes without saying; but M. Stroobant inclines to the opinion that a couple of months' constant practice ought to render it almost equally constant; though he thinks that very protracted observation tends to make the observer note transits too soon. Another remark he makes is worthy of note. It is, that in observing by the method of eye and ear, the observer has a tendency to pick out certain tenths of a second in preference to others. There is no publisher's name on the brochure before me; but it seems, from the printer's colophon, as though it had been reproduced from the *Comptes Rendus* of the Académie des Sciences. Whencesoever, though, it is procurable, it is worth procuring, and should be obtained and read by all observers with the Transit.

The phenomena observed during the transit of Jupiter's IIIrd. Satellite, as described by Mr. Harris in letter 32869 (p. 239) are very familiar ones. Satellite III. has such conspicuous dark, or rather dusky, markings upon it as to be visible, under adequate optical power, upon the dark sky. Now, Mr. Harris must be familiar with the fact that Jupiter's limb is visibly less bright than the centre of his disc, and when the satellite in question, showing of course bright on the sky, enters onto the planet's limb, it is so nearly equivalent to it in illumination as to disappear. As it progresses in its passage it arrives at brighter and brighter parts of Jupiter's disc; and when it is central, and away from any belt, it looks quite dark by contrast. As it passes off the face of the planet, of course these phenomena are reversed in order. I strongly recommend your correspondent to obtain No. I. of Vol. XLVIII. of the R.A.S. *Monthly Notices*, for the sake of a most elaborate and interesting paper by Dr. Spitta on this subject. It will well repay him.

I may mention, as a matter of history, that 25 years ago, under the *nom de plume* of "A Member of the Microscopical Society," I described and illustrated the section-cutter of Mr. Dixon (letter 32881, p. 243) on p. 12 of your IVth Volume.

Adopting Clarke's spheroid, I may tell "A.B.C.D." (query 75743, p. 250) that in latitude 42° 53′, the length of 1″ of parallel is, as nearly as I can compute it, 74·456ft.; and that hence 1 second of time in longitude would be = 15 times this, or 1116·84ft.

The astrolabe, concerning which "L." puts query 75754, on p. 250, had two forms. Originally it was applied to the large instrument of the ancient astronomers very much like the common "armillary sphere." Later on it came to mean a circle graduated, with sights, for taking altitudes and angular distances at sea. I described the "cross staff" at considerable length on p. 232 of your XXVth volume. Of course these instruments would only give the latitude and the local time in the rudest possible way.

The object-glass of the telescope described by "M. D." (query 75790, p. 251) is unquestionably a defective one. The "flood of misty light" should on no account appear round a bright star, which should be seen as a very small disc, surrounded by two or three concentric (though more or less broken) rings of light. Of course I am assuming that the appearance is *constant*, because if any objective be covered with dew on a cold night, it will show a bright haze just round a star or planet. I don't quite know the prices of object-glasses; but I should think that my querist ought to get a first-class 3in. one for £8 or £9. I am glad to find that I am not the only man who cannot fairly divide ϵ^2 Lyræ with a power of 50 on a 2¼in. telescope.

A Fellow of the Royal Astronomical Society.

THE VARIABLE NUCLEUS OF THE GREAT ANDROMEDA NEBULA AND AN ANOMALOUS STAR NEAR IT.

[32891.]—It is greatly to be regretted that Mr. D. Packer (letter 32867, p. 239) did not at once telegraph the discovery of the bright star north of the nucleus of the great Andromeda Nebula. At the time Dr. Copeland was removing from Dun Echt, but had a telegram been sent to me I would have looked it up at once, and observed the spectrum with the means at my disposal. The same remark applies to 1 Geminorum. As regards the stellar nucleus of the Andromeda Nebula, some observations were made with the 17¼in. on the nights of 1885, Sept. 27, Oct. 1, Dec. 11; 1886, Jan. 5, Feb. 4, March 6; and communicated to the *Observatory* (No. 109, p. 157). On all these nights the nucleus appeared stellar, and in No. 111, p. 233, there is a letter from Prof. Pritchett, mentioning observations in September, October, and November, 1885, "fully confirming" the stellar characteristics of the nucleus. As regards the variation, I communicated to the Liverpool Astronomical Society, Vol. III. p. 85, a paper on the photographic appearance and brightness of the nebula. Perhaps I may repeat here the results of these observations. They give the equivalent star magnitude of the most central part of the nebula as determined from the various plates:—

1884	Sept. 17	....	8·3 mag.
	Nov. 5	....	8·3 ,,
	Nov. 21	....	8·0 ,,
	Dec. 20	....	8·0 ,,
1885	Jan. 13	....	7·7 ,,
	Feb. 20	....	8·2 ,,

Pickering's photometer observations give 6·1, 4·8, 5·0, and the eye estimate as 5·3. Houzeau gives 6·0, and my own 6·0 also. The final words of this paper are: "In conclusion, I may say that I doubt very much if the light of the nebula is quite constant throughout, and the photographs seem to suggest the same." **T. E. Espin.**

Tow Law, Darlington, Nov. 6.

THE BRILLIANT METEOR OF OCTOBER 11, 1891.

[32892.]—I have been comparing together the observations of the large meteor of October 11 last, referred to in several letters published in the "E. M.," but the result is not very satisfactory. It is most unfortunate that in cases of this kind the materials one has to work upon are generally so discordant that it is impossible to reconcile them.

The meteor probably had a radiant in Auriga, near Capella, in which case its first appearance occurred at a height of 66 miles over Macclesfield, Cheshire, and its disappearance took place at a height of 36 miles over Bideford, Devonshire. Real length of path about 187 miles, velocity 31 miles per second.

This determination satisfies several of the observations, but it requires that the altitudes estimated by Mr. Mee at Ammanford, and by Mr. Coglan, at Dublin, be considerably reduced. This is in accordance with past experience, for it is usually found that in roughly judging altitudes the values come out very excessive.

Will Mr. Mee kindly state whether the section of the meteor's flight which he observed was nearly horizontal, or whether it formed a considerable angle with that plane. I shall be obliged to Mr. Mee, or any other of your readers, who will supply further details, to be applied as a test of the accuracy of the heights I have derived. The end point, 36 miles over Bideford, is pretty accurately defined; but the position and height at first appearance and the place of the radiant are doubtful.

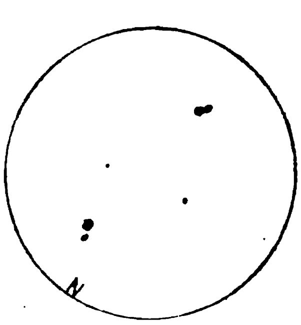
I have been wondering why Mr. M. Richards (letter 32871) has ridiculed and misconstrued the observation of this meteor by Mr. E. J. Cope, of Brecon, quoted by Mr. Mee, in letter 32825. Mr. Cope's position was very much nearer to the meteor than Mr. Richards's, and to the former it probably appeared about *nine times brighter* than to the latter. Even if my computation of the real path is incorrect, the meteor must have been *much* nearer Brecon than Enniscorthy. The glare from so brilliant an object, and the probably blurred aspect of the nucleus, caused by the clouds in front of it, justify Mr. Cope's statement, that it "looked to be about the size of the moon." As to reading small print by its light, that may have been quite possible. I have seen fireballs which momentarily illumined sky and landscape with a vividness nearly rivalling daylight. Colonel Tupman, in describing the large meteor of Sept. 3, 1875, said its lustre was of "blinding intensity—for a moment almost as bright as the sun!" There is every reason to believe that the meteor of Oct. 11 last was one of the most brilliant class, for Mr. Mee alludes to it as giving several lightning-like flashes, though its lustre must have been greatly dimmed by clouds. Mr. Cope said "the meteor *appeared* to be this side of the clouds," but did not necessarily regard it as being actually *below the clouds*, as inferred by Mr. Richards. No doubt Mr. Cope overestimated the duration of flight, but rough estimations of this element are rarely to be relied on.

The visible appearance of a meteor is different to each observer according to circumstances. Mr. Richards had not, perhaps, sufficiently considered this when he criticised Mr. Cope's description.

Bristol, Nov. 6. **W. F. Denning.**

STAR-TESTS WANTED.

[32893.]—Like Capt. Battersby (letter 32850, page 220), I have an object-glass from Aronsberg and Co., Liverpool, that I bought from them some 25 years since, and have only this year mounted it, and it seems also of high excellence, although only 2⅞ aperture, 31½ focus, of the green crown kind. I have divided the double-double Epsilon Lyræ on two or three occasions to something like the inclosed sketch, copied from my note-book, and worded—"Aug. 21st, little past ten: air steady, power 140; ⅛in. paper disc stuck on centre of o.g."



I shall be much obliged to anyone having a first-class instrument of similar size, for a comparison of their observation of this star, and also of others they may have made.

Walton-road, Liverpool. **Geo. Whittle.**

JUPITER.

[32894.]—In my letter (32869), when giving the power of an eyepiece, the printer left out the fraction ½, and so makes me say, if the distance be the sum, instead of half the sum, of their focal lengths, the power of the eyepiece is what a lens would be of half the focal length of the field lens.

Darlington. **W. H. Harris.**

THE TELESCOPE.

[32895.]—Kindly allow me to refer to that portion of "F.R.A.S.'s" letter 32846, which relates to me. "F.R.A.S." states that what he said was that "Fridy" certainly "ought to see ϵ^1 Lyræ double without any difficulty with a power of 200 on a really good 2⅞ achromatic, and ϵ^2 also, by the aid of *a little sustained attention*."

If "F.R.A.S." thought it could be seen better with a lower power, why did he not say so? Those of your readers who are not experts in these matters would naturally conclude that such a power was necessary for that object.

"F.R.A.S." stretching spider lines across the diaphragms of even one of the eyepieces of his equatoreal has no bearing whatever on the eyepiece of a finder. I suggested that the wires should be put inside a negative eyepiece for a finder, and as these are invariably shallow eyepieces, the field is practically flat. Many of your amateur readers, who make up their own telescopes, may have odd negative eyepieces suitable for such a purpose; while they might have difficulty in getting a Ramsden one.

If "F.R.A.S.'s" intention, as he says, was simply to caution Mr. Strother against any attempt to remove not *either*, but the double concave of his objective, what was the use of the explanation about the secondary spectrum, which had nothing to do with the question? Mr. Strother should have been told that Mr. Peter Dollond introduced the triple objective, to better correct the spherical aberration.

I need not notice what he says about "Tyro's" microscope, as it is undeniably wrong.

"F.R.A.S." has given great offence to many of your readers known to me by the terms he uses in reference to communications which appear in your columns. Allow me to quote a few:—23rd Jan., 1891, "utterly irredeemable trash"; 6th March, "idiotic and contemptible trash"; 3rd April, "sheer impudence"; 12th June, "most utterly hopeless twaddle"; same date, "soap and pills style of quack puffery"; 18th Sept., "miserably cadging crew." These, and many more, are samples of a style quite unbecoming any scientific man, especially one who is allowed to append F.R.A.S. to his name. They look more like what one would expect from the captain of Ranterpike trader to his incorrigibles, than from a member of the leading astronomical society in the world. **Wega.**

A DIVIDED OBJECT-GLASS—EPSILON² LYRÆ.

[32896.]—I have to thank "A Fellow of the Royal Astronomical Society" for taking notice of my letter (32815); but his somewhat facetious reply did not include precisely what I wanted to know. I was aware that a divided object-glass is called also a heliometer; and, besides possessing such an instrument myself, I have a figure and a description of one by P. and J. Dollond, published more than a hundred years ago. I wanted to learn whether a divided object-glass has been successfully used for any purpose besides that of measuring the angular diameter of such heavenly bodies as have sensible discs.

In response to the request of "A Fellow of the Royal Astronomical Society" (letter 32846, p. 217), I wish to say that with a telescope having an aperture of $2\frac{8}{10}$in., and a power of about 140, I see ϵ^2 Lyræ clearly divided; with a power of about 90 the components seem to be just in contact; and with a power of about 40 they appear as one star distinctly elongated. Zed.

THE LATHE INDEX.

[32897.]—The transverse index described by "O. J. L." in No. 1389, appears to have decided advantages; but I should be glad to know whether, in practice, it is found sufficiently stiff. It seems to me that to secure the absence of all vibration, the pillar must be decidedly substantial; and I notice that Mr. Evans speaks of a *strong* steel pillar, which strikes me as a somewhat cumbersome addition to the mandrel head. Are the crowded circles which we generally see on ornamental lathes really necessary or desirable? Perhaps my experience is limited, but I seldom see more than 100 or 120 repetitions of a pattern upon a piece of work.

The following six circles, 144, 131, 120, 108, 96, 84, give a better range of divisions up to that number than Holtzapffel's plate with its dazzling 360, and with the additional advantage of larger and stronger holes. With such circles as the above, I frequently count without looking at the plate at all. Having found the zero, and locked the index on to the circle required, the point slides over the plate, and is momentarily dropped into each hole. I have very seldom made a mistake in this way, and my eyes decidedly approve of the system. I should be glad to know the experience of my brother turners. H. L. Howell.

INCUBATORS.

[32898.]—I have nearly exhausted this subject so far as I am able to carry it, and with a reproduction of Dr. Gerard Smith's incubator from July 24, 1884, and a few notes on regulators, your readers will now have abundant material for experimental guidance. Here is Dr. G. Smith's incubator, with his own description:—

The following remarks by Dr. Smith preceded the description, and may be of interest. They appeared in the number for July 11, 1884, and except for a few lines, referring especially to the remarks of another correspondent, which I have expunged, are here reproduced. Dr. Smith is talking of the necessity for providing a current of damp air, and he says:—"In whatever way the air current is regulated, it should be so arranged that an extra quantity of cool damp air should pass through if the egg chamber rises in heat above 104°. At all times a continuous gentle current should flow, and no air should pass through the eggs which has not first passed through some damp medium. An air current, if not laden with water vapour, will cause the drying of the albumen, which is undoubtedly the greatest difficulty. I, in common with all students of incubation, have found this point the most important. If you will place two eggs, one under a hen and another in an incubator aired in the ordinary careless way, and, having weighed them first, weigh them again after two weeks' incubation, the loss of weight in the incubator egg will be very noticeable; the hen oils her egg, and the heat of 104° is, in her case, applied only to the upper part of the egg; the incubator egg is usually surrounded with hot air completely, and is not oiled. If a current of air not saturated with water vapour be passing over it, things are worse still. I have tried to grease eggs, but never could do it slightly enough to avoid filling up the air-pores; also, no doubt, I used the wrong kind of grease. The plan followed by many is to shut the eggs up in a close steaming atmosphere for the first ten days; this certainly prevents the drying of albumen during its most fluid period; but one loses chicks from want of air unless airing is done much more frequently. Let there be a constant stream, and that obliged to pass through damp; I use Muir's patent regulator, which works by having a brass plate hanging over a chimney, which runs quite through the tank to the egg-drawer; this plate is at one end of a balanced lever, the other end supports a bottle full of mercury, under the surface of which dips the end of a glass siphon tube containing also mercury, and connected with a series of copper tubes under the tank just over the eggs; these contain water, and expansion and contraction of the water causes more or less mercruy to flow into the little bottle. When used with a good thermostat in the tank, this regulator is perfectly efficient, the brass damper being usually balanced so as to allow a slight stream of air to pass, which becomes greater, and consequently cools the eggs. If the tubes rise over the heat at which the balancing was done, a rise in temperature of one degree will open the chimney so far that the egg-chamber and tubes will cool down in ten minutes: the water in the tubes, of course, contracting, and the bottle becoming lighter, the damper sinks again and diminishes the air supply. Another point is the importance of not jarring the eggs or so moving them that the delicate blood-vessels of the earlier period are injured; my egg-tray remains *in situ* when I air and cool. The whole of the bottom of my incubator is made to drop down on a hinge, the whole length of the front also. I then slide in along a shelf made to receive it a wooden frame containing a thick sheet of felt; this goes close below the tubes of the regulator, and cuts off all heat from the eggs. I bed my eggs in short straw with a little broken charcoal, and thus avoid the complete surrounding of hot air, which results with the eggs simply laid on a sheet of flannel. I use cocoanut fibre for the damp part. I will try and draw a section of my incubator, to show how my drawer is arranged so as to force all air to pass over and through the damp fibre, next week. Mr. Muir, of Thornliebank, Glasgow, is the inventor of the regulator.—Gerard Smith, M.R.C.S., The Acacias, Upper Clapton."

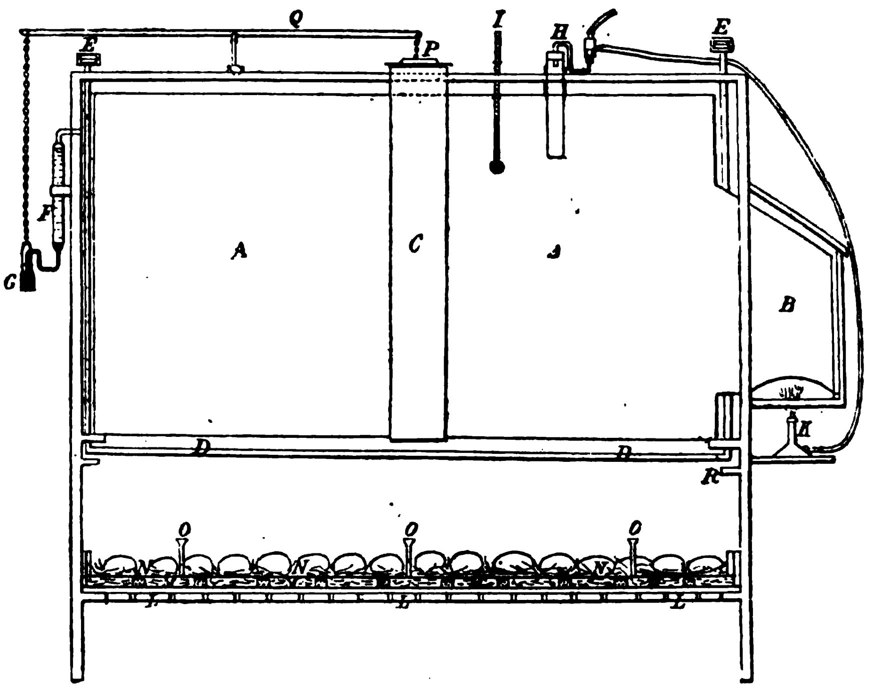


Fig. 1.

A, tank; B, boiler; C, chimney from egg drawer; D, one of the tubes of the regulator filled with water; E E', air-tight stoppers to filling pipes of regulator; F, glass siphon, communicating with water in tubes; G, bottle of mercury; H, thermostat; I, thermometer; K, gas burner; L, perforated bottom of wood (this is hinged to open); M, lower tray, having wet fibre, and perforated zinc chimneys, open below to air; N, egg tray of perforated zinc, eggs in straw; O O O, tubes for pouring water into lower tray; P, brass damper; Q, lever; R R, shelf for introducing non-conducting sheet to cool eggs. Front of machine removed.

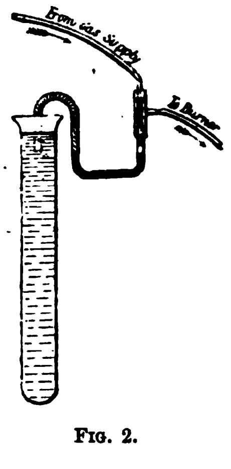


Fig. 2.

In a subsequent communication (Aug. 8, 1884), Dr. Smith said, "The tank of my incubator is 17in. long, 12in. broad, and 10in. deep; the boiler part projects 4½in.; my egg-drawer holds fifty eggs easily. I calculate an average egg to occupy 2¼in. lengthways, and 1½in. broad. My tray is 17in. by 12in."

Dr. Gerard Smith describes the thermostat he uses in the number for May 16, 1884, and it is shown herewith (Fig. 2). "A test-tube full of spirit pressing on mercury in the bent glass tube, which shuts off the gas coming into the apparatus when it rises, allowing only a small supply by a minute hole in a piece of rubber tubing, which forms an interruption in the small glass supply tube. The junction of glass tube and test-tube must be air-tight; the rest only gas-tight."

Here (Fig. 3) is a description of an electrical regulator, sent by Mr. F. M. Rogers (Aug. 7, 1885). "Obtain an ordinary electrical thermometer, and connect it up with, say, three moderate-sized Daniell cells. Bore a hole, 1in. diameter, in the top of the incubator case, and cover this with a piece of soft leather, to the top side of which is fastened a light strip of soft iron. Directly over the strip of soft iron is suspended an electro-magnet, the coils of which are included in the circuit. Set the thermometer to required temperature; when this is exceeded, the electro-magnet will open the valve, but will allow it to close when the temperature falls."

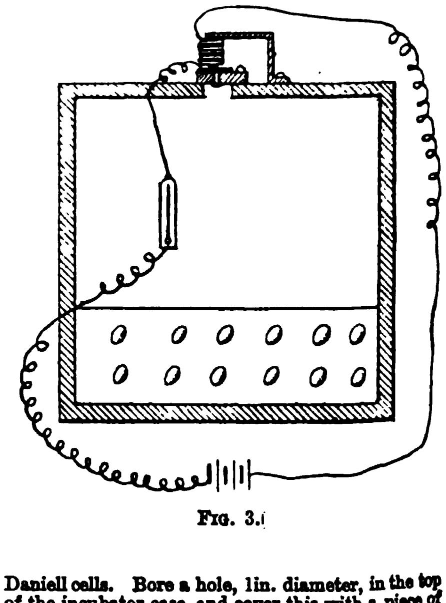


Fig. 3.

I may, possibly, find up some other devices that will answer for regulators; if so, I will send them on. Incubans.

ORGANETTES (AND PIANISTAS).—X.

[32899.]—Having gone through the series of instruments up to the point reached in my last letter, I propose now to take up that branch of the subject in which the apparatus, instead of being complete in itself, is used to play on other instruments, such as a piano or organ. To this class one may give the general name of Pianistas in the same sense in which that previously dealt with has been embraced in the term organettes.

For convenience I divide them into three sections —viz., mechanical, pneumatic, and electro-magnetic, though it is quite possible to combine two or more of these sections in the same apparatus, as I may have occasion to explain when describing certain modifications that might be worth trial.

Though it is intended to use the term pianista in the sense just mentioned, we may consider it first as including a few instruments in which the playing part and the sound-producing part are included in the same outside case. These, in fact, form a kind of connecting link between organettes and pianistas, and as such may fitly be introduced here. Let us begin with a venerable specimen of inventive skill of unknown date.

In an old book, which I cannot now refer to even by name, I remember coming across what I think must have been the first suggestion of the principle of changing the tune by changing the portion that acted on the valves. The proposed arrangement consisted in substituting for the wooden barrel of a barrel organ a cylinder containing an elastic cushion tightly fitting inside it. Through perforations (distributed thickly and evenly over the whole surface of the cylinder) the brass pins and staples that act on the valve-levers were to be inserted as required, and kept steady by the internal cushion into which their ends were stuck. It goes without saying that such an excrcise of patience and skill as this would have involved, whenever the tune was to be changed, would have prevented any practical use of the invention, supposing it could have been ever put into a "workable" shape, so I only mention it as a curiosity in its way.

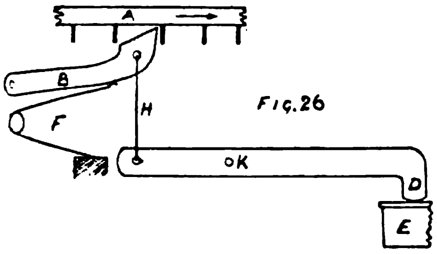


FIG. 26

Starting also with the barrel of a barrel-organ, I myself thought of substituting for the usual pins and staples, a row of thinnish brass discs (one for each note) threaded on to a central axis at such distances apart as would suit the levers that actuate the pallets. These distances were to be maintained by using intermediate discs of hard wood, and the whole series of brass and wood discs was to be jammed tight by means of a nut running on a screwed portion of the axis. Obviously by using wood washers of half or one-third the spacing of the levers, two or three sets of discs (and therefore of tunes) could go on at once. By a slight modification mere rings (say ¼in. deep) would rest on shoulders of the wooden dics, and serve instead of the complete discs of metal.

The labour and cost of preparing the rings would, however, be so much greater than the pinning of a barrel that I abandoned the scheme, despite the portability the rings would have had.

The first instrument that I know of as having been actually carried out, was that of Debain which I saw in (I think) the 1855 Exhibition at Paris. This, though complete in itself as an ordinary piano, and able to be played upon in the ordinary manner, contained in the upper part of its case an arrangement for automatic performance. In thus containing in itself the automatic mechanism it differed from the more modern pianista and similar constructions in which the automatic portion is separate from the instrument on whose keys it acts, so that it illustrates my previous remark on this point.

The details of construction of the "Antiphonel," as it was called, are not known to me, but the actuating portion consisted of flat plates of wood called "planchettes," in which were fixed brass pins to move the hammers that struck the wires of the piano. These "planchettes" were fed in by hand, and were then drawn through and discharged in succession at the opposite end of the channel in which they were made to travel. It was, in musical effect, just like an ordinary street piano—neither better nor worse.

Though I have called it an "Antiphonel," I am not sure that this name was not that of an instrument to play an organ or harmonium, the piano being called a "piano mécanique," so I am open to correction on the point.

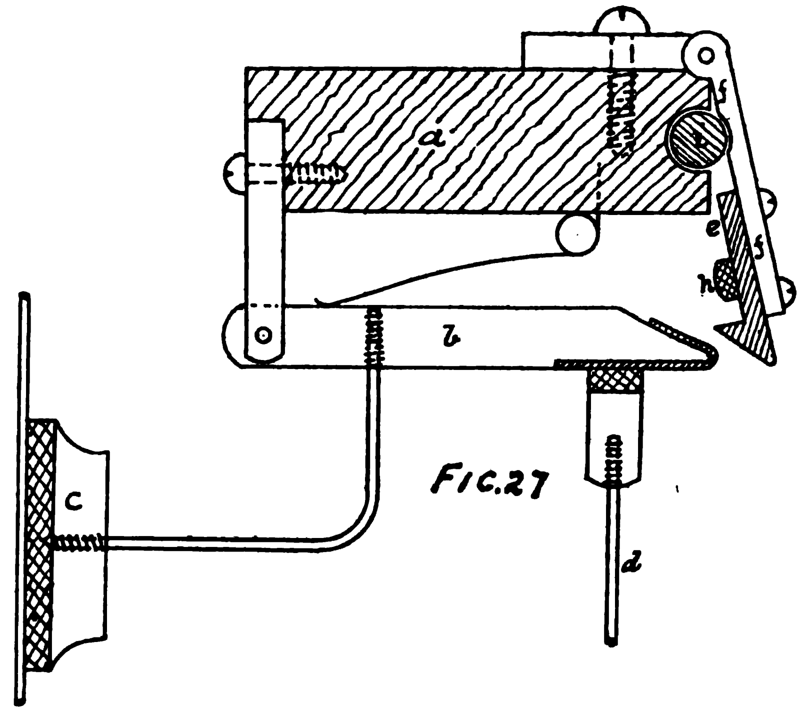


FIG. 27

Failing a detailed drawing or description of Debain's apparatus, I give a sketch of one on the same principle, for which I am indebted to a Glasgow correspondent, who informs me he made it about the same time that Debain was supplying the "Antiphonels."

In Fig. 26, A is the wooden "planchette," with its pins projecting from the under surface; B is a lever pivoted at the end, and having its upper part formed into an incline as shown. To this lever is connected, by the link H, a lower lever pivoted at K, and of which the end D rests on the piano key E. Owing to the upward pressure of the spring F, the key E is kept constantly depressed, as will be easily seen from the way the levers are arranged and connected. If, however, the "planchette" is caused to travel from left to right, one of the pins will depress the lever B, and thus allow the key E to rise. The moment, however, the pin escapes past the inclined portion of B, the spring will suddenly throw up that lever, and thereby force down the end D of the other lever, and cause the key to strike the desired note.

It should be noticed, in comparing this arrangement with others to be presently referred to, that the piano-key is not merely struck down, but held down, so that the effect would be like playing with the "forte" pedal always in use, and no "expression is possible. From the whole work being thrown on the pins of the "planchette," these, as well as the lever B, had to be of steel, and kept well oiled to reduce the wear and tear to a minimum.

It was mentioned in one of the earlier letters of this series that the tune bands were sometimes of very great length in the case of organettes, so, for comparison, it may be as well to state that ten "planchettes" about 5in. square contained a set of quadrilles. For one kind of pianista, the same set would require nearly 100ft. of paper tune-band.

I now come to Mr. F. H. Wenham's pianoforte-player. In this we have, I think, the first pianista (purely mechanical), in which the tune-band merely selects the note to be struck, the actual striking being done by the prime mover, so that the tune-band may be made merely of paper.

The apparatus has been fully described by Mr. Wenham himself in the "E. M.," but he has kindly sent me a sketch and particulars of an additional contrivance which improves the musical effect while not affecting the general arrangement.

In letters that have been written by myself and others, before this series was commenced, allusion has been made to the difficulty of *holding down* a note that has been struck, and I believe I mentioned that I had abandoned an organ-player that I was trying to work out, owing to this same difficulty.

In piano-playing this holding down is of *less* consequence, but still it has an unpleasant "staccato" effect if the key is sharply depressed and immediately released as is the case when using Mr. Wenham's original pianista.

To obviate this, a peculiar mode of retaining the dampers of the "action" is employed, the additional parts being applied to the ordinary action of an upright piano in such a way as scarcely to interfere with the usual construction. It can, moreover, be instantly thrown in or out of use at the player's option.

Fig. 27 is an end-view of the arrangements as applied to an upright piano. *a* is the damper rail, *b* the damper lever felted at the tapered end, *c* is the felted damper resting on the string or wire, *d* is the lifting wire from key, *e* is a strip of wood extending the length of the damper action. This strip or catch is divided into three equal sections, acting independently, in order that the striking of the treble notes may not stop the sustaining action of the other two, or that when the bass notes are struck this may not interfere with the others to be sustained.

Each section swings freely from two wooden hinges, *ff*, and each has a wire spring attached to the back, which pulls the section or catch down from a looped cord passing over it, and fastened to the damper rail. By unhooking the wire from the loop each section or catch is freed, and may be turned over the top of the damper rail.

The action is as follows. When the damper is raised by the key or note struck (or if several are struck simultaneously), the taper end of the lever is caught by the hook end of the catch, by which it is held up till the striking of the next key again raises the catch, which is then thrown off the end by the last note (or notes) struck, thus instantly freeing and damping the preceding note. The damper of the preceding note would not, however, be set free if the lever end in the least degree projected beyond the last one. It is necessary, therefore, that the catch should be thrown back a sufficient distance to clear all of them. To effect this there is a strip of felt, *a*, attached to the catch; this receives an impact from the surplus stroke of the damper lever, and the catch is thus thrown off sufficiently to clear the ends of all the levers. The beak of the catch must be well polished and blackleaded, to lessen friction.

When the sustaining action is not required in the ordinary use of the piano, all three catches must be raised clear from the damper ends. This is effected by the rod *i* having three wires projecting under the strips or catches *e*, so that by slightly turning the rod the three catches are raised and become inoperative. In Mr. Wenham's own piano this raising is effected by a third pedal; but it may, perhaps, be more simply arranged by using a small key inserted through the side of the piano.

Mr. Wenham's description is so full and clear that it is unnecessary to add any remark of my own further than this. It may be objected that the piano must be specially fitted with the apparatus, whereas in using some other forms of pianista this is not necessary. This objection, no doubt, is true in itself; but, on the other hand, when the piano has received the addition, it is (as has been explained) in no way injured for its use in the ordinary way, so that virtually the question becomes one of expense. Now I have no actual figures to guide me, but I should say that if manufactured for sale the cost of Mr. Wenham's pianista would be so much lower than that of the French one (to be described later on), that a considerable margin would be left towards the expense of the piano additions. Perhaps Mr. Wenham could give us a little information on this point.

Soon after Mr. Wenham's description of his pianista appeared, I mentioned that I had made a rough model of a modification to enable it to hold down the keys instead of merely to strike them. I did not then describe the device, so will do so now.

I introduced in a slot in the side of the "plunger" a trigger or catch, much like the spring in an umbrella handle. When the plunger was depressed the trigger sprang out, and caught under a fixed bar, thus keeping the plunger from rising. When the passing of the peforation in the tune-band pushed back the plunger, the trigger was forced from under the bar, and the plunger was released. The trigger must only project, say, half the amount that the plunger moves sideways, or it will not be set free.

A. S. L.

DID THE ANCIENT EGYPTIANS USE STEEL?

[32900.]—The English mechanic who takes an interest in the mechanics and mechanical appliances of ancient Egypt has presented to him by his study of these ancient people several problems that sorely puzzle him. Foremost stands the problem, What metal was used by them to hew, carve, and elaborately finish the numerous and hard stones that remain to this day, testifying to the great skill and mastery of the art the ancient workman possessed?

I am fully aware that this question has been discussed many times, and that it has been many times settled (?). It has, however, been settled in such various ways that I, with many others who have given attention to this subject, am still at a loss for an adequate solution, and have no satisfactory evidence on which to rely.

The many recent discoveries that have been made may possibly throw some light upon this very interesting question; and I address the readers of the English Mechanic in the hope that among them one or more may be found in possession of some well-established facts that may throw light upon, if not settle, the question beyond a doubt.

The information we possess is chiefly derived from travellers, few of whom, if any, are practical engineers, or are possessed of sufficient practical knowledge to express an opinion worth acceptance or in any way conclusive.

Sir Gardiner Wilkinson was at one time certain about the use of steel. This certainty was distinctly modified in his later works.

Evans, in his "Stone Implements," quoting from De Rougemont's "L'Age du Bronze," says:—"We find in Egypt . . . no trace of iron before the twelfth dynasty, and of its use even then the evidence is only pictorial."

W. M. Flinders Petrie, in his work on the Pyramids of Gizeh, writing upon this subject in 1883, says:—"Various suggestions have been made, some very impracticable; but no actual proof of the tools employed, or the manner of using them, have been obtained. From the examples of work which I was able to collect at Gizeh, and from various fixed objects, from which I took casts, the solution of the questions so often asked seems now to have been found.

The typical method of working hard stones—such as granite, diorite, basalt, &c.—was by means of bronze tools. These were set with cutting-points, far harder than the quartz that was operated on. The material of these cutting-points is yet undetermined; but only five substances are possible—beryl, topaz, chrysoberyl, corundum or sapphire, and diamond. The character of the work would certainly seem to point to diamond as being the cutting jewel; and only the consideration of its rarity in general, and its absence from Egypt, interfere with this conclusion, and render the tough, uncrystallised corundum the more likely material."

Wilkinson, without doubt, concluded that the various tools and implements which he found depicted upon the walls of the tombs, and which were coloured blue, must, therefore, be steel. The possibility of their being of iron did not occur to him; and, had no doubts been expressed to the contrary, he would probably have adhered to his first expressed opinion. It would scarce occur to anyone, unless from the very desire to differ, that iron might be indicated rather than steel.

The opinion of De Rougemont may be dismissed without comment, as iron has been discovered of earlier date than the twelfth dynasty.

Flinders Petrie is so careful and exact in his investigations, that his opinion should be of weight. Tools of corundum set in bronze, according to him, were the instruments used to produce the mass of worked stone that lies scattered along the Nile valley. How could stone be rough-hewn and worked into shape without a tool capable of sustaining a blow? Corundum set in bronze would only be set into the bronze the deeper every blow the tool received, or smashed, and little, if any, impression would be made upon a block of basalt.

Fancy attrition, or scratching, at an obelisk 70ft. long and 8ft. square! It is useless to suggest time and an unlimited number of "hands." Fancy the rock-cut Temple of Aboosimbel scratched out with bits of corundum set in bronze!

Against this theory may be advanced the fact that no such tools have been discovered, and that—although many bronze chisels, &c., have been found in Egypt—none bear evidence of having been set with corundum or other stone.

The tools, especially chisels, used by the ancient Egyptians, must have been exceedingly numerous; and if of bronze it is probable, to say the least of it, that very many more would have been unearthed than have been.

The suggestion made by some writers that bronze stocks, tipped or shod with steel-cutting edges, receives some support from the fact that at Villanova, a bronze celt of the socket type was found with a cutting-point of iron *inserted*. This was in an Etruscan tomb. Scandinavia also, according to Boyd Dawkins, affords instances of iron-tipped bronze stocks. These facts are sufficient to warrant the supposition that iron-tipped tools may have been used by the Egyptians. But iron is *not* steel, and this fact seems to be lost sight of by many when writing upon this subject.

That iron-tipped tools were an improvement on those with bronze cutting edges may be taken for granted; otherwise the ancient users of them would not have taken the trouble to insert the iron. But for what purpose were these iron-tipped tools used? Certainly not for the manipulation of hard stone!

The mechanic who has had any experience of tempering steel will fully realise the difficulty of tempering a steel shoe, such as would be required to form the cutting-edge to a bronze stock. And for steel to be of any use at all in connection with bronze for the purpose of stone-cutting, it *must* have been in the form of a shoe or cap, and not as an inserted piece of metal; for, if inserted, it would either become loose or split the stock. But surely the workman who could fabricate a steel shoe would see the advantages of a tool wholly composed of steel. It may be urged that steel was scarce: but waste in forging, breakages during the process of hardening and in use, would require a far larger supply of steel than if the tools were made wholly of that material.

Moore, in his "Ancient Mineralogy," states that bronze, as made by the ancients, if cooled slowly would be made as hard as steel, and at the same time its brittleness removed.

Chavas is of opinion that the ancient Egyptians knew how to temper bronze, and that, although they were intimately acquainted with iron, they used it with reserve.

Against the assertion that the ancients knew how to temper bronze may be urged the fact that no bronze implement has ever been found that would cut away hard stone. It may be said in reply that the temper has been lost through chemical or physical change taking place during the lapse of time since they were tempered. This is certainly possible; but when it is remembered that all the attempts of the engineers of the present day to produce a bronze that will usefully cut hard stone have failed, it appears highly improbable.

Again, the fact that iron-tipped bronze tools have been found, suggests that even a cutting-edge of *iron* was superior to one of bronze. Here again it might be remarked that the art of tempering might not have been known to the fabricators of these iron-tipped bronzes; but this does not appear a satisfactory answer.

G. Maspero, in his "Egyptian Archæology," offers the following solution with an amount of cock-sureness, that, to say the least of it, requires confirmation.

From Miss Edwards's admirable translation I quote as follows:—"If, however, it is quite certain that the Egyptians were acquainted with, and made use of, iron, it is no less certain that they were wholly unacquainted with steel. This being the case, one asks how they can possibly have dealt at will upon the hardest rocks, even upon such as we ourselves hesitate to attach, namely, diorite, basalt, and the granite of Syene. The manfacturers of antiquities, who sculpture granite for the benefit of tourists, have found a simple solution of this problem. They work with some twenty common iron chisels at hand, which, after a very few turns, are good for nothing. When one is blunted they take up another, and so on till the stock is exhausted. They then go to the forge, and put their tools into working order again. The process is neither so long nor so difficult as might be supposed. . . . I have no doubt that the ancient Egyptians worked in precisely the same way, and mastered the hardest stones by the use of iron."

To the practical mechanic this suggestion offers no solution. If with iron chisels "the process is neither so long nor so difficult as might be supposed," then the European workman would not "hesitate" to attack diorite, basalt, or even syenite from Syene, with *steel* tools! But is it a fact that the fellaheen of to-day uses *iron* chisels? If he does, he must be a . . . when steel is so easily procurable, and would give him much less trouble (that is, *if* he does use iron). Let anyone with a chisel made from the very best *iron* that can be procured for the purpose (not common iron) try his hand at hewing either diorite, basalt, or Syenic granite. He will certainly produce impressions; they will, however, be upon his chisel, and not upon the stone.

It is just possible that the antiquity (?) makers of the present day use very inferior steel—and anything is good enough to send to such folk; at least, so thinks the manufacturer or middleman who supplies such markets. But supposing they used the very best procurable, visits to the forge would need to be very frequent while operating upon such intractable materials.

The process of "stunning" has been suggested. No doubt blows from a hammer of bronze, or even of stone, would sometimes assist in the manipulation of these hard stones; but even this, together with bronze tools, and they tipped with corundum, offers no satisfactory solution to the problem, How were the numerous and hard stones wrought by the ancient Egyptians?

It would be interesting to have upon record the instances of iron having been found in Egypt.

From beneath one of the sphinxes at Karnak Belzoni secured a scimitar-like blade; and from between the stones of the great pyramid a wedge-like piece of iron was rescued.

To this interesting subject an answer can be found, and among the readers of the English Mechanic there must be some who can help to solve it. Facts are what is wanted, not theories, although a theory may lead to the discovery of a fact.

Liverpool. W. T. Haydon.

A CHEMICAL APPLICATION TO BICYCLES.

[32901.]—I use a little device to facilitate propping a safety bicycle up against a brick wall or other support, which, perhaps, is simplicity itself, and consists in making use of the conical india-rubber bungs, which are made in all sizes, and used by chemists in their laboratories to stopper bottles, &c. A pair of these is selected with their middle diameters about equal to diameter of the handle-bar tube, and one is inserted—i.e., "screwed" into each end, which, of course, must not be closed by a metal plug. The rubber bungs being conical or tapering, and perfectly round, will screw in fast, the operation being aided, if necessary, by wetting (not greasing) the surfaces, where ordinary lumps of rubber, that could be cut more or less round by the hand, are not secure. Obtainable in the chemically purest rubber, the bungs are also far superior to the ordinary article, from their great softness and resilience. Protruding ¼in. to ½in. they form a cushion, which serves in a possible fall ongreasy roads, to break the concussion with the ground; and when a bicycle is propped up against a wall, to prevent the polished horn handles being scratched; also to [steady the machine by neutralising any vibration which is apt to cause it to "slip away." A little channel obtains between the extremity of the handle-bar and the thicker end of the bung, which exerts a good hold on the brick or stone-work, far better than the "spike" used by some riders, that on disturbance easily slips or works round, besides being a rather dangerous instrument to use and carry about.

If the handles are much bent inwards, the usefulness of the bungs is considerably lessened, hence riders of ordinaries would, no doubt, find the application of most value in their straight or vertically bent handle-bars; though, with my experience of yore with the "good old Ordinary," it was generally pretty steady against a wall.

If a rubber cap is used on the handle, it may be drawn over, especially if a thin one, and the advantage gained of having an extra rubber plug and elastic cushion inside, which cannot be forced into the tube. Many riders, I find, disregard the thick corrugated cap—which alone, perhaps, has cushion sufficient—as being too bulky in the hand.

The conical indiarubber bungs can be purchase for a few pence at any chemical warehouse, and I venture to suggest this inexpensive device, culled from the chemist's "workshop" to your readers.

C. Gerland, M.Sc., Ph.D., &c.
Laboratory, Blackburn Technical School.

GAS-GLOBES AND HEATING APPARATUS.

[32902.]—Whether the gas-globe is effective or not in warming a room (and Mr. Fletcher is about right in what he says on this question), there is no doubt that it is very effective in poisoning the air in the room. Every one who has much to do with Bunsen burners, even of the best construction, knows that they produce, especially when the flame impinges directly on a colder surface, a quantity of carbon monoxide (carbonic oxide), a gas which when breathed acts as a direct poison in the blood, and which is all the more dangerous because it has no smell, and hence escapes detection. It is this gas which is responsible for most of the headaches and giddiness felt in churches containing gas-stoves heated by non-illuminating burners.

In arranging a gas-heating apparatus it should be an absolute rule never to use any form of non-illuminating burner unless ample provision is made for carrying the products of combustion right away from the room. If this cannot be managed, then unless the direct object is to commit suicide, ordinary illuminating burners must be used, and even with them good ventilation should be provided.

Mr. Fletcher is perfectly right in contending that a heating apparatus must be as near the floor as possible. The Romans well knew this: they used "hypocausts" (systems of hot-air channels just below the floor), and probably no rooms have ever been more effectively heated than those of a Roman villa.

I warmed my work-room (about 24ft. by 16ft.) quite sufficiently last winter by a rough apparatus consisting of a piece of black sheet-iron about 2ft. square, bent into a shallow tray, and supported (inverted) about 6in. above the floor. Under it three common fish-tail burners were placed, consuming altogether about 15 cubic feet of gas per hour.

For a smaller room may be used a 2ft. length of sheet-iron stove-pipe, 5in. diameter, closed at one end, and supported vertically with the closed end upwards a few inches above the floor; a single fish-tail burner being placed underneath it. Even a candle will answer fairly if gas is not available.

Some time ago I had a very cheap heating apparatus constructed, consisting of a few short lengths of the common thin cast-iron rain-pipes, 3in. diameter (costing about 1s. 3d. a yard), ranged horizontally like the usual hot-water coils, and connected by "bends." To the lowest of these a bend is attached, with its open end downwards, and underneath this a couple of fish-tail burners are placed, so that all the heated air and products of combustion pass through the coil of pipe, and part with their heat entirely by the time they reach the upper end. A good deal of water is, of course, condensed, and the pipes should be laid with a slight downward slope throughout, a jug or bucket being placed under the lowest point. **E. R. P.**

THE NEW GAS-GLOBE STOVE.

[32903.]—Prof. Barrett (letter 32878, p. 241) obtained a rise of 10° at floor level with this, and I should very much like to know the size of the room in which the test was made. Mine was in a small sheltered office, 8ft. by 9ft. by 10ft. only; the maximum rise was 5½°, and, if the air had been disturbed and the temperature equalised beforehand, it is pretty certain that the rise would have been decidedly less. It is manifestly unfair to test any globe against a form of light rarely used, and I therefore tested globe against globe—the old and the new, and the only point prominent was the loss of light in the new form.

There is no doubt that a simple stove is most desirable; but if all other circumstances were favourable, the position of a lighting burner condemns it at once.

If the lighting burner is to be used as a stove, an opal globe with a wide opening below has many advantages; the heat downwards is too strong to be pleasant on a hot, close night, and the burnt gases go straight up, and remain, to a very great extent, in a thin layer against the ceiling.

The mistake Prof. Barrett made was in testing a globe against a naked flame, and reasoning from theory on this basis. My own opinion was formed from experience with various arrangements of a similar nature which have been brought out during the last 20 years, the best of which, I think, was the ball or slab of pumice-stone, which got red-hot, and no doubt did radiate a considerable amount of heat. **Thos. Fletcher.**

MR. BOTTONE TO HIS FRIENDS.

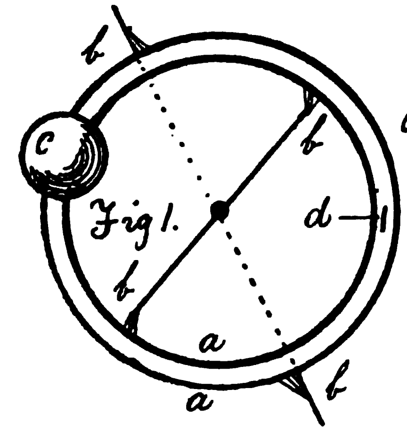
[32904.]—I am always delighted to render what assistance I can to all my friends in "Ours" in the way of replying to queries in these columns, free of all charge. But I am so overwhelmed with business matters, that I really cannot, in justice to myself and those dependent on me, answer *privately* any letters asking for information, unless accompanied by an adequate fee. **S. Bottone.**

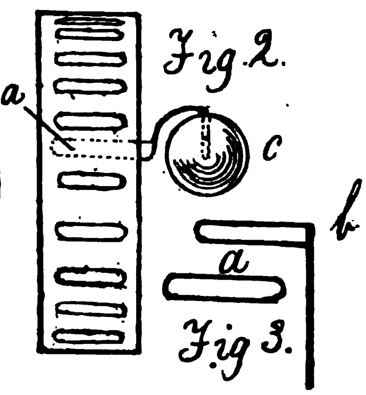
AN EXPERIMENT WITH INCANDESCENT LAMPS.

[32905.]—Perhaps some of ours would like to try the following experiment, which I accidentally found out.

I have an incandescent lamp, six-volt, in which the filament is broken, also a small induction coil. I attached the lamp to the secondary terminals of the induction coil and sent a strong current through the primary from a small dynamo with Siemens H armature. Immediately a beautiful faint glow seemed to entirely fill the lamp, and continued so long as the current was continued. Perhaps someone with a damaged lamp and a stronger induction coil than mine would try the experiment, and report.

I should say that I did not allow the contact-breaker to vibrate, the fluctuations caused by the H armature being sufficient. **J. T. B.**





SOME CURIOUS EXPERIMENTS WITH THE WIMSHURST MACHINE.

[32906.]—About two years ago, whilst experimenting with the "Wimshurst" Machine, we discovered a simple way of throwing the whole power of the machine into one only of the prime conductors, so that the machine, instead of giving, as usual, both + and − electricity in equal quantities from the two conductors, gives electricity from one conductor and of one sign only (whether + or − depends on which way the machine is polarised) but of about double the power obtained from either of the conductors with the machine in its original form. How these results are obtained will be understood from the following description, with reference to the diagrams, where AA (Fig. 1) represents a pair of cylinders, BBBB neutralising rods and brushes, C one prime conductor, the other one, together with its insulating rod, must be removed. Now take two slips of very thin brass or other metal, of the shape shown at A (Fig. 2), about the same width as one of the sectors or cylinders, and the width of cylinder in length. Insert one of these *between the cylinders* at D (Fig. 1), in line with the sectors. It may be soldered to a stout wire, as at B (Fig. 3), and stuck up in insulator socket on machine frame, but, however fixed, must *not be insulated*, but put to "earth." Insert the other slip between the cylinders in the position shown by dotted lines at A (Fig. 2) and fix there by means of a bent wire soldered to it, the end of which is inserted in the hole in top of conductor-ball as shown. Adjust both slips so that the cylinders may revolve freely without touching them. Arranged thus, on working the machine, slip D (Fig. 1) acts as a neutraliser, causing the inner surfaces of the glass or ebonite to take a charge of the opposite sign to that of the sectors, as they pass over it outside. This charge is in a "bound" state until, by the revolution of the cylinders and the action of the neutralising brushes, it meets with electricity of the same sign on the sectors outside, and becomes a "free" charge, which is carried over to, and is collected by, the slip in connection with conductor G. If the collecting slip be removed from G, and the machine worked for a few seconds, the sectors will be found to act as condensers and take a charge similar to a Leyden jar, as may be proved by applying the knuckle to either of the revolving cylinders exactly opposite slip D (Fig. 1). Whilst the hand touches its supporting wire a stream of sparks will be seen and felt during several revolutions of the cylinders, resembling that from a small induction coil.

That the inner surfaces of cylinders are highly charged may be proved by observing the action of machine in the dark. A blaze of sparks will be seen at both the neutralising and collecting strips, or, when the collecting strip is removed, apply the knuckle to edges of the revolving cylinders, as near as possible to the conductor-ball G, without drawing sparks from it, when a continuous stream of sparks with branched ends, which often extend the whole width of cylinders, will leap to it. Work the machine for a few seconds, stop it quickly; crackling sounds will be heard all over the cylinders as from a Leyden jar when highly charged. In this state the sectors will remain charged for a considerable time. They may be discharged at leisure, one after another, by applying the knuckle and touching the wire as before whilst the cylinders are slowly revolved.

R. Tudsbury and Sons.

NICOTINE.

[32907.]—One never reads an advertisement connected with a tobacco-pipe without seeing some reference to the removal of nicotine by mechanical means from the smoke which is taken into the mouth. It is a well-known fact that the British public will swallow any absurdity, if it be only offered in a tempting manner; and the nicotine scare is one of these absurdities. Nicotine is a very volatile and poisonous alkaloid, one drop of which in a pure state will destroy human life. The largest quantity existing in any tobacco is about 3 per cent. Of course it is not in the free state but in combination as a salt of an organic acid. When the tobacco is burnt the nicotine is volatilised and passes off in the smoke, some being destroyed in the process. The tarry liquid which settles in the stem of the pipe is not nicotine at all, but water, essential oil, and extractive matter. It is the oil which makes the smoker sick. While I am on this subject I may say that all patent pipes containing obstructions in the form of clay cylinders, portions of sponge, &c., &c., included in the cavity of the stem are a great mistake, and only intensify the evil they are supposed to prevent. What is wanted in a pipe is a *wide* bore which can be easily cleansed, and all old smokers will tell you the same thing.

Sm.

HOW TO MAKE A VIOLIN.

[32908.]—"Orderic Vital" (letter 32864) touched upon the right string when he said that the amateur violin-maker may as well start fair with a good outline and model, especially as on these so much depends.

It certainly would be far wiser and safer to follow a correct method of obtaining a perfect outline than to waste years of time and a heap of valuable materials in trying "to get his eye in." I say trying advisedly, for he will most assuredly no more accomplish his object than Mr. Pickering himself has done after his great number of experiments, his close study, and his love for the subject.

A glance at Mr. Pickering's outline of a violin given on p. 108, vol. LVI. will convince anyone, I think, who knows anything about the contour of the instrument how he has failed to produce a correct idea of what the outline should be; and this, we will presume, is because he has trusted too much to his eye instead of employing the right means to obtain a good form.

Mr. Pickering advises the amateur to intercept a perfectly modelled instrument between a light and a piece of paper pinned to the wall, and make a drawing of the shadow on the paper. This rule-of-thumb-school-boy method of obtaining an outline has doubtless made a good many practical men smile. It is more than likely that not one in fifty of the amateurs makers who have made up their minds to follow Mr. Pickering has access to a perfectly modelled violin. But should some be so fortunate, I think their own common sense would dictate some method better than Mr. Pickering's "shadow on the wall."

There is no need to resort to rule-of-thumb methods while practical modes exist. I might have said geometrical methods. Mr. Pickering says that all the instructions he has met with follow the same beaten track. I think I might venture to predict that Mr. Pickering's track is not at all likely to become beaten. Mr. Pickering prefers to use the tools of the wheelwright, and is greatly surprised to find that no practical man will use a spokeshave instead of the gouge. His cotton-reel-bradawl purfling tool only deserves a passing smile.

Mr. Pickering (on p. 53) ventures to suggest that, after repeated trials at drawing by his method, the student may possibly produce something like Fig. 16 on p. 53. I agree with Mr. Pickering in this, and think it highly probable that they would. At this point Mr. Pickering assumes that the tiro has his back and belly well shaped in outline. Now for the model or contour. He suggests that it would be advisable to make three templets like Fig. 17; he also adds that another, like Fig. 18, for the lengthway of the instrument may be made "on the same plan." What plan? Mr. Pickering does not even suggest a method of obtaining these curves.

Does he imagine that the violin is an instrument which is put together by guesswork? It seems marvellous to me that Mr. Pickering can for one moment fancy he is giving practical hints to amateurs how to make a violin.

Mr. Pickering advises his follower to build his instrument without a mould, and justifies this mode of procedure by saying that some of the old masters did. Query, which old masters? But even supposing that it might be proved that an old master did not employ the mould, surely Mr. Pickering does not expect his followers to be old masters; and yet in this, as in every respect, he is leading them along the most difficult path possible. I would venture to suggest that of all the makers, ancient or modern, not one in fifty ever thought of building an instrument without a mould.

Mr. Pickering's public-house spills for linings is an idea which is too ridiculous to deserve more than a passing notice, inasmuch as they are made of the commonest wood possible, and could give neither support nor strength to the instrument. This one idea alone would lead any practical man to believe that Mr. Pickering never made a violin in his life. If, says Mr. Pickering, the ribs have been properly formed (he seems to have a doubt about it—we most certainly have) the belly should fit nicely.

Now we come to the *f* holes. Here, again, Mr. Pickering advises his student to get his eye in, and make *f* holes for himself, and when he has arrived at a degree of perfection which he deems satisfactory Mr. Pickering says make a tracing of one, cut it out, and lay it first on one side and then on the other. He admits that it is not sufficient to lay them on the centre bouts in a haphazard manner, and strongly advises his tiros again to get their eye in. It occurs to us that whenever real knowledge is required Mr. Pickering cleverly avoids giving it, and bridges it over with that pet advice of his to get their eyes in. Surely Mr. Pickering knows that there is a recognised position for the *f* holes, and if so why does he not give it, inasmuch as he is giving practical hints, and not allow his would-be amateur makers to flounder about in the dark?

The neck and scroll. Mr. Pickering says, after having satisfied himself about the design, the amateur may saw out as much of the wood as possible with the bow-saw and remove the rest with a small chisel. I wonder he had not said spokeshave. He seems to have taken a thorough disgust to the gouge, which tool, let me say, is never absent from the fiddle-maker's bench.

After having fitted carefully the pegs, &c. Fitted them to what? or in where are they to be fitted? Mr. Pickering does not say a word about the peg-box or the peg-holes, the position of these holes, size, &c., which are very important. He hurries on with some vague hints about pitch of finger-board, more rule of thumb, &c. The tiro may, after he has decided about the position of the neck, says Mr. Pickering, glue on the finger-board permanently, and afterwards insert the neck into the body of the fiddle.

Here, again it would appear that Mr. Pickering never made a violin in his life, or he would certainly have discovered that it is almost impossible to varnish a violin after the finger-board is glued in position. Either he is exposing his ignorance of real practical knowledge or he is misleading the amateur maker as much as possible. Mr. Pickering again says, choose a piece of "soft" deal for the sound-post. Now this, again, is a very important item in a violin; and, instead of selecting a piece of "soft deal," practical men take a good deal of care, and are particular to choose the "closest" and straightest-grained pine it is possible to get, and so hard that, when it is finished ready to be set, if it be thrown down smartly on a table it has a tendency to ring like metal; then it is that your sound-post is well chosen and in perfect condition.

Then, abut setting the sound-post. Mr. Pickering's description of a sound-post setter is most misleading. I fancy I see an amateur attempting to set a sound-post with a piece of wire formed in the manner described by Mr. Pickering.

It might appear that I have been unkindly severe on Mr. Pickering's method of teaching. What I have written is given conscientiously for the general good. We no longer believe in the introduction of wrong means to bring about the right end. That is a method of instruction which has long since been exploded: hence our old Murray's and Lennie's systems have died a natural death.

I shall be pleased to supply "Orderic Vital" with geometrical methods of obtaining both the outline and also the Templet curves. I use six Templets, five at different points across the back and belly and one lengthways, and find them quite sufficient.

Some little instructions are required for the successful working of these curves, which, with the Editor's permission, I shall be pleased to give, either in one long or a series of short articles.

Glasgow. Scio.

[Please send. Your information ought to be good, for your criticism is unsparing. Mr. Pickering has probably given his fellow-readers his best on a subject of wide interest, but with regard to which few seem of late years disposed to give information in our pages. If you can fill the void, by all means do so.—Ed.]

REPLIES TO QUERIES

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[74424.]—**Midland Locos.**—Thanks to Mr. Stretton for his note on p. 246. By a curious coincidence, on the very morning that I was reading my "E.M." the coach I was in stopped just opposite No. 1870 at St. Pancras; but "Loco." stated some time ago that 1870 had 7ft. 10in. wheels—the largest ever put on a single-driver inside-cylinder engine on the narrow gauge. So far as the dimensions of the wheels are concerned, "Loco." must have been mistaken, or is the mistake in the No.? Is there a 7ft. 10in. wheel loco. on the Midland, or any other line, with inside cylinders? That is the interesting point. Perhaps "Loco." will explain his statement of May 15 last. T. L.

[75355.]—**Galanty Show.**—A favourite book of my urchin days was (Routledge's?) "Boy's Treasury of Sports and Pastimes." This contained a very full description of the galanty show. Arthur Mee.

[75410.]—**Xylophone.**—Although I have not yet been favoured with a reply through the columns of "Ours" to my query, I venture again to repeat my request, as no doubt many besides myself would be glad to employ the long evenings in making what appears to me to be a simple and effective musical instrument. I have just learned that the xylophone (which seems to me to be on the same principle as the harmonicon of our youth) is composed of a certain number of pine sticks, and has a compass of from 2 to 2½ octaves. I should be glad to know the dimensions and shape of these sticks, and how they can be tuned. Foghorn.

[75413.]—**Sloyd Work.**—I understand this sloyd work is something like the so-called "technical education" which is being given in some institutions in this country. It is, as I understand it, teaching children the use of tools and giving them primary instruction in the art of making something. It is naturally highly thought of by those who want "hands" already skilled to their special work, and wish to avoid the trouble of teaching apprentices; but it is not "technical" education in the proper sense of the term. It is practically useless to teach boys a trade they may never follow. T. L.

[75414.]—**Pyrotechny.**—A license is required to sell fireworks; but I know of nothing to hinder an amateur making them for use. But if manufactured in any quantity, no doubt it would have to be under the restrictions of the authorities. "Rocket" will find in back volumes a number of recipes for different kinds, and I think there is a useful work by Dr. Browne, published by L. U. Gill, 170, Strand, W.C. G. F.

[75418.]—**Dust Fuel.**—Dust fuel can be burned in ordinary boiler furnaces, especially where they are fitted with what are called mechanical stokers; but I think the best plan is to mix the dust fuel into a plastic mass with tar or some other combustible—say, to the consistency of putty—and then put that on the fire in shovelfuls at a time. Where the dust is used by itself as dust, it is necessary to have a bed of, say, coke, on which to place it. Bilston.

[75427.]—**Pyrometers.**—There is a useful letter on p. 71 of this volume about pyrometers, and Messrs. Bailey, of Salford, issue information about them in their lists. Wrought iron, at a "bright red," is rather warm, and it may be necessary to use pyrometers made of porcelain. If possible, the querist should read up articles on the subject in the encyclopædias, in back volumes, and procure the descriptive lists from makers of pyrometers. Nun Dor.

[75428.]—**How to Make a Violin.**—If this querist will examine a lot of violins at a wholesale dealer's, he will find that some have the backs in one piece; but whenever the backs are jointed, the grain of the two pieces invariably "breaks joint," so to speak. I do not see how there can be any other "reason" than that of taste. Capital violins can now be bought for 4s. 6d. each, if you are lucky enough to pick out a good one from a lot, for, though all made in same mould, they are not all alike. Pag.

[75438.]—**Small Lathe.**—This question is addressed to Mr. Bottone, but I do not think it has been answered. Of course an electro-motor can be made to drive a watchmaker's lathe; but I think, on the score of expense as well as of trouble, the querist would do better to drive his lathe in the usual way. X. T.

[75443.]—**Air-Pressure.**—Air can be used instead of steam to drive the engine, but the exhaust ports must be kept warm, or they will freeze up. The querist must experiment for the rest. Video.

[75446.]—**Distilling.**—Coffey's still was illustrated many years ago in this paper, and no doubt all necessary details as to size can be obtained from the makers, and as to regulations for use in the Channel Islands from the Receiver-General of either Jersey or Guernsey. I did not know that water was used to ferment saccharine, so cannot answer that question. R. S.

[75510.]—**Model Electro-Motor.**—To Mr. Bottone.—As you described for making four-poled instead of two, I have worked out your kind instructions, and have tried various alterations, but not successful in making it to work. I have made the four poles with bobbins, and joined them in pairs to four-part commutator-brushes at right angles. I observe that the brushes are connecting the two opposite poles, by which, I consider, no electric current can pass. Please say where I am wrong, with a sketch for connections, will greatly help Somerset Lad.

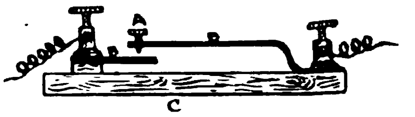
[75573.]—**Stable Fittings.**—During my decade of experience in fox-hunting, and previous to my agricultural pastime, the heaps in the farmyards of straw and dung thrown out, partially urine-soaked under the unguttered eaves, repeatedly drew my attention to one of the main causes of Great Britain's agricultural poverty. As an experiment, early in September I covered a loose horse-box, 8 yards square, with spent tan, 6in. deep. In that stable, in the centre of a town and adjoining a leading street, I kept one of my hunters until the following April. Every morning the dung was spread about, and once or twice a week several wheelbarrow loads of tan were scattered on the surface. No urine ever reached the flagstone floor—no smell, except that of the tan, was ever to be detected, not even when that Augean stable was cleaned out of its seven months' accumulations, amounting to I don't remember how many cart-loads of the very best fertiliser I ever met with, excepting the waste liquor of the gasworks which I used to cart on to my clover sward. To "Sigma."—Was it not the urine of the depastured animals that altered the character of the herbage of the Australian pastures, &c., of which you wrote in "Ours" some years ago?

The Lydney Dispenser.

[75602.]—**Speed of Milling Cutters.**—Before asking this query, I searched through my English Mechanics as far back as Vol. XL., and found nothing to aid me except in Vol. XLVI. p. 132, where it is said, "Speed of cam-cutters quite fast for cutting, and feed slow for finishing. Cast-iron for cutter ½in. diam., 150 revolutions per minute, and, for the feed, 200 or more to the inch." Now, this gives about 40ft. per minute at the periphery of cutter, and at about that speed I spoiled the edge of a cutter twice by running it on soft steel. Some definite information on this subject might save me and many of your readers much trouble and vexation—viz., best speeds for cutting steel, wrought iron, cast iron, brass, gunmetal, &c.; also if something about speed of, and proper directions for, feeding were thrown in, it might be very useful. If this information is published, I shall be glad to know where I can get it. Acier.

[75604.]—**Lubricant for Rubber.**—Ordinary blacklead makes a good lubricant for solid articles like rubber. W. J.

[75610.]—**Electric Fire Alarm.**—You will find it rather difficult to construct a good sensitive one yourself; but the annexed sketch shows a fairly good one, and of simple construction. A, regulating screw; B B, brass or copper strip; C, wooden base. A good one may be bought for 6s., consisting of an ordinary mercury thermometer with a platinum wire inserted in the top of the glass tube and one in the bottom to connect your wires to. When the mercury rises with the heat and reaches the desired temperature, it touches the top wire and completes the circuit and rings the bell. These are bought regulated to any desired temperature. To adjust the one in sketch, immerse it in water of the required temperature, and adjust the screw A until the bell rings. C. V. V. F. B.



[75612.]—**Interest.**—The answer by "Too Much for the Whistle" is the correct one, as I have ascertained by trial. Will he or others kindly inform me if he can show how to obtain the value of y in his equation otherwise than by trial? What I want is to obtain a formula which I can apply to several cases I have come across, and thus obviate the tedious process of trial. DISCERE CUPIO.

[75612.]—**Interest.**—"Too much for the Whistle" has given the only approximately correct solution to this query. I understand him to say that 10¾ per cent. compound interest per quarter is the rate really paid. This, by the way, would amount to rather more than 49 per cent. per annum. I have made the actual calculation with quarterly rests and payments of the instalments, and I find that after the fourth payment of £40, the balance remaining due is £36 12s. 6d., which, with another quarter's interest, would produce £40 9s. 5d., being 9s. 5d., more than required. This is very approximately accurate; but the explanation of the method of solution is far from lucid. The general equation given—

$$Ay^n - b\,(y^{n-1} + y^{n-2} \;\ldots\ldots\; y^2 + y + 1) = 0$$

appears to be correct, and filling in the special values as suggested, it becomes—

$$150y^5 = 40\,(y^4 + y^3 + y^2 + y + 1) = 0.$$

But how is this equation to be solved? It involves the finding of the ratio and first term of a geometrical series, which Todhunter's Algebra, article 471, tells us cannot be done by any method thereinbefore given. Will "Too much for the Whistle" explain how *he* solves it? S. M. C.

[75612.]—**Interest.**—The answer to this query may be stated thus—equate the time as follows:—40 × 3 + 40 × 6 + 40 × 9 + 40 × 12 + 40 × 15 = 1,800. Then 1,800 ÷ 200 (amount of instalments = 9 months. It will therefore be seen that if the borrower had the option of paying the £200 in a lump sum, he would have to pay it at the expiration of nine months—i.e., he would pay just the same amount one way as the other, and neither lender nor borrower would be the loser by the different mode of payment. Then, 1st, if £50 be gained by £150, what would be gained by £100 in the same time? This may be said to percentage it; and, 2nd, if £50 be gained in nine months, what would be gained in twelve months. This may be said to per-annum it. So that we get the following general proposition:—

$$\begin{array}{l} 150 : 100 :: 50 \\ \;\;\;9 : 12 :: \end{array} \quad \frac{100 \times 50 \times 12 = 60{,}000}{150 \times 9 = 1{,}350}$$

$$= 44\cdot\dot{4} \text{ per cent. per annum.}$$

$$\text{Then } \frac{44\cdot\dot{4}\dot{4}\dot{4}}{4} = 11\cdot\dot{1}\dot{1}\dot{1}, \text{ and } 44\cdot444 - 11\cdot111$$

= 33·333 = £33 6s. 8d., or 33⅓ per cent. the borrower would have to pay for the nine months, or five quarterly instalments, or 6s. 8d. in the pound. Proof, £150 at 33⅓ per cent.:—
150 × 33·333 = 49·9995 or £50 interest + 150 = £200. Amount borrower would pay.
Wolverhampton. W. WITTON.

[75615.]—**Tempering Clay.**—The clay should be dug before winter comes on, and left in a heap all winter till the frost entirely disintegrates it. It should then be thoroughly ground, and if too fine, ground ashes should be added. The bricks must be made by machines, which probably you have not got, or have them driven only by hand. The cracks are due to having rather much moisture in the clay. W. J.

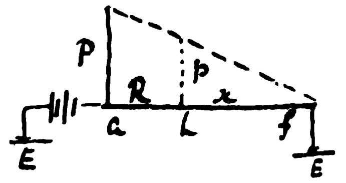
[75635.]—**Water Power.**—No; a water-wheel 20ft. diameter will not give more power than a wheel 12ft. diameter if the less wheel will take the water and meet the requirements of the fall. The larger wheel may possibly give out less power, on account of extra friction. You are quite wrong with your lever idea, as you do not take into account the resistance side of your wheel. Let the axle of the wheel represent the fulcrum of wheel or lever, and *r* the resistance 12ft. from the fulcrum, and *w* the weight, also 12ft. from the fulcrum; then, no matter how far the levers extend equally, *r* will always = *w*.
Todmorden. W. H. S.

[75664.]—**Model Electro-Motor.**—The number of reply to which I referred Mr. Bottone is 75510. SURREY LAD.

[75668.]—**Dynamo Getting Hot.**—You say that your brushes are not tight on the holders. Most likely they vibrate so much as to form an arc between themselves and the commutator. This would heat your brushes, and burn them away very soon. I found this from experience on a small dynamo of my own. J. T. B.

[75670.]—**Contents of Cylinder.**—Result incorrect. Gave formula too bad to work out, as I had no time myself in which to do it. Bad plan. SM.

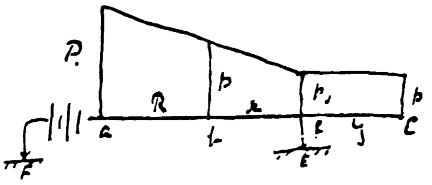
[75673.]—**Broken Electric Wire.**—(1) When the fault itself offers no resistance, the distance from the test end to the fault is $\frac{R}{r\,m}$. Where R = measured resistance from one end, $r\,m$ = resistance of the wire per mile. (2) By fall of potential, when the fault is "dead earth," the fall of potential due to a battery connected as shown in sketch, will be regular along the wire from the end *b* to zero at fault *f*. Let P *p* be the potential at



the parts *a* and *b*, separated by the resistance R, which is known. Then—

$$P : p :: R + x : x \text{ and } x = R\,\frac{p}{P - p}.$$

Where x = resistance of the cable *b f* to the fault.



(3) If fault is not dead earth, the equation becomes—

$$x = R\,\frac{p - p_1}{P - p}$$

where p_1 is the potential at the fault *f*. A. D. S.

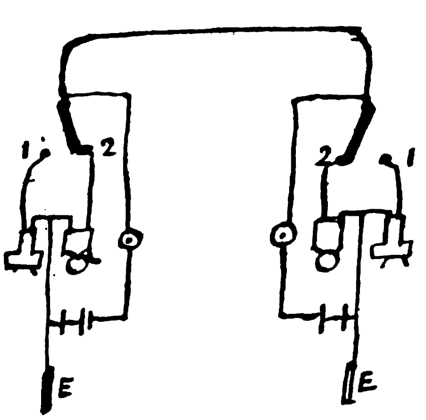
[75681.]—**Faust.**—The following are the lines required, from Anster's translation (Routledge):—

"See! all things with each other blending—
Each to all its being lending—
All on each in turn depending—
Heavenly ministers descending—
And again to heaven up-tending—
Floating, mingling, interweaving—
Rising, sinking and receiving
Each from each, while each is giving
On to each, and each relieving
Each, the pails of gold, the living
Current through the air is heaving;
Breathing blessings, see them bending,
Balanced worlds from change defending,
While everywhere diffused is harmony unending!"

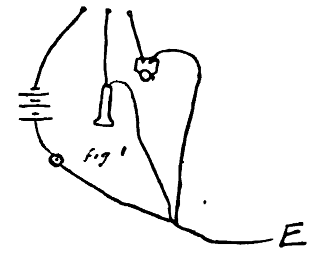
These lines were great favourites with the late Mr. Proctor, and no one who had the privilege of hearing them rendered by him would ever forget it. ARTHUR MEE.

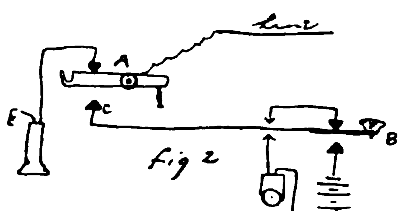
[75685.]—**Limelight.**—Since 123 grains of chlorate give 140c.in. of oxygen at 60° F. and 30in. barometric pressure, rather under 2lb. will be required to give 10c.ft. This should be mixed with ¼lb. of black oxide of manganese to facilitate the evolution of the gas. C. I. OHM.

[75686.]—**Bell and Telephone Connections.**—As you do not wish to use an automatic switch and three-contact push, I show connections according to your sketch. To work the line, say A wishes to speak to B. Place arm of switch in middle, and press push; replace switch on contact 2 for reply. B then replies in like manner. Afterwards both switch levers should be placed on contact 1 for telephonic conversation. When not in use, the circuit should be as shown in drawing. MICK.



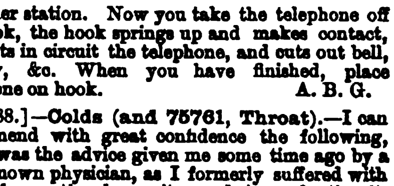
[75686.]—**Bell and Telephone Connections.**—You will have to use a 3-way switch, and connect up as Fig. 1 (sketch A). I should advise you to have an arrangement as per sketch B. An arrangement of this description acts far better. A (Fig. 2) is a piece of metal which works on a stud, and has a spring attached to the end to allow the hook to spring up and make contact on the telephone being taken off. B is a battery-key, or ringing-key. To work this, the telephone is on the hook, which weighs it down, and makes contact with C, therefore the connection is right for the other station to ring above station. Then to ring back, all that has to be done is for the key to be depressed that rings the other station. Now you take the telephone off the hook, the hook springs up and makes contact, and puts in circuit the telephone, and cuts out bell, battery, &c. When you have finished, place telephone on hook. A. B. G.





[75688.]—**Colds (and 75761, Throat).**—I can recommend with great confidence the following, which was the advice given me some time ago by a well-known physician, as I formerly suffered with colds of exceptional severity, and since adopting it, now for nearly three years, I have not known what a cold is—viz., to always take care and have your sitting and bedroom windows open at least 4in.—more if you can stand it—all the year round, night and day, in all weathers. No doubt some of our readers will laugh at this—I did at first; all I can say is, let the incredulous try it, and they will soon alter their views on the subject. As a rule, as soon as ever the weather becomes the least bit chilly most people close up their windows, draw thick curtains around them, and shut out every bit of fresh air and literally roast themselves in a room, the air of which becomes fouler the longer they sit in it, and it is the inhaling of this bad air which produces colds, coughs, sore throats, bronchitis, and other pulmonary affections which are erroneously attributed to the cold weather. LEVER.

[75689.]—**Accumulators.**—To find out this, you must know the resistance of the dynamo. Let r be the resistance of the dynamo; your 10 cells will give at the most 22 volts. As the current is 12 ampères, which will be a fair charging current, $12r$ volts will be absorbed in the machine; so total E.M.F. = $55 + 12r$. Volts available to read 12 ampères will be $55 + 12r - 22 = 33 + 12r$. If your total resistance in circuit does not exceed $\frac{33 + 12r}{12}$ ohms, the dynamo will charge the accumulators. Put an ammeter and switch in circuit, and run the dynamo so as to give 12 ampères, then rapidly switch on the cells. Watch the ammeter, and if the current begins to reverse, break the circuit at once; as if the dynamo reversed, the armature would be burnt up and the cell destroyed. On no account put on the cells until the dynamo is giving 12 ampères. AMPERE C. J.



[75689.]—**Accumulators.**—As machine gives 12 amps at 55 volts, the E.M.F. is 67 volts, i.e., assuming resistance of machine 1 ohm. Taking the E.M.F. of cells as 22 volts, there is a remaining

E.M.F. of 45 volts. Hence, if the total resistance (dynamo, cells, leads, &c.) does not exceed 3 ohms, the machine can be used. The dynamo running with the external circuit open must on no account be switched directly on to the cells, or reversal would take place, the dynamo would then help to discharge the cells, and great damage would be done to both. To charge, start machine, close external circuit with suitable resistance, and when 12 ampères at 55 volts are indicated, quickly switch on the cells. As, however, a small addition of resistance may cause reversal, there should be an arrangement to break the circuit when too little current flows, by using magnetic attraction in opposition to gravity. With this and care there is not much danger. C. I. Ohm.

[75696.]—**A Stopping for Electro-plating.**—Any hard copal varnish will do. I use what is known as hard carriage varnish. Colour it with a little rouge, so that you can see what parts of the article you varnish, and let it get thoroughly dry before you put it in vat. The above will not stand hot cyanide solutions.

Brighton. T. C. Smith.

[75697.]—**Heating Workshop.**—In our works we use stoves with coke, and find them quite warm enough for winter. Ernalfpar.

[75698.]—**Poster Writing.**—When visiting Lowestoft, some weeks since, I saw a notice of the regatta being hand-painted in rainbow tints, which looked very pretty. I cannot now remember name attached. A letter addressed "Secretary, Regatta Committee, Lowestoft," I should think, would bring name and address, with particulars. Wish I could give more assistance. Ernalfpar.

[75710.]—**Preserving Oak Posts**—Steep the ends in creasote, or just as good, char them slightly. Stockholm tar is obtained from pines by destructive distillation. W. J.

[75710.]—**Preservative for Wood.**—Boiled linseed oil, mixed with finely-crushed charcoal to the consistency of paint, is the most effectual preservative known, I believe; but I cannot tell him if it would be less expensive than paint; but if not, it would surely pay him best in the end.

Mrs. Chambers.

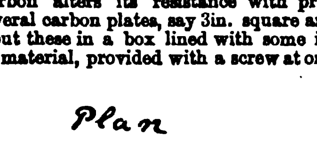
[75711.]—**Eucalyptus Oil.**—You can only use it as an emulsion in hot water. Fir-tree oil is a distillate used for exterminating vermin. W. J.

[75711.]—**Eucalyptus Oil.**—An antiseptic of great value; a leading dentist has prescribed this as a wash for the gums to a lady of my acquaintance who has used it for two years. It appears to be only the oil, diluted with alcohol, and mixed with distilled water. I only know fir-tree oil as an insecticide used by florists. I have had circulars sent to me by nurserymen describing its merits for cleaning the foliage of house-plants. Any of the essential oils dissolved in spirits will mix readily with water or soapsuds; by the latter mode I often make a pleasant toilet lather. Eos.

[75718.]—**Adjustable Resistance.**—Would a water regulator such as is used with induction coils suit your purpose? If so, you will find instructions for making in back numbers of "Ours."

Brighton. T. C. Smith.

[75718.]—**Adjustable Resistance.**—A very simple form may be made, depending on the fact that carbon alters its resistance with pressure. Take several carbon plates, say 3in. square and ¼in. thick; put these in a box lined with some incombustible material, provided with a screw at one end, pressing against a metal plate to prevent breaking carbons. The current enters by this screw and leaves by another metal plate, which may be inserted between the carbons where desired (not shown in sketch). This arrangement gives a large range. C. I. Ohm.



[75720.]—**Lifting-Power of Air-Propeller.**—

(1) $\text{I.H.P.} = \cdot000016\, V^2 A p.$

Where p = pressure of blast caused by fan;
A = area of the sum of the tuyere in square inches;
V = velocity of tips of fans in feet per second.

(2) Molesworth's "Pocket-book of Engineering Formulæ," 4s. 6d. A. D. Southam.

[75721.]—**Red Spot on Jupiter.**—This object ought to be nicely visible in a good 6in. telescope about the following hours in the evening: Nov. 14th, 6; 15th, 12; 16th, 8; 17th, 4; 18th, 9; 19th, 5; 20th, 11, and so on. Arthur Mee.

[75721.]—**Red Spot on Jupiter.**—If "Eta Argus" is a member of the British Astronomical Association, and will send a stamped envelope to the director of the Jupiter section of the above Association, there is little doubt but that he will receive a copy of the monthly ephemeris of the passage of the red spot over the central meridian of Jupiter's disc. The director is the Rev. W. R. Waugh, F.R.A.S., The Manse, Portland. X.

[75724.]—**Alabaster.**—I have just finished turning a small vase, about 6in., thin and hollow, within ¼in. of base. It wants a good sharp tool, such as is used for ivory. Care must be taken not to catch your tool, as it is very brittle. Mine was foreign or Italian alabaster, which is chemically carbonate of lime, the English alabaster (inferior in appearance) being sulphate of lime. The dust (not shavings) will not hurt the lathe save by clogging it and requiring the use of paraffin before re-oiling. Polish with putty powder same as ivory. But ivory is far to be preferred for turning. Z. Y. X.

[75727.]—**To "Sm."**—In the first place, the conditions are impossible. Secondly, assuming them possible, the potential of the drop would increase as its volume decreases. When no water was left, the electrical charge would remain upon the non-conductor. Sm.

[75728.]—**Wheel-making.**—To "Grosby."—The small size of your wheels in wood does not justify the amount of labour. The easiest way is to drill holes in hub, make round tenons on end of spokes, and glue in. Sheffielder.

[75728.]—**Wheel-making.**—To "Grosby."—I have never heard of a machine for cutting the holes in the hubs of wheels; but if "Grosby" will communicate with me, I shall be happy to do them for him. I am making a similar model, with wheels the same size as "Grosby's," and if he is working from the directions given in the *Boys' Own Paper*, I can also supply him with some of the castings, also some of the fittings, such as springs, &c., necessary in such a model, as I have most of mine already finished, and also have the patterns and core-boxes by me. I have advertised my address in the Address Column if "Grosby" cares to communicate with me. B. and P.

[75731.]—**Motion for Equatoreal.**—"A.S.F." is in same fix as I was formerly. If he will give me his address, I will send him particulars of the mode in which I met the difficulty. Fear, Mr. Editor, it would take up too much of your valuable space, and not be very interesting matter for your general readers, were I to send it.

Borrowash, near Derby. R. J. Newcomb.

[75732.]—**Silvering Mirror.**—No accidents have, to my knowledge, ever happened, as the fulminate is in solution only. Sm.

[75734.]—**Alabaster.**—Holtzapffel's "Turning and Mechanical Manipulation" contains full information on this subject, too lengthy to transcribe. Derby used to be the chief seat of this industry in his time; but Italy has long ago been noted for the best quality of material and workmen. As no mention is made in the above book of alabaster dust being injurious to lathes (Vols. I. and III.), I should think that, with common care, such cannot occur. Eos.

[75735.]—**Galvanometer.**—To Mr. Bottone.—Although it is possible to make connections of coils by soldering to brass frames, yet I always avoid so doing, as it increases the tendency to leakage. The best way is to wind all the fine wire on one frame, say the left-hand one, and connect the two ends of wire on to the left-hand terminal, and the other to the central terminal. Then start winding the other frame on bobbin with the coarse wire, starting also from the centre terminal, winding in the same direction as the fine wire was wound, and carry the ends of the coarse wire to the right-hand terminal. In this way you will have the low resistance or quantity coils in action, when you couple up right-hand and central terminal; you will have the high resistance coils working when you connect the left-hand and central terminals; and, lastly, you will get the highest resistance when you couple up the two outer terminals. S. Bottone.

[75736.]—**Henley's Quadrant Electrometer.**—It is neither desirable nor necessary that the brass portions named should be solid.

S. Bottone.

[75737.]—**Arches.**—The expression 30 − 10 × 2 stands for 30 − (10 × 2) = 10. If it were otherwise it would be written (30 − 10) × 2 = 20 × 2 = 40. A. D. Southam.

[75741.]—**Magnetic Attraction.**—The pull will be at right angles to A B, and the force will vary inversely as the square of the distance.

A. D. Southam.

[75741.]—**Magnetic Attraction.**—If the pendulum bob were of iron, or other magnetic metal, and poised so as to be exactly at equal distance from either pole of magnet—a thing, by the way, not easy of attainment—the resultant attraction would be in a line with the swing, and would tend to bring the bob at rest between the poles. Were the bob ever so little out of the centre of attraction, then it would be pulled at right angles to the line of swing, towards that pole to which it happened to be nearer. If the bob were of a non-magnetic metal, electric current would be set up in it, the tendency of which would be to check the motion: so that in any case the effect of the magnet would be retardation of movement.

S. Bottone.

[75744.]—**Engine Flywheel.**—The diameter of the flywheel is generally 3½ to 4 times the length of the stroke, which in your case is 4 × 2 = 8in. diameter. Calculate H.P. by the usual formula, which was given only last week.

A. D. Southam.

[75746.]—**Electric Alarum.**—You can easily arrange the clock so that when the alarum had run right down it closed the circuit of the lamp and battery. As regards the battery, you could have a bichromate; but what would be very much less trouble would be about six of the six-block agglomerate Leclanchés. This, however, would hardly run for ten minutes without a rest, as the brilliancy of the light gradually decreases owing to the E.M.F. falling. I have a battery in constant use for a similar purpose, and, when the light begins to drop, switch on an extra cell or two. F. C. Allsop.

[75748.]—**Flattening German Silver Wire.**—Take your wire to a working jeweller—a genuine one; he will put it through the flatting mill. This will both flatten and harden it at the same time.

R. G. Mason.

[75749.]—**Nickel Plating.**—To every four gallons of solution add 3lb. of double salts of nickel and ammonia, three quart cells Bunsens. Read "The Electroplater's Handbook." Unless you have steam power to prepare and finish work, send it to a practical plater: it will save you time, money, and disappointment.

Hammersmith. W. Wade.

[75749.]—**Nickel Plating.**—To prepare iron, clean in the following solution: Nitric acid 2 parts, HCl 2 parts, and H_2SO_4 8 parts; water 100 parts. For cast iron the proportions are: 3, 3, and 12, to 100 of water. For solutions see reply 75695, p. 249. The weight of nickel deposited per ampère hour is 1·0953 grain. Connect up Daniell cells in parallel, and work from 0·5 to 1·0 volt; also buy or borrow a good textbook on electro-metallurgy. A. D. S.

[75753.]—**Papyroxyline.**—To Mr. Bottone.—The following proportions will be found to give good results:—Oil of vitriol, s.p.g. 1·845, at 60° F., 18fl.oz.; nitric acid, s.p.g. 1·457, at 60° F., 6fl.oz. Let the solution be cold when used, and the paper quite dry. I don't think you could use millboard for immersion in the acids: I am afraid the action would be only superficial; better join several sheets together, after preparation, by means of good shellac varnish. S. Bottone.

[75755.]—**Water-Colours.**—Glycerol will arrest the drying-up of moist colours. Sm.

[75755.]—**Preserving Water-Colours.**—If J. A. Bellringer, before moistening his water-colours, will agitate the water he intends to moisten them with in a small bottle with a few drops of a one to one mixture of glycerine and creosote, which he can obtain at any chemist's, I think he will find that no mouldiness will afterwards appear.

A. E. B.

[75755.]—**Preserving Water Colours.**—Water colours are sold in three forms—in cakes, tubes, and pans. The two former will keep good an indefinite time; the last for two or three to several years, depending on their nature, and are consequently practically always ready to hand. When hardened by age, a little water, or a drop of glycerine, left upon them will generally restore them more or less to their pristine condition. It is not clear whether it was a dry cake, or a pan of hardened moist colour, that was inclosed in an air-tight vessel containing water—most probably the latter; but whichever it was, mouldiness on the colour would presumably be the result. The colour contained in the tubes is somewhat more fluid than that in the pans; but on exposure to air it soon hardens, and assumes the same consistency. If J. A. Bellringer only requires to use colours at long intervals, these offer to him the most convenient form in which he can buy them, as he need only squeeze out into a pan sufficient colour for the work in hand.

G. G. B.

[75761.]—**Throat.**—Diet would probably have little to do with your sore throat; moderate smoking would be rather beneficial than otherwise. The discharge from your throat apparently requires diverting; try very small doses of purgatives taken daily, so small as to produce no appreciable purgative effect, such as powdered rhubarb or sulphur tablets, or even a much-vaunted curative syrup; and at night time apply a stimulating liniment such as opodeldoc or turpentine to the outside of the throat. The occasional use of a gargle of water with a pinch or two of powdered alum dissolved in it might also assist. A. E. B.

[75761.]—**Throat.**—Try compressed tabloids of potash and borax. Any druggist. Sm.

[75761.]—**Throat.**—Cocoatina in place of tea and coffee; one or two red-gum lozenges daily for a week or two; dry and warm feet; wool collar and shirt in place of cotton; sponge chest and throat on rising, and dry. This had best be commenced in summer. Salt-in-water gargle daily.—Hints from "Relaxed Throat." No Sig.

[75761.]—**Throat.**—Try the "Voice Tabloids" of Burroughs and Wellcome, sold in small tin boxes at about 1s. each, by all good chemists. I, and many others, can swear to their efficacy. Place one of these tiny lozenges on the root of the tongue, and let it slowly dissolve there. Never fail to do this on going to bed, and after washing your throat by gargling with very cold water at an early hour when you rise. They are composed of cocaine, chlorate of potash, and borax. At first you can carry one, as above described, all day between meals, making about four per diem. In very foggy weather, a lump of loaf-sugar steeped in good whiskey, and held in the throat, removes hoarseness. Eos.

[75761.]—**Throat.**—In my younger days, I was troubled as you are. I put myself under several medical men, and got relief from some of their treatment. Cure came at last from one, who told me I had run down generally, and wanted toning up. He made me feed well, no stimulants, take plenty of out-door exercise, and gargle my throat frequently with the following:—Sulphate of quinine, 12 grains; water, 1 pint; hydrochloric acid, 12 minims. In less than a month all trouble ceased. Please note that the tendency to grunting and clearing the throat is a habit that grows on one, and is often sheer nervous irritability; and the more it is indulged in, the more irritation is produced. S. Bottone.

[75761.]—**Throat.**—Gargle morning and evening with tepid water containing salt in solution, made with half-tablespoonful of salt (as we have on our table) dissolved in a tumbler of water. During the night, each time you awake, eat a lump of sugar on which you have poured not more than six drops of spirits of camphor. You can, and will, get it at any chemist (3d. an ounce). You should eat during the night not less than four such lumps. Wrap your throat before retiring with a slice of fat (from salted bacon), and fasten it on spot corresponding to pain with a woollen bandage. When you rise in the morning have some warm soap-water ready, and rub the neck well with it as soon as you take the bacon fat away and dry well, and don't wear woollen tie. If there be no relief in a day or two, put some pure spirits of camphor in an egg-cup, dip in it your mid-finger, and touch each side of top of throat inside; it will smart a little, but be quickly over. You might chew some pomegranate rind and swallow the juice. Take a foot-bath twice a week, with addition of soap and soda crystals—2oz. of soda crystals. Wear woollen stockings, and keep feet dry. You can also rub the throat outwardly with salt water, and occasionally with spirits of camphor. You will find this a very good remedy, not poisonous or irritating.

Raspatiste.

[75762.]—**Stone from Signet Ring.**—Push stone out from back with end of file handle; if hollow ring, stone must be pulled out from the front, with a pulling-stick made from beeswax, powdered charcoal, and short hairs; mix well together with gentle heat, roll into a stick; when cold, press end on face of stone, and pull.

Hammersmith. W. Wade.

[75763.—**Screw-Cutting.**—"Young Blacksmith" can replace his wheels for screw-cutting by the following formula. Let S = the number of threads per inch in leading screw, and N = the number of threads per inch required to be cut, and d the driving-wheel, and c = the driven wheel. Then $\frac{d}{c} = \frac{1}{N} \times S$ will give the wheels required. Example: Suppose the leading screw has four threads per inch, and we require to cut a screw with nine threads per inch, then the wheels required will $= \frac{1}{9} \times 4 = \frac{4}{9}$. The numerator of the fraction gives the driver, and the denominator the driven wheel. Any number taken as multipliers will give the wheels required. Thus $\frac{4}{9} \times 4 = \frac{16 \text{ driver.}}{36 \text{ driven.}}$ If the pitch is more than 1in., say $1\frac{1}{8}$in., reduce to improper fraction by multiplying the integer or whole number by the denominator of the fraction, and add the numerator. Thus, $8 \times 1 + 1 = \frac{9}{8}$; then proceed as directed above. I think you will be able to construct a table of change-wheels from what has been said, and then you will see what wheels you are short.

Todmorden. W. H. S.

[75764.]—**Batteries.**—To Mr. Bottone.—Your cells are dry cells, and want recharging, as described by me a few numbers back. Graphite is the hard scale which forms inside the gas retorts. You can get it from the gas-works under the name of "retort scurf." The price of all incandescent lamps from 2½v. to 110v. is 5s. each (see my advertisements and lists). Every Leclanché cell, be it dry, agglomerate, or ordinary type, gives about 1½ volt. Hence 4 cells equal 6 volts—enough to light a 2½c.p. lamp. You will not gain anything by increasing size of zincs. S. Bottone.

[75766.]—**Paint for Boiler.**—Recipe for black varnish:—Fuse 6oz. of asphaltum (Egyptian), and when liquid, add 1oz. shellac and 1 pint of turps. A. D. S.

[75769.]—**Dynamo.**—It would certainly not improve a dynamo to bare half its cores and heap up the wire on the remaining half space, because, as you get farther from the core, the inducing effect of the current becomes less, almost inversely as the square of the distance. S. Bottone.

[75770.]—**Magnetised Watches.**—The chances of a watch being affected while riding on an electric railway are so very remote that no trouble from this cause need be anticipated. F. C. Allsop.

[75770.]—**Magnetised Watches.**—The current carried by the rails would not affect your watch. But if you are in the proximity of the electro-motor itself, your watch will probably feel the effects. However, even this can be entirely prevented by putting it into a small tinned-iron box, such as a small blacking or tack box. S. Bottone.

[75770.]—**Magnetised Watches.**—Yes, a watch *may* get magnetised by being moved near a powerful magnet or in the close neighbourhood of a current. This induces magnetism, and causes the delicate coils of the hair-spring to cling together, rendering the watch useless as a timekeeper, until the fault is repaired, which can sometimes be done by separating the coils with a pin. I may add that I wear a common 8s. 6d. watch when at work, and although I have constantly bent over and examined dynamos when in motion, no damage has been done. A. D. Southam.

[75771.]—**Influenza.**—To "The Lydney Dispenser."—The symptoms described by you are certainly more akin to hay-fever than to influenza. S. Bottone.

[75772.]—**Leclanche.**—(1) Hardly worth the trouble, at any rate, with the porous pots; you might take the zinc rods out. (2) The battery that is used continually will be exhausted first.

F. C. Allsop.

[75772.]—**Leclanche.**—If a battery is to be used only two months out of twelve, it would be better to dismount the battery altogether and wash and dry the parts until again wanted for use. Of the two batteries, one of which is constantly in use and the other only occasionally, this latter would naturally last much longer. S. Bottone.

[75772.]—**Leclanche.**—Unless the battery is kept in an unfavourable position, where there is chance of the current leaking from wire to wire, very little is gained by withdrawing elements after use. This is the chief advantage of the Leclanché. Of course, the more often a cell is used, the sooner it will run down; but, practically, no action takes place in this cell on open circuit. F. Askew.

[75772.]—**Leclanche.**—1. Undoubtedly your zincs would be, if washed and dried, better out of the solution when the cell is not in use; the porous pot and its contents are better left in than taken out. 2. *Cæteris paribus*, the Leclanché cell in frequent use will be first exhausted, although, I believe, the amount of zinc actually expended usefully is very small, for the reason that it is slowly dissolved even when the battery is not in use, compared with that which is, though very slowly, yet continuously, being dissolved when the battery is not in use. A. E. B.

[75772.]—**Leclanche.**—(1) Under the circumstances stated, it would be advisable to take the porous cell and zinc out of the solution, as the sal-ammoniac is very apt to creep and short-circuit the cell; also the zinc will be eaten away (although very slowly). (2) The life of a battery depends on the amount of work done: the cell used the least should last the longest; sometimes, through some fault, local action will set up and wear the battery, whilst, apparently, very little or no work is done. H. H. Headworth.

[75775.]—**Voltmeter.**—To Mr. Bottone.—Use about 1oz. No. 40 German silver. Calibrate by means of 50 Daniells coupled in series. 2. Because the resistance of secondary is so great that only an infinitesimally small current passes. 3. Taking the E.M.F. of the bichromate cell as 2 volts, and the resistance of No. 20 B.W.G. copper wire at 2 ohms per pound of 80 yards, it follows that as the resistance of a pint bichromate is only ·08 of an ohm, it would force an ampère through nearly 1lb. of the said wire. S. Bottone.

[75777.]—**Bell Telephone.**—To Mr. Bottone or Mr. Allsop.—Microphones can be, and are, used with the above; with the gain of increased delicacy in speed, and greater distance speaking power, No. 38 is quite fine enough. It is better to paraffin the bobbins by letting them soak in melted paraffin wax until no more bubbles are given off.

S. Bottone.

[75777.]—**To Mr. Bottone or Mr. Allsop.**—A microphone (if of the right kind) will considerably increase the loudness of the speech. The magnet should be wound with No. 40 B.W.G., or even a size smaller, to a resistance of about 70 ohms. The silk covering is in most instances sufficient, but paraffin wax would improve the insulation. See the articles on the construction of microphones which recently appeared in the "E. M.," or my book, "Telephones: their Construction and Fitting." F. C. Allsop.

[75782.]—**Electro-Plating Bath.**—The strength of the cyanide has evaporated. Add distilled water to make up the 2½ gallons, and 2 or 3oz. of fresh cyanide; stir and filter. Silver can be precipitated with sulphuric acid (this should be done in the open); collect and melt. W. Wade.

[75784.]—**Making Dynamo to Fit a Ring.**—To Mr. Bottone.—Make the Manchester type machine, with tunnel 3in. diam. 1½in. deep, wrought iron cores 3in. high, 1in. diam. Put 1lb. No. 22 on the armature, and 4lb. No. 26 on the field magnets. Connect up in shunt. Probable output at 2,500 revs. per minute, 3 ampères at 25 volts to 30 volts pressure. Twelve sections on armature will be enough for so small a machine; 28in. wire much too fine. Full particulars, with sketches, in my book, "The Dynamo," seventh edition. S. Bottone.

[75786.]—**Cart Grease.**—Boil together 1½cwt. tallow and 1¼cwt. palm-oil. When boiled allow to cool to about 100° Fahr., with constant stirring, run through sieve into solution of ½cwt. of soda and three gallons of water. Mix well. A. D. S.

[75788.]—**English Lever Watch.**—Your balance-wheel is out of poise. Place staff in calipers, the heaviest part of balance will fall to the bottom. File carefully rim of balance (inside) until of equal weight all round.

Hammersmith. W. Wade.

[75790.]—**Telescope.**—The misty appearance round a bright object that you see with your 3in. o.g. is owing to the o.g. having considerable spherical aberration, although the chromatic aberration may be corrected, and nothing you can do will cure it. You might reduce the aperture to 2½ or 2¼, and try again. I assume the o.g. is put together rightly, but if you like to send it to me I will test it for you free of charge. Of course, you can buy o.g.'s without fittings, but I expect the prices of first-class ones will surprise you.

Ramsgate. J. C. Linscott.

[75794.]—**Gun-Metal Castings.**—Put your castings in a box, or preferably, a metal cylinder. Put some pieces of common brick in with them, shake them violently for some time—this will clear of all sand. R. G. Mason,

Manufacturing Optician, 69, Clapham Park-road,
London, S.W.

[75795.]—**Grinding and Cutting Gunmetal**—"Cyrus" can safely utilise all the emery-whee he can for brass and gunmetal; the wheel in question should run very fast, say 1,000, also be very true. Sheffielder.

[75798.]—**Induction Coil.**—The primary, most likely, leaks—that is, the current, instead of traversing the whole of the primary, leaks from coil to coil. Take off one end of coil, and try to remove primary iron bundle as well. Now soak for some time in melted paraffin. If, after this, your coil still refuses to work, unwind primary, and look for bad places. Rewind with four layers of 24s.c. wire. F. Askew.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75222. Leyden Jars, p. 46.
75233. Folding Mètre Rules, 46.
75237. Photographic—Blue Prints, 46.
75238. Testing Rape-seed Oil, 46.
75244. Catenary Curve, 46.
75249. Japanning Round Wire, 46.
75250. Japanning, 46.

75410. Xylophon, p. 141.
75430. Overshot Water-wheel, 141.
75432. Fusee of Spring Clock, 141.
75440. Registering Earth's Magnetism, 142.
75442. Enlarging Lantern, 142.
75454. Making Platinum and Zinc adhere to Glass, 142.
75458. Altering Halse's Medical Battery, 142.

QUERIES.

[75800.]—**Cleaning Copper Utensils.**—Is there a practical way of cleaning off old copper utensils for re-tinning, without using sulphuric or other acids giving off noxious or unhealthy vapours?—CHARLES.

[75801.]—**Scroll-Chucks.**—I have several scroll-chucks which require new jaws, and one a new scroll also. I have good self-acting and surfacing lathe. Will "J. H." or "F. A. M.," or any other practical reader tell me how to cut the scroll teeth on chuck jaws? Also the way tool-makers do this job. I am a practical hand, but this is a fresh job to me.—FRED COYNE.

[75802.]—**Tangent Galvanometer, &c.**—When the above does not give equal deflections on each side of the zero line for equal currents, can the fault be remedied by changing the position of the pointer relatively to the needle, or how? Is there any objection to using a fibre suspension for the needle? It does not seem to be often done. In an astatic galvanometer of many turns of No. 36 wire, is the magnetism of the needles changed every time a current is sent through?—if so, does it affect its accuracy and delicacy?—H. G. D.

[75803.]—**Red Heat of Iron.**—Will someone kindly inform me the number of degrees of temperature, either C. or F., of red-hot iron.—KENT.

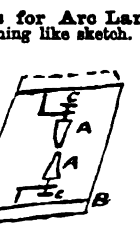
[75804.]—**To F. C. Allsop.**—Would Mr. Allsop kindly tell me how to connect up the receiver to the transmitter without the coil, also the running wires and battery? Are they connected to each transmitter? If so, what terminals? It is only from one room to another in the house, and will not need the coil.—PHONO.

[75805.]—**Centring Short Lengths of Steam Pipe.**—Will some reader please give a good way of centring short lengths (2ft.) of 2in. steam pipe in lathe for cutting thread? At present I let in a piece of iron at each end, and then square centre; but want a fresh piece of iron every time.—MECHANIC.

[75806.]—**Hydraulics.**—Can anyone give me a rule for finding quantity of water that will flow through any pipe at any given pressure? For instance, what quantity will flow through a ¾in. pipe at 40lb. pressure, the length of pipe being short—say 10ft.?—H.

[75807.]—**Reflector for Incandescent Lamps.**—What is best reflector for hanging incandescent lamps? NORFOLK AMATEUR ELECTRICIAN.

[75808.]—**Batteries for Arc Lamp.**—I have a small arc lamp, something like sketch. A, carbons; B, stand; C, screws for altering carbons. What batteries (number, &c., of cells) shall I need use for this?—NORFOLK AMATEUR ELECTRICIAN.



[75809.]—**Single-Stroke Bell.**—What batteries of how many cells shall I need to work this, and can I use a Morse key for this, or an electric bell push?—NORFOLK AMATEUR ELECTRICIAN.

[75810.]—**Screw-Cutting.**—Having some fine square-thread screws and nuts to cut on ¾in. steel spindles, will any practical mechanic oblige by letting me know the best way of setting the lathe, so that the following cuts will follow exactly after the first cut, as I find it difficult in doing so? and, likewise, the best way to screw nuts to fit screws? The lathe is a 5in. centre foot screw-cutting one.—B. SMITH.

[75811.]—**Motor for Model Electric-Railway.**—To MR. BOTTONE.—I intend making a small electric-railway, having an engine 2ft. long. The motor I have chosen is one of the Manchester type. Would you kindly tell me the sizes of the F.M's., and of the armature respectively, and also the amount of wire required for each? Would 6 volts be sufficient to work it, or would I require more? I should like the motor to be as powerful as possible.—MOTOR.

[75812.]—**Electrical.**—Will Mr. Bottone tell me the best charge for a 4-celled box-battery, carbon and zinc, to light a 5c.p. lamp? And also tell me which is the most efficient battery, a double fluid or a single fluid, for incandescent lighting?—GLENGALL.

[75813.]—**Telescope: Angle of View.**—A fence measuring 144ft. in length, at a distance of 4,700ft., was just covered in the field of my telescope. What would be the angle of view? Would some correspondent kindly show working by logarithms? Some fencing-wire, ·22in. diameter, was distinctly visible at same distance. Would this be considered good for a 1⅝in. o.g.? Taking the above as a basis, what distance would a rifle-bullet mark, ½in. diam., be visible on a target?—INQUISITIVE.

[75814.]—**To Mr. Bottone.**—I have thirty ebonite cells of the dimensions 4in. by 2½in. and 6in. deep, which I wish to convert into chloride of silver batteries. Will you please let me know the size of elements required and construction? also the number of hours constant work, probable voltage, and amperés? also if it would drive a motor and of what power?—ELECTUS.

[75815.]—**Hand Camera.**—I should like some fellow subscriber to give me a sketch, if desirable, to make a hand camera to take plates 5in. by 4in. I have seen the sketch of some in your issues this year, as cheap ones, but I want to make a good one to throw each plate to the focus front by turning a rack or knob, carrying about ten plates? Also which is the best R.R. lens, 5in. by 4in., I could buy? I don't mind it costing me £3.—BUCKEYE.

[75816.]—**Torsion.**—A magnet A suspended by a vertical wire without twist is deflected from the magnetic meridian, 30°, by turning the upper end of the wire half-way round (180°). How much from the zero must the top of the same wire be turned in order to place a magnet B, similarly suspended, at right angles to the magnetic meridian, if the moments of the magnets A and B are to one another as 2 : 3?—RAYMUR.

[75817.]—**Cement for Lamps, &c.**—I should like a tried receipe for fastening the burners to glass and porcelain petroleum lamps, also tops of ink-bottles to the glass wells.—CASENHEM.

[75818.]—**Ink.**—I want to make a quick drying oil ink which will not require constantly shaking to prevent the colouring matter falling to bottom. I have tried olive and almond oil with lampblack, but the black settles down in a day; it must be of the consistancy of cream.—CASENHEM.

[75819.]—**Incandescent Lamps.**—To MR. BOTTONE.—I have seen it stated that eight 5c.p. lamps can be made to give their full light with an E.M.F. of only 9 volts. Will you please say if this is so?—and if true, what would be the resistance of the eight lamps, and what number of ampères would have to be passed through them? I understand they would be of low resistance, and connected in parallel.—AMATEUR.

[75820.]—**To S. Bottone.**—Following your instructions, I constructed a Fizeau's condenser, and connected the two lugs to the contact screw and platinum pillar of the medical coil. I am still unable to get a ⅛in. spark upon connecting the terminals of the secondary coil. Size of condenser, 9in. by 7in. Should a condenser work without noise? Putting my ear near it, I could hear a clicking sound as of sparks passing in it, and this always took place, even though I put several sheets of paraffined paper between each sheet of tinfoil.—A. B.

[75821.]—**Golf Balls.**—Could some of your readers give me some information about a machine for making and remaking golf balls?—C. J. P.

[75822.]—**Damaged Boiler.**—I have a semi-portable boiler, and the angle iron holding fire-box is badly eaten and leaky through standing in wet ashes. Can any reader tell me of some substance that would prevent leaking—say, fill up to first row of stays, betwixt fire-box and outside shell, and lift fire-bars accordingly.—BOILER SMITH.

[75823.]—**Electrical Temperature Indicator.**—Could any reader kindly inform me how to fit up an electric bell arrangement between my bedroom and an orchid house (about 15 to 20 yards apart) to warn me when temperature in said orchid house falls below 45° to 40° Fahr.?—F. W. V.

[75824.]—**Incandescent Light.**—I have been told that this light is very injurious to water-colour paintings by causing the colours to fade. Is this correct, as it seems rather curious it should possess this effect on them?—J. C. S.

[75825.]—**Tide Gauge.**—I should be glad if any of our obliging correspondents would tell me how to make a simple and effective self-registering tide gauge.—FOGHORN.

[75826.]—**Choosing a Pianoforte.**—I have no doubt that there are many readers of the "E M." who would feel obliged for some hints and suggestions as to chosing a piano; and I am sure that there are many of our talented friends who would willingly give them. How many octaves are comprised in a piano of full compass, and what other sizes are usually made? What are the advantages of an upright over a cottage? Is it best to have a trichord, iron or steel framing, and check action?—FOGHORN.

[75827.]—**Rusty Kettle.**—A recipe for removing rust in galvanised iron kettle, will oblige—NINE YEARS' READER.

[75828.]—**Double Launch-Engine.**—I am fitting up a double launch-engine, 4½in. by 4in. stroke, and wish to compound them by placing two large cylinders beneath the h.p., making them into a double tandem. Will some of your readers kindly give me size of l.p. cylinders, and also condenser required? What diameter the crank-shaft should be? How to make the stuffing-box between the h.p. and l.p. cylinders, as I want the top cover of the one to be the bottom cover of the other? Size of steam-ways, &c.?—NOVICE.

[75829.]—**Astronomical Telescope.**—I have a 4¼in. o.g. 44in. focus, which I intend using for a telescope. What size of diaphragm should I use, and what distance should it be placed from the lens? also, what sort of eyepiece should I use?—W. JAY.

[75830.]—**Dead Black.**—Would any practical optician or other give instructions for dead black for brass—not varnish, or anything liable to rub off; but similar to the beautiful even black so much admired on photographic-lens diaphragms, &c.? No information in back vols.—NINE YEARS' READER.

[75831.]—**Pyrography.**—Would some reader give a description and sketch of the tool used in pyrography, or burnt-wood etching?—S'IL VOUS PLAIT.

[75832.]—**Photo Micrography.**—Can any one give me a few hints as to the way by which I could photograph microscopic slides? Could I adapt a ½-plate camera so as to do this?—J. P.

[75833.]—**Brown Spots on Glass Photographs.**—I have several valuable photographs (mounted on glass) which are covered with brown spots caused by heat. Can anything be done to remove same?—AN OLD SUBSCRIBER.

[75834.]—**Electrical Water-Level Indicator.**—Will some one please tell me how to arrange an instrument that will show exactly the varying height of water in a tank quarter mile away? The method kindly suggested three months ago by Mr. Bottone is far too rough, the indications in that case depending upon the resistance of the water between the two plates. Kindly oblige with a rough sketch, or, better still, give the names of any books that have engravings and details of the desired apparatus, and greatly oblige.—M.M.I.So.S.

[75835.]—**Maquay Battery.**—Will Mr. Dale kindly give particulars of construction, &c., of this battery, which he so strongly recommends? I badly want a battery that can be used for lighting without the trouble of zinc amalgamation.—W. C. P.

[75836.]—**Balanced Swell Pedal.**—Can any reader give me a description of the above, or refer to No. of "E. M." in which it is described (if any)? I fancy I saw something on the subject some time since, but my indices are lost. Can an ordinary "recovering" or "hold-down" pedal be converted into a balanced one without much trouble?—DISCERE CUPIO.

[75837.]—**To Mr. Bottone.**—Which would be the best kind of iron to employ for the field-magnet of a 48-volt dynamo of the Simplex type, with Gramme armature? The machine is designed for running both incandescent and arc lamps. My proposal is to make the field-magnet of best malleable iron; but a fellow-student says this iron would not retain enough magnetism for the machine to be self-exciting, and advises me to use an ordinary good quality of soft cast iron.—ANGLO-SAXON.

[75838.]—**Sand Balls.**—I want to make some very fine sand into balls that will dry and hold together, and not crumble. I do not want to bake the balls of fine sand; and is there any thing or substance I could put into a bucket of water, then pour the water upon the fine sand, and mix the sand and water, and afterwards form the balls so that they would dry and become hard? That which is put into the water must be very cheap.—JOHN BENNETT.

[75839.]—**Old Bracelet.**—I have an old bracelet which is set with small pieces of some material like bone or wood, about the size and shape of half-acorns, which were of a red colour like coral; but the colour has worn nearly all off, showing the white or yellow substance of which they are made. Will one of your readers kindly tell me how I can restore them to their original colour? Can I paint them with something, or rub something on them that will restore them to their original colour? Please state cost of such required? Also the test for silver and gold.—A TWENTY YEARS' READER.

[75840.]—**Microscopical.**—Can any reader inform me of a microscopical club or society in London suitable for a beginner? If so, address of same? Are the French objectives, as supplied with students' microscopes, any use for photo-micrography? Is a rack and pinion for coarse adjustment a luxury or necessity? What are the most useful powers for a beginner?—A TYRO PYRO.

[75841.]—**G.N. Loco.**—Would anyone refer me to a sketch of G.N. single driving-wheels, and also say how is it the boilers do not prime, they having no dome on them? Nearly all other class of locos. are fitted with dome to prevent priming.—J. H.

[75842.]—**To Mr. Bottone.**—Will you please tell me what proportion is best length to diameter and gauge of wire to get the best results in electro-magnets?—ODYLE.

[75843.]—**To Mr. Bottone.**—In your "Electrical Instrument Making" you give details for drilling and mounting glass plates; but I cannot find how to grind the edges.—ULTIMATE PARTICLE.

[75844.]—**Four-lobed Clover Leaves.**—To "Eos."—Some weeks ago I inquired in these columns whether the above was not a curiosity, as I always understood it was a myth until myself and a friend found several specimens last autumn. Only one reply appeared, sent from Yorkshire; the correspondent merely stating that there were different kinds of clover, and that if I would send him a leaf or two, he would advise thereon. I accordingly inclosed him three or four specimens; but have since heard nothing of the matter, though I asked him to reply in the "E.M." for the general benefit. Would "Eos" kindly answer the query? If he wants a specimen, I will try and find another; but I am rather doubtful of success now.—B. H.

[75845.]—**Natural Drinks.**—Will "Eos," W. John Grey, "F. G. Ll.," or other reader kindly aid me by giving particulars of a palatable, non-starchy drink, to take the place of tea and coffee at meals? I have to avoid stimulants and irritants. There are many drinks made by infusion from leaves, berries, shells, and bark, also a drink made from milk thinned down by some agent, or fermented, but I have no particulars of these, and want such.—AN OLD READER.

[75846.]—**Tamarind Wine.**—How is tamarind wine made, and is it a wholesome, staple drink?—AN OLD READER.

[75847.]—**Glycerine and Turpentine.**—What are the therapeutic properties of glycerine and turpentine? Would it be injurious to take glycerine daily in food?—AN OLD READER.

[75848.]—**Jam.**—Can any of our readers say what is the best thing to do to prevent this going mouldy on the top? It is properly made, no water was added during the manufacture, and a good deal of the juice was skimmed off.—LEVER.

[75849.]—**Scarf-Pin.**—I have a horseshoe pin, silver, which some time ago I had plated with gold; the latter is now beginning to wear off, and I wish to restore the article to its former state. How can I do this?—LEVER.

[75850.]—**Small Arc Light.**—Will "Electrician" assist? Am about fitting up small arc light. What size motor, how many cells to battery, size of dynamo to work smallest arc light, and cost?—THEATRE.

[75851.]—**Midland Railway.**—Would some reader give me the dimensions of the four-coupled bogies on this line—1818 class, for instance? Also of the six-coupled goods working the main line traffic? A rough drawing of the latter would oblige.—LOCO. No. 2.

[75852.]—**Castor-Oil Plant.**—What is the best method of growing these plants, and training them? As fast as new leaves appear they fall off. What is the reason?—LOCO. No. 2.

[75853.]—**Small Riveting Machine.**—What sort of machine is used for riveting the little facets of steel brooches, or are they done by hand? I want a small machine for rapidly riveting small rivets made of pin ends, but do not quite see how to get the "elastic blow" which is so characteristic of hand-work. A simple drawing of anything of the kind in actual use, or any practical experience, would much oblige.—A. E. H.

[75854.]—**Hot-Air Engines.**—Given a constant supply of air, compressed to 14lb. and heated up to 300lb., should the cylinder have a long or short stroke, and why? Diameter of cylinder 6in. Should it be covered

COOPER UNION NEW YORK

by non-conducting compo, or would there be any fear of getting too hot? What would be the best cut-off so that the pressure at end of stroke is 14lb.? Also the probable speed and power of such an engine (single acting)?—A. E. H.

[75855.]—**Vacuum Tubes.**—Would Mr. Bottone or any reader kindly inform me how to fill with gas, and seal up a vacuum tube, after having exhausted the air with a mercurial pump?—VACOTE.

[75856.]—**Fish Refuse.**—Could any fellow reader or chemist kindly say best form of drying and grinding, so as to utilise for purpose of manure? Would smell from process be very offensive near curing establishment?—R.

[75857.]—**Plating Solution.**—There is a man who stands at a certain street-corner in Battersea, and who plates brass and white metal and other articles without the aid of a battery. He first puts the articles in a bowl half-full of a brown solution, like cloudy vinegar, and brushes the articles well with it. He then rinses the articles in what appears to me, water, and polishes it with boxwood sawdust, and he will guarantee the plating to last a reasonable time. Can any of "Ours" put me in the way of making the solutions, as I have a few articles I wish to do myself?—W. H.

[75858.]—**Colouring and Stiffening Sea-Weeds.**—I have a case of sea relics, and want to get some small weed such as you see in fancy shops and in brooches. Would some one tell me how to stiffen it and colour it, and what is the best to do it with?—D. W., EASTBOURNE.

[75859.]—**Coppersmithing.**—1. Can I braze with gas and a blowpipe, and if so, what kind of spelter should I use to braze 3-32in. copper? 2. Are 1-16in. copper rivets sold? 3. What kind of tools should be used fo working copper into a taper?—C. W. S.

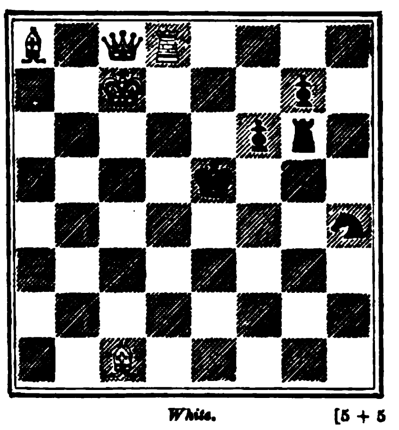
[75860.]—**Boiler Covering.**—Required a good recipe for a non-conductor for covering boilers or steam-pipes, where the known mixtures are not available.—GRAIGOLA.

CHESS.

All communications for this column to be sent to the CHESS EDITOR, at the office, 332, Strand.

PROBLEM MCCLXXX.—By W. GLEAVE.

Black.



White. [5 + 5

White to play and mate in two moves.

SOLUTION TO 1278.

White.	*Black.*
1. B to R 3.	1. Any move.
2. Mates accordingly.	

The pawn on K R 2 should be a black pawn.

NOTICES TO CORRESPONDENTS.

CORRECT solutions to 1278 by F. J. Wardale, C. M. O., A. Fellows, H. Fellows, James Kistruck, W. T. Hurley, and Biene; to 1277 by R. W. Houghton, T. H. Billington, A. Fellows, and H. Fellows.

H. P. HOSKEN.—Problem received with thanks.

W. GLEAVE.—Thanks for problem. It is most acceptable.

H. M. C. H.—1277 cannot be solved by 1 Kt takes Q B P ch.

T. H. BILLINGTON.—We have replied to you by letter.

W. T. HURLEY.—We have entered your name for the new tourney.

BIENE.—You have been credited with both solutions to 1276.

*** The present solution tourney terminated with Problem No. 1277. The new tourney, in consequence of the serious illness of Mr. James Pierce, must be deferred for the present.

The *British Chess Magazine* for November fully sustains its high reputation. It is chiefly remarkable for the autobiography of the chess career of Prof. Charles Tomlinson, whose chess reminiscences are unique, and are of the utmost historical value as chess mementoes, which, dating so far back into the past, must be unknown to most living players. In addition, the Rev. W. Wayte continues his valuable review of the new edition of *Bilguer's Handbuch.*

HERREN SIEMENS AND HALSKE are experimenting with a view to extracting copper from the ore by a new electrolytic method. The whole process lasts barely ten hours, and the loss is scarcely one-half per cent., so that even the poorest ores can be rendered remunerative.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, November 11, and unacknowledged elsewhere:—

H. W. SCRIVEN.—Wilson and Pfleifelder.—S. R. Bonney.—J. T. M.—Kentish Jolly.—J. R.—J. Willis.—Bike.—F. R. Copal.—H. A. Grace.—Fairy Lamp.—Anxious One.—Bacchus.—Alf. Taylor.—Crucible.—Dell.—N.—Threesquare.—J. Lamb.—H. S. P.—J. P. H., Hulme.—R. O'H.—Geo. Collins.—W. Pickering.—F. J. Garrard.—J. F. Vickery.

ELAION. (As to whether oil, gas, or steam is cheapest depends very much on the surrounding conditions. With steam there is always the boiler risk and trouble, and so far as oil-engines are concerned very little is known about them at present, and those who make them do not seem anxious that their virtues should be known. Where fuel can be had at a low price, probably the gas-engine using Dowson gas is as cheap as anything for a 5H.P. engine. A good deal of information on the subject will be found in back volumes, and your query cannot be inserted, because a reply to it would involve a gratuitous advertisement.)—WILLIAM COX. (You may find a book to suit in the list of Messrs. Spon, 125, Strand, W.C.; but possibly Fourneyron's and Jonval's turbines are as useful as any, and they have been described in many works. Most makers of such water-power machines publish descriptions of them, and much information can be found in back volumes. The "best" water-power engine depends to a certain extent on the local conditions.)—E. S. W. (We do not know of a work of the kind. The gramophone was fully described in the number for Aug 6, 1890.)—BLACKSMITH. (As the pipes are placed there seems no cure but to re-lay, so as to reach the pump more directly. If the pipe-joints are sound and the pump bucket fits closely, there ought not to be much difficulty in exhausting the air.)—W. HOLLES. (Sulphuric acid, carbolic acid, or a solution of sulphate of iron will do for "weed killers." We suppose you mean for use on gravel paths.)—REALIST. (Many would like to hear of good substitutes for tea and coffee. The subject has occupied the attention of one, at least, of the staff at Kew for some years, and you could probably get some information there. The leaves of the Chimonanthus fragrans are said to be an excellent substitute for tea. 2. A good "fat" cheese melts readily enough in a "slow" oven; but what can be the object of "dissolving" it? Why make the curd into cheese if it is afterwards to be dissolved? 3 There is, perhaps, nothing better than Culpeper's work. That should be found at any good bookseller's.)—ENQUIRER. (Cover every part of the mould with finely-powdered plumbago by means of a brush—"blacklead" it, in fact—and attach a wire from the battery to the surface of the plumbago.)—THE TWELVE YEARS' READER. (If your invention has been patented you can offer it to capitalists, and they may form a company. Put the question to Mr. F. Wetherfield, the Legal Editor of the *Weekly Times and Echo*, which is published at 332, Strand.)—MANAGER. (Possibly you mean the Clark electric gas lighter; but it is doubtful. At any rate, you can see back volumes in Manchester, and can look through. Most likely you will find what you require.)—T. A. (Do not know the work; but any textbook of dyeing would no doubt give sufficient information. Such works are rather expensive.)—T. W. G. (Probably the noise in the ears is caused by an accumulation of wax. Try syringing with warm soapy water, and if it does not effect a cure after a few applications, get a surgeon to look to it.)—J. HAINES. (There are instructions in nearly every back volume. See indices. Perken, Son, and Rayment, 90, Hatton-garden, publish a useful little work on the subject by Dyer. You do not say what size coil you require.)—GLYCERINE. (It is generally purified by means of superheated steam, keeping the temperature high for some hours. See such a work as Wagner's "Chemical Technology," published by J. and A. Churchill. You cannot purify it without rather expensive plant.)—ASTRO. (Please see the arguments adduced in the recent and previous discussions about the moon's surface.)—F. L. (Such instructions are frequently given for some special make, and most batteries are described in the textbooks.)—AMATEUR. (We are afraid we must refer you to the indices. The method of manufacture has been described, but the patent has not yet expired, we believe.)—J. J. F. (Various methods have been given in back volumes; but perhaps the best method is to smooth as much as possible with water-of-Ayr stone, and then finish with rottenstone and oil. The work is necessarily slow, as care must be taken not to heat the vulcanite. 2. The statement was made by correspondents; but see any textbook of electricity. Platinum is used for certain purposes because it is less corrodible than other metals.)—A CONSTANT READER. (We cannot afford space for such matters. As a correspondent said, the best way is to advertise the springs, and purchasers can then judge for themselves.)—T. BURDEN. (It was readily twisted into a circle, and seems to be made of too soft wire.)—ZED. (We think about two guineas the three—two are larger than the other; but Mr. H. Frowde, Oxford University Press Warehouse, Amen-corner, E.C., can answer the question definitely.)—OLD MAN, A SUBSCRIBER. (We think it is carbonate of soda acted upon when wanted by sulphuric acid; but the makers no doubt issue instructions.)—AN ENQUIRER. (The method of galvanising iron has been frequently described: it consists briefly in dipping thoroughly clean iron into a bath of molten zinc. The process was described so recently as May 29 last, p. 298.)—E. W. LAURENCE. (If you intend to go in for keeping pigeons on the large scale, better procure one of the handbooks. The mere fitting up of the nest boxes may take a variety of forms according to fancy, but it is essential to be able to get at them to clean them out.)—A. W. B. (Better procure catalogues from such publishers as Macmillan, Longmans and Co., and John Murray. The *Transactions* of the Royal Society contain papers on the subject.)—CAUTION. (We have received several complaints about an advertiser in the Sale Column who appears under more than one alias to be swindling readers who give him, or them, orders for apparatus. We advise all to be cautious, and to part with no money till goods are received.)—GRATEFUL. (Try rubbing a little petroleum spirit, with which a little essence of bergamot has been mixed to disguise the smell, into the hair, about twice a week. It banishes all scurf, is a cleanly hair-dressing, and promotes the growth.)—THOS. BATTY. (We really cannot carry this discussion further.)—THOS. KAY. (Thanks; but we have no more space just now for gas-globe radiators.)

Men who "Sow their Wild Oats" ruin their constitutions, and Harness' Electropathic Belt is the only reliable and speedy restorative, poisonous drugs and quack medicines being perfectly useless in such cases. All in search of health should call if possible, and procure one of these genuine Electric Belts, and avail themselves of a free personal consultation. A book of testimonials and descriptive pamphlet will be sent gratis on application to the Medical Battery Company, Limited, 52, Oxford-street, London, W. Those who cannot call should write at once before they forget it.

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Holloway's Ointment.—Go where you may, persons will be found who have a ready word of praise for this Ointment. For chaps, chafes, scalds, bruises, and sprains, it is an invaluable remedy—for bad legs, bad breasts, and piles, it may be confidently relied upon for effecting a sound and permanent cure.

OUR EXCHANGE COLUMN.

The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.

Wanted, to exchange small Donkey Pump, with ¾in. ram, suitable for small boiler, for smallest size inspirator.—PRICE, Hampton Wick.

12½in. excellent Glass Speculum, 1¼in. thick, turned edge, unsilvered. Trial. Offers.—T. W. B. WILLEY, Old Hall, Broseley, Shropshire.

The Chenies-street Exchange offers best value in cash or instruments for scientific appliances and tools of all kinds.—CAPLATZI, Chenies-street.

New **Ediswan Lamps**, brass holders, switches, &c., ought, cash or exchange.—G. Bowron, 93, Praed-street, London, W

I have in addition to a complete set of "**English** Mechanics," a quantity of the early numbers, about 1cwt. Some volumes complete. What offers?—Harper, Engineer, Jersey.

Telescope. Equatorial, 6in. aperture, by Sir Howard Grubb, finder, silver circles, driving clock, position circle, slow motions, six eyepieces, illumination, micrometer, photometer. Exchange offers.—Below.

Telescope, Equatorial, 5in. aperture, by Cooke of York, finder, prismatic, illumination, silver circles, slow motions, driving clock, five eyepieces, and accessories, complete. Exchange offers.—Below.

Telescope, Equatorial, 4½in. aperture, by Alvan Clark, equatorially mounted by Cooke, finder, gunmetal circles, verniers, and microscopes, slow motions, four eyepieces. Exchange offers.—Below.

Telescope, Equatorial, 6½in. reflector, by Horne and Thornthwaite, London, hour and declination circles, slow motions, clamps, finder, six eyepieces, Barlows, solar, diagonal, &c.—Below.

Telescope, 3in., refractor, **Unifiler Micrometer**, by Grubb; Wedge Photometer, by Hilger, 8½o g. Electric Hand Lamp, two Cameras, pair Telephones, Astronomical Diagrams.—Below.

Microscope, Binocular, large, by Crouch, magnificent instrument; also Monocular by Powell and Lealand. Exchange offers.—Apply Box 30, Post Office, Liversedge. List 3 stamps.

Two new **Limelight Jets** for dissolving view apparatus; also 6 pair of Skates, complete. What offers? Exchange.—Swioe, 36, Drummond-road, Bermondsey, London.

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The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, NOVEMBER 20, 1891.

CLOCKMAKING.

MANY amateurs, who are fairly expert in the use of the lathe for ordinary operations, when they attempt clockwork fail in the small details of turning and polishing. This is not from want of skill on their part, but mainly from want of knowledge. The object of this paper will be to put such on the right road as far as is possible by means of written instructions.

To begin with, very little clockwork can be done without wheels and pinions. These are at once the most important parts, and the greatest stumbling-block to amateurs generally.

For all ordinary work, pinions made from pinion wire are quite good enough, and are the most convenient to make, the wire being procurable in any size to suit wheels of all pitches. The general process of making a clock pinion from a length of pinion wire, was explained in the articles on "How to Construct a Quarter Chiming Clock," which appeared recently in this paper. But, judging from a number of letters from constructors of that clock, more exact details would be welcomed by many readers.

The first consideration is the lathe. A large pair of turns is without doubt the best; but not many amateurs possess this useful tool. Fig. 1 shows the arrangement of the clockmaker's turns. It is, in fact, a small bar lathe, with steel runners for centres, and a hand rest. It is grippled in the vice at the bench, and the operator seats himself in front of it. The work is rotated by means of a bow of cane, or an umbrella rib, strung with either thin gut or fine twine, varying in size according to the work in hand. The turning tools are ordinary square gravers, averaging ⅛in. to 3/16in. square, driven into small handles that will conveniently rest in the palm of the hand, while the forefinger rests upon and guides the point. Figs. 2, 3, and 4 are examples of the gravers, and the shape to which they should be ground. These gravers must be sharpened only on the faces, and on no consideration from the sides. For roughing down, Fig. 2, with the point rounded off and sharpened from the underneath, is the most suitable. Fig 3 is useful for ordinary work, the turning being done with the point only. Fig. 4 is used for giving the finishing cuts to straight arbors and square shoulders of pivots. For cutting a square shoulder to receive a wheel Fig. 3 is used.

To those used to ordinary lathe-work, turning with a bow will seem strange at first. Cutting can only be done on the downward stroke, and the graver, by a slight movement of the wrist, is freed from the work during the upward stroke.

A ferrule is fixed to the work instead of a carrier. These ferrules can be of various forms to suit different kinds of work. Some are adjustable as at Fig. 5, by three or four screws; others as at Fig. 6, by a clamping arrangement.

Fig. 7 shows the manner of turning with a bow between dead-centres, when ferrules are fixed to the work. A better, but rather more elaborate means is shown in Fig. 8. A is a specially-made runner to hold the centre B by means of a clamping screw. C is the loose pulley for bow, provided with carrier-arm, D. In using this useful addition, a miniature lathe dog, as in Fig. 9, is fixed to the work, and is in many respects handier than a ferrule. Also the bow may remain on the pulley while the work is removed for inspection. Fig. 10 shows arrangement when using this method.

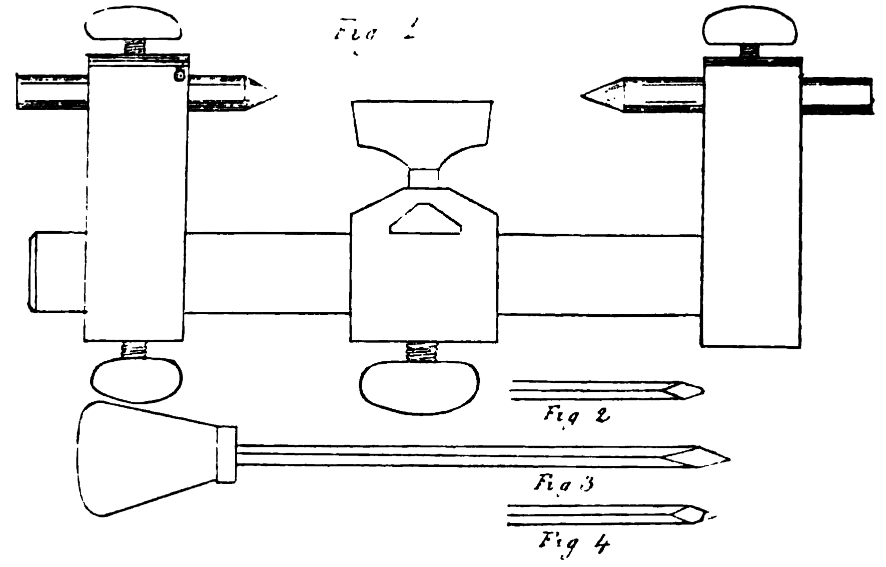


Fig 1
Fig 2
Fig 3
Fig 4

The foregoing is a description of the method of turning adopted by most clockmakers; but amateurs may not perhaps care to purchase a pair of turns, though I should certainly advise them to do so, where expense is not a great object. A pair of turns costs about 10s., though many a serviceable pair may be picked up in second-hand shops in Clerkenwell for a few shillings.

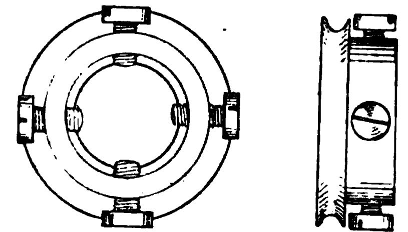


Fig 5

Pinions and pivots can be turned in a lathe in the ordinary way. There is no special difficulty about it, but the resulting work is never so true as work turned between dead-centres.

A good way for the possessor of a small lathe to turn fine and small objects, is to temporarily fix the mandrel and use the lathe as a large pair of turns, turning between dead-centres (female centres) with a bow as just described. If this method is resorted to I should certainly advise the making of the carrier, shown in Fig. 11, for the same purpose as that shown in Fig. 8. The dimensions are: spindle ⅛in. in diam. speeds 1in. and ½in. The loose pulley is best made of soft steel, the hole slightly coned. It may, however, be made of brass, but in that case had better have a rather longer bearing surface to prevent wear. The arm, or steel, is tapped in, and removable. The spindle or centre is turned from good steel and hardened, then tempered to a red or brown.

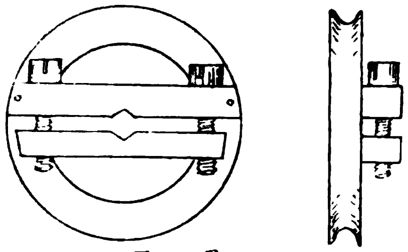


Fig 6

So much for the lathe and turning tools. We now come to method of forming a pinion from a length of wire. First file the leaves through all round, and by a quick motion snap the wire. This done, proceed to file down both ends to a centre, as in Fig. 12. Having ascertained that the wire runs true (this pinion wire is very soft, and easily bent), remove it from the lathe and harden. To do this without distorting it requires great care. It is a question of even heating and equal cooling, vertical dipping being greatly conducive to the latter. If hardened before removing the leaves, there is less tendency to warp. The leaves may be either broken off, or filed off. To break them off requires a little experience, as the last one has an awkward way of refusing to leave the centre without undue force. Filing is, perhaps, safer on the whole, though it is more tedious, and does not improve the files. When the leaves are to be broken off, a nick is cut all round on either side of the pinion proper, and the leaves broken off with pliers while quite hard, and before tempering. When filed off, it is, of course, done after tempering to a full blue.

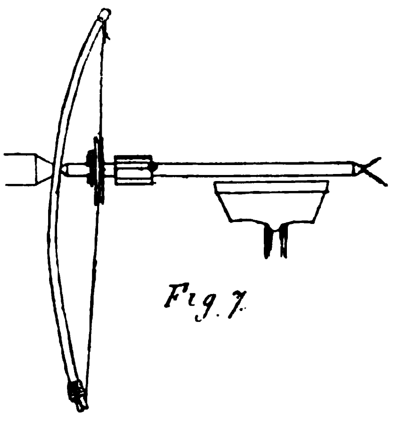


Fig. 7

When this operation is performed, place the stripped pinion in the lathe to see if it runs true; if so, "run" the centres, using a runner, as in Fig. 13, with a hollow in which to lay end of pinion arbor. The method is shown in Fig. 14. A is section of file, which is held in firm contact with arbor, and moved forward during downstroke of bow, and drawn back during upward stroke. Serve both ends alike, reversing the carrier or ferrule for this purpose. When this is done, place between centres, and, taking the roughing-down graver, proceed to turn arbor smooth and straight, and square-up faces of pinion roughly. Then take the pointed graver and finish pinion faces and arbor, and also rough-out pivots, finishing the latter with the third graver, as in Fig. 15. The arbors must taper slightly where wheel collets are to be knocked on.

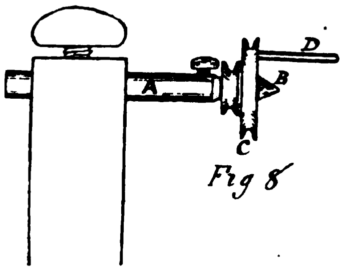


Fig 8

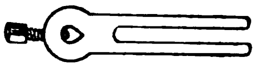


Fig 9

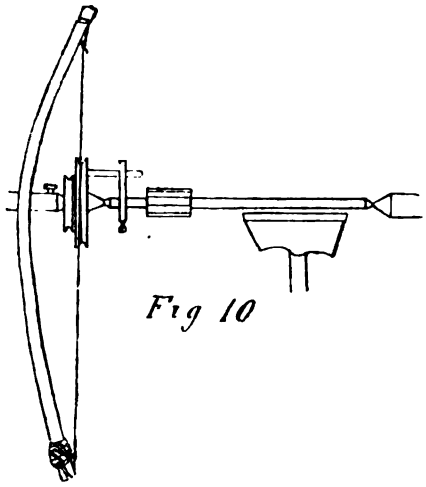


Fig 10

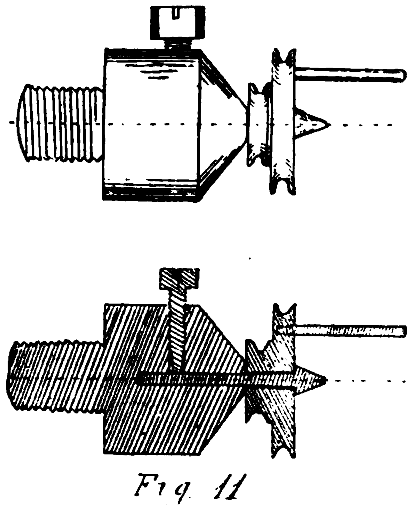


Fig 11

We now come to the polishing. A flat steel polisher ½in. wide (soft steel) is the best for the arbor. It has a grain in the direction of the cuts of a file, put upon its face by a smooth file or an emery stick. The left-hand edge, which goes against the pinion face, is bevelled off from the top, as in Fig. 16. A is the polisher, B the pinion. This polisher is charged with oilstone dust and oil, and used as a file, but with very little pressure. A similar polisher, but smaller, is used for the pivots. The effect of the oilstone dust is to smooth the work; when this is done, thoroughly clean the polisher and recharge with red-stuff and oil. This is applied till a fair polish is obtained, and a boxwood polisher, charged with the same material and used very lightly and rapidly, completes the polish.

The safest way is to keep distinct polishers for oilstone dust and red-stuff, as the slightest trace of the first mixed with the red-stuff will make polishing an impossibility. Frequently clean off and recharge the polishers during the process. The pinion faces will come up pretty fairly during the polishing of the arbors, and need not be further operated upon.

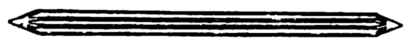


Fig. 12

The process of turning a hardened pinion is not an easy one, and there are thousands of cheap clocks made with soft pinions. These, however, will not stand very many years' wear; but if readers cannot get on with hardened pinions, they had better turn them soft. In this case red-stuff will not polish them; after the oilstone dust, they must be burnished by means of a hard steel burnisher of the same shape as the polisher, and used with considerable pressure, the pivot meanwhile resting upon a "bed," as in Fig. 17. This not only gives them a kind of sham polish, but hardens the wearing surface. Clean oil must be used to lubricate the burnisher.

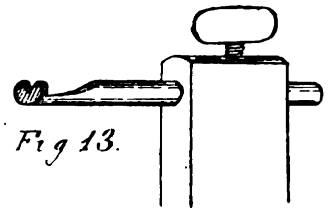


Fig 13.

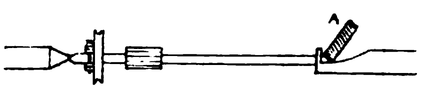


Fig 14

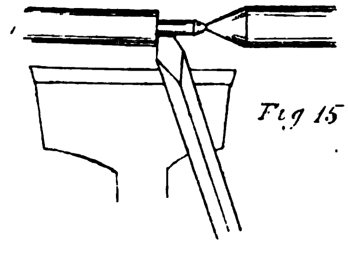


Fig 15

Now to the pinion itself. An inspection by a good light will show that the shape is by no means perfect, nor the polish between the leaves exactly as it should be. With a little polishing out they will run as they are; but being rather shallow, it does not take much dirt to block them; also the imperfectly formed curves do not make a frictionless gear. In decent work they are filed out deeper with a pinion-leaf file (to be obtained at tool-shops in Clerkenwell and elsewhere). Fig. 18 shows shape of file. It cuts on both sides and bottom, and, while deepening the teeth, files the sides flat, thus improving the shape of the tooth at the same time. After this filing, they are polished out with boxwood and oilstone dust and red-stuff. There are various arrangements for insuring straight filing during the operation of deepening; but as good a way as any is to lay the pinion in a groove in a block of wood in the vice, and trust to a steady hand.

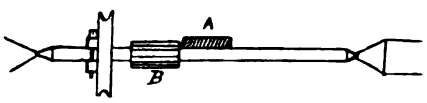


Fig 16

Brass wheels, after being crossed out carefully with a file, are polished flat with Ayr stone (Tam o' Shanter hone) and water, after which they may be treated with rottenstone and oil, and finished with chalk.

The centre hole in a wheel fresh from the wheel-cutter cannot be depended upon as the centre upon which the wheel will run true. All wheels must, therefore, be centred from the *points of the teeth*, and the centre holes turned out to fit the collets or pinion-heads, as the case may be. This is best done by chucking a piece of hard wood in the lathe and turning out a sink, into which the wheel is pushed tight. The points of teeth will bind it sufficiently to turn out the centre.

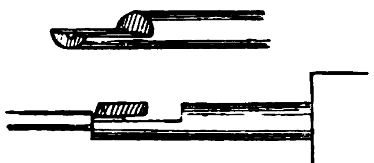


Fig 17

All shoulders to receive wheels must be quite true, and a shade hollow in preference to being flat. This helps to bind the wheel. To rivet them on, various shaped punches may be used. A round punch as large or larger than the hole in wheel, is in favour with some. This, of course, has a deep hole in the centre to pass over the pivot and arbor. A stake with a graduated row of holes is screwed into the vice, the pinion is passed through one of these till the back of collet rests upon the stake. The punch is then held quite upright, and tapped lightly, the wheel being meanwhile rotated slowly by the fingers to insure equal riveting all round. If it is struck more on one side than another, it will not run true, and no subsequent manipulation will make it true. This form of punch is, perhaps, as good as any for riveting wheels on to brass collets, but for affixing them to pinion-heads direct, as many are done, a semicircular punch is to be preferred, or even a small round punch applied separately to each pinion leaf.

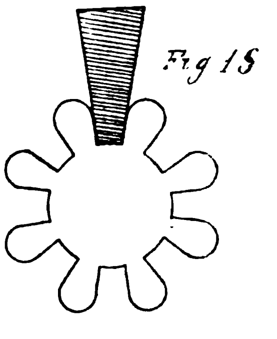


Fig 18

In turning pinion-heads to receive wheels, the face of pinion head to be riveted over must be turned hollow, the bottom of hollow to be level with the wheel when placed upon the shoulder made to receive it. The ends of pinion leaves should stand up as a circular row of so many points, and in riveting on, each point must be punched outwards into the brass of the wheel slightly, and the whole then turned off flush for appearance sake, taking care at the same time not to turn off too much and so weaken the hold upon wheel.

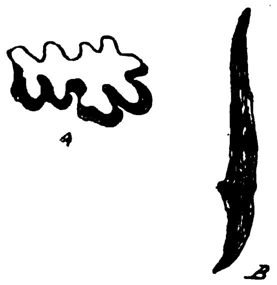
In a subsequent paper I may, with the Editor's permission, describe the process of making lantern pinions accurately, as these seem to be in great favour with many readers. Also how to cut brass wheels for clocks and similar work by means of an arrangement to be fixed temporarily to the slide-rest of an ordinary lathe, and with fly cutters, easily made by hand for any shape and size of tooth.

PRACTICAL MICROSCOPY FOR STUDENTS.—VII.

By Frederick Davis, B.Sc.

In reviewing the yeast-plant, we found each individual cell obtained its nourishment by the process known as intussusception. We shall find in plants of the higher groups that they also obtain their nourishment in the same way. The forms of cells known as prosenchyma consist merely of modified parenchyma—that is, by external pressure they become elongated and overlap one another, whilst in parenchyma they exist side by side, and although of varying shapes, such as elliptical, polygonal, and oval, they are essentially the same. We have so-called "secondary deposits" formed in these cells, and it is our intention in the present chapter to examine these deposits.

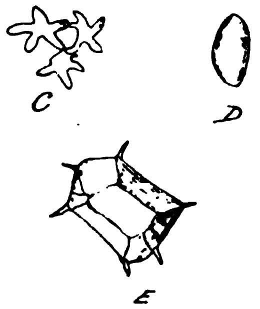
Sclerenchyma would appear to be an intermediate state of transition from parenchyma to prosenchyma, as we found in examining the section of the fern-stem. The shape of the cell is affected not only by pressure, but also by its merismatic or growing power—that is in many cases we find certain parts of the cell-wall will develop more than others; for instance, if the two ends grow more rapidly than the sides, we shall get the elliptical form of cell, and then from this, by further growth, the fusiform or spindle-shaped cell. Secondary deposits are formed in the same way, with the exception that, in place of the growth taking place regularly in the cell, we find it to confine its merismatic powers to certain patches of the cell-wall: we thus get the form of cells known as spiral. A very good example for the microscopist to examine for this form of cell would be any species of Opuntia, as we find in these plants well-defined spiral bands are developed. Annular cells are well seen in almost any plant.



A, Tabular cell; B, Fusiform Bast fibre.

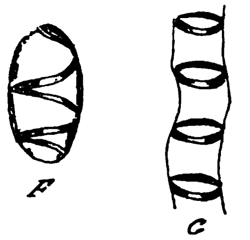
Muriform, or wall-shaped cells, may be observed in the transverse section of the exogenous stem, the portion described as the medulla sheath and rays showing them to advantage.

It may be well to mention that plant-life consisting entirely of parenchymatous cells or tissue is termed a cellular plant, and to this division all the lower forms of plant-life belong, such as the fungi, thallophytes, and lichens; whilst those possessed of prosenchymatous cells and tissue in addition to parenchyma are termed vascular plants, and under this heading all the higher forms of vegetable structure are placed—as, for example, the exogenous and endogenous structures previously described. We have a very good instance of the merismatic cells in the cambium of the exogen, and an equally good instance of permanent tissue in the hard wood or duramen of the same formation. Disc-bearing cells are formed from pitted cells chiefly by, in the first instance, the unequal deposits, and secondly by a partial separation of the cell-wall, thus forming a kind of circular disc, from which they take their name. This form of cell is largely met with in the Coniferæ, frequently in the Gymnospermia, and less frequently in the Phanerogamia.

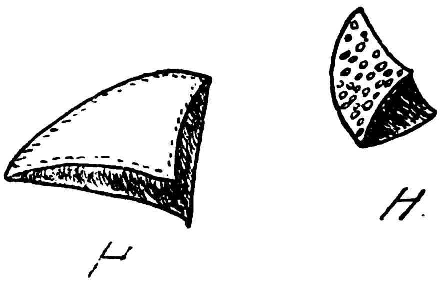


C, Stellate cells; D, Elliptical cell; E, Polyhedral cells.

Vessels are formed by a combination of vesicular cells—that is, by the partial or entire breaking down of the cell-walls, the union of the cells thus taking place. The sieve tubes previously examined in the section of the exogenous stem consist of cells in which the walls are perforated, that is not entirely absorbed, giving the cell-wall the appearance of an ordinary sieve. These cells, when placed one above another, form the sieve tube or bast vessels. In bast fibres we have the cell-walls so intimately coalesced that even under the $\frac{1}{8}$th power we are unable to distinguish their union. It will be understood, therefore, the bast fibres or bast tubes differ in this respect from the bast vessels or sieve tubes.

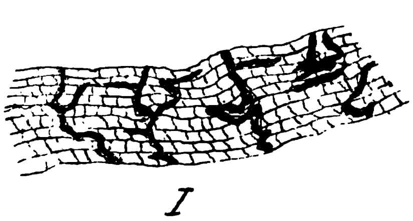


F, Spiral cell from Opuntia; G, Annular cell.



H, Tetrahedral cells.

Bast fibres are generally longer and more pointed than bast vessels. We have intimately acquainted with sieve tubes other vessels termed laticiferous vessels; these contain a nutrient fluid called latex. These vessels branch and ramify to an immense extent, carrying the latex for the purpose of nourishing the surrounding tissues.

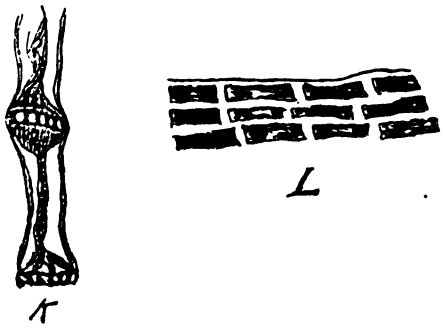


I, Section showing laticiferous vessels.

Vesicular vessels are of a similar type, but in addition to containing latex, they are possessed of acicular crystals, generally in bundles. The student should examine every form of plant life he may come in contact with, and not be satisfied until he has exhausted its structure by means of the microscope.

In cutting sections, a little difficulty may at first arise, owing to the fact of not being able to cut the section thin enough. This, with practice, will be overcome if the object be properly imbedded, as described in a previous chapter, and a sharp razor or scalpel be employed for the cutting. Should the student, however, not succeed to his satisfaction, he may have recourse to the instrument known as the microtome. This may be purchased at any optician's for about 10s., and with it a section of any degree of thickness or thinness may easily be cut.

In speaking of the starches, I referred to the various sizes; but I did not explain how the sizes might be calculated and ascertained. The student may do this by means of the micrometer. There are several forms—the stage micrometer is, however, the best for student purposes. The instrument consists of a glass slide ruled with lines at distances corresponding to the one-hundredth and one-thousandth part of an inch respectively, and by carefully adjusting the object to the division or lines, its size is ascertained. Another plan is to place the camera lucida upon the eyepiece, and sketch the object in the ordinary manner. Then remove the object from the stage of the instrument, substitute the stage micrometer, and sketch the lines as seen upon the drawing of the object. The lines being one-hundredth of an inch apart, it is evident, if the one-hundredth line corresponds with an inch, the object must be magnified one hundred diameters.



K, Sieve tube; L, Muriform cells.

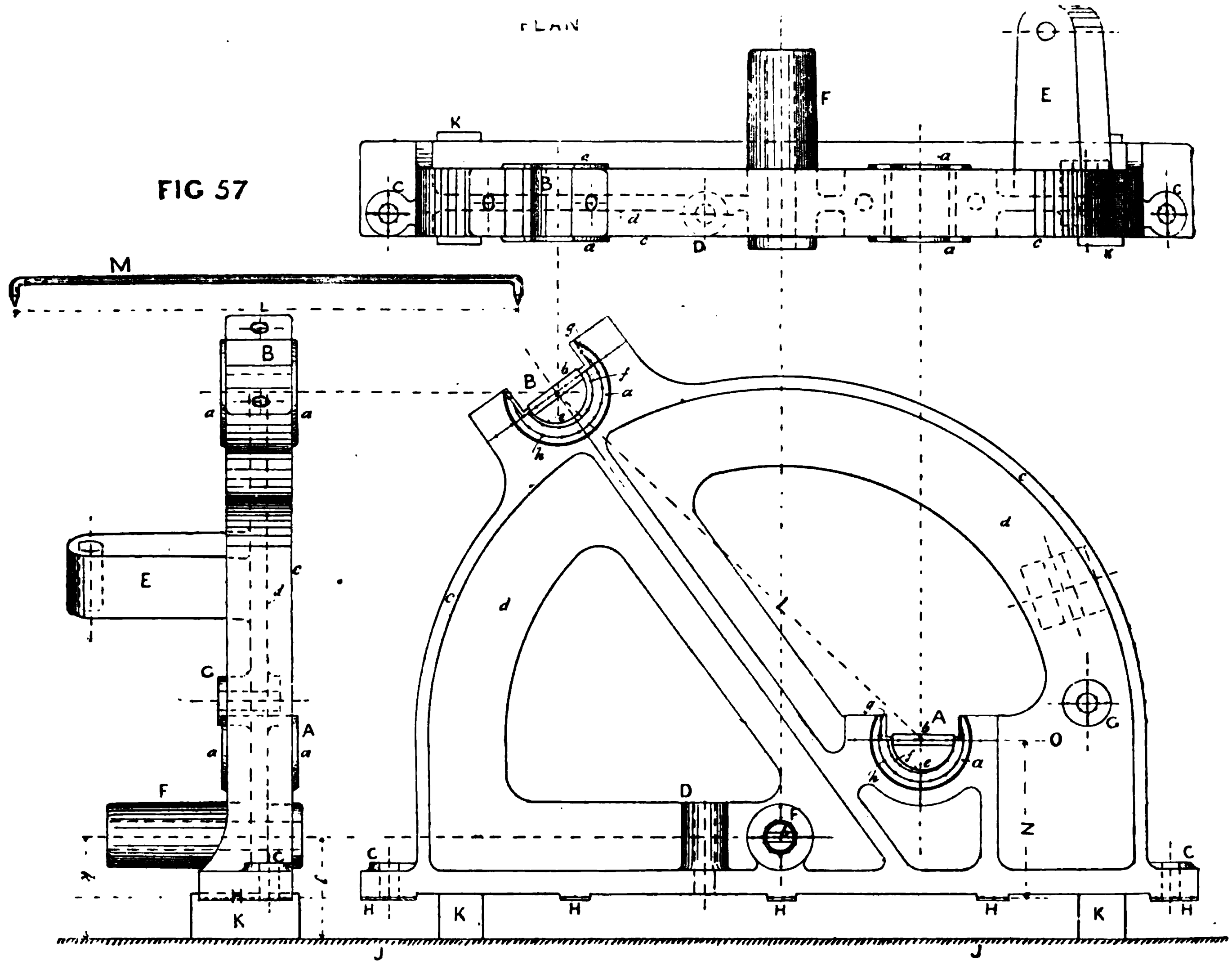
The camera lucida is an instrument for reflecting the object in such a manner that the student may draw most exactly the form of any object as seen beneath the object-glass. I shall not explain its construction here, because it comes entirely under the study of Optics; the student, however, must not be disappointed if his first attempts are complete failures. In sketching with its aid, the eye must be so arranged that one-half of the pupil is directed upon the prism, whilst the other half is directed to the paper upon which the sketch is to be made. It frequently happens also the point of the pencil used for sketching gets in the way, and a rearrangement of light is necessary. By practice, and practice only, are these difficulties overcome.

FITTING.—IX.

I FEEL a slight difficulty in selecting suitable examples of lining out. Jobs are so numerous and varied that it is impossible to comprise all that should be said on the subject in a few pages. Still, I will crowd all I can into the space available.

Fig. 57 is a comparatively simple example, typical of a large number of cases that occur in practice. The type is that of the side frame, cheek, or standard, with bearings for shafts. Both right and left hand cheeks are nearly, though not quite, identical in form. A is the bearing for a first-motion pinion-shaft; B is the bearing for a shaft that carries a hoisting barrel and its spur-wheel. Each of these bearings is fitted with brasses and cap. C C and D are bosses for bolting down the cheeks to a truck. E is a lug. In the boss F a bell-crank lever is pivoted

FIG 57



for tightening or letting loose a brake, the bell-crank lever being operated with a pedal or foot lever. The boss G carries a pin, upon which a lever attachment is pivoted. H H are the planing strips on the foot. These are the cardinal parts that have to be lined out accurately. I have roughly shaded these figures—not that workshop drawings are shaded, but in order to render the form of the casting perfectly clear to such amateurs as cannot readily grasp the outlines of mechanical drawings.

The most important centres are A and B for the shafts of the gear wheels. Their centres must be exact, and both frames must be precisely alike, not only as regards centres, but in respect of perpendicular heights and horizontal distances.

Frames of this general type are marked off differently, according to their size. When small, they are stood upright upon the lining-off table, and marked with the square and scriber from the table's face. When large, they are not stood upon the table, but are laid upon trestles, and struck out with straightedges, square, and trammels. Again, the facings *a a* for the brasses, and the faces of the bosses F G are often planed off on the table of a planing machine before any centres are lined out. As often, however, the lining-off is performed before the facings are machined, the latter being done immediately after the boring with a broad facing cutter. The choice depends on the practice of the shop, or it is often regulated by what machines, planing or boring, happen to be least pressed with work at the time. Whether the facings are left rough or machined first of all, makes no difference, however, in the method of lining out.

The first step is to bridge all the rough-cored holes, either with strips of hard wood or of iron bar, *b*, driven in firmly, and to chalk the faces of the bridge pieces, and of the planing strips H.

Bearing in mind that both frames are lined out simultaneously, if they are marked while lying flat upon trestles they will be merely laid side by side upon the trestles If, however, they are marked while standing upright upon the table, then they should be stood with the bottom flanges at the same height, and both frames exactly perpendicular. As the latter plan will afford me the better opportunity to illustrate some of the cardinal methods of lining out, I illustrate that.

I have shown only one frame in the figure; but it must be understood that the fellow one is standing alongside of it, either back to back, or end to end, dependent on circumstances.

The frames may be stood by the planing strips H of the bottom flange upon the table J. But it is, on the whole, more convenient to insert packing blocks, K, of, say, 1½in. or 2in. in thickness underneath, because then the scriber point can operate better on the facings, and dimensions can be trammelled up better from these facings than if the strips rested directly upon the table.

The frames will have to be packed up perpendicularly, trial being made with the blade of a long square whose stock rests upon the table. The blade may be tried against the edges of the flanges *c c*, or measurement can be taken from the blade to the plated portion *d* of the frame. As the under face of the flange is rough and uneven, it will probably be necessary to insert thin iron or wooden wedges between the packing pieces K and the casting, in order to throw it into a quite perpendicular position, and to keep it steady in that position. If wedges are too thick, small cuttings of thin sheet zinc, tin, brass, or paper are inserted where required.

It is as well to set the frames with their faces, or the edge of the bottom flange or foot, just over one of the longitudinal lines scribed upon the face of the marking-off table.

The frames being set perpendicularly and steadily, the next thing to be done is to mark faintly the centres of the *cored* holes for the bearings A and B. I say faintly, because it is very unlikely that these will be quite identical with the centres of the wheels. Next set a trammel to the wheel centres L, which should be taken, not from the drawing, but from the wheels themselves, when their teeth are put into the right depth for gearing. Also, it is the practice in most cases to make use of *fixed* trammels for such centres, in preference to the regular trammels with movable heads. There is the risk of the movable heads becoming slack, and shifting on the rod; and, further, they are not a permanent record of work done. A trammel is therefore usually made of round rod, M in the figure, and kept in the shop with the templets. This is now tried upon the centres of the cored holes A and B, and as its centres probably do not correspond with those, the question of how to average these centres has to be considered.

The centres of the cored holes may be nearer or farther apart than the wheel centres, and then the usual plan is to divide the difference equally between the two bearings. Sometimes, however, the cored holes may happen to be so much out of truth that they cannot be made to machine up upon one side, and the holes may have to be bored larger than was originally intended, and new brasses may have to be made correspondingly larger upon the outside. But this, of course, is excessive inaccuracy. It is, however, good practice to leave more than the average machining allowance in the bottoms *e e* of the cored holes, say $\frac{5}{16}$in., or even ¼in., instead of ⅛in.

Then, further, there is another matter that often has to be considered. In many cases—this among others—the position of one centre is fixed in relation to some other portion of the general mechanism. The position of the bearing A is fixed absolutely, both in the vertical height N and horizontal plane, O. Hence all the adjust-

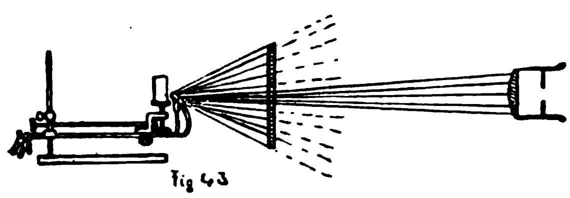
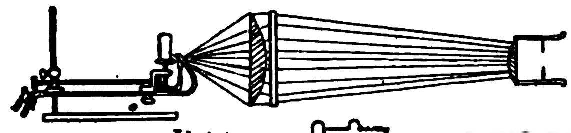


Fig 43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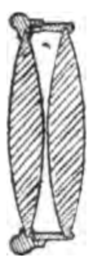
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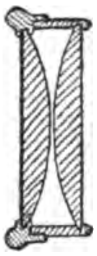
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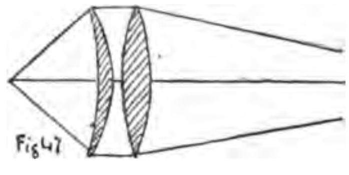
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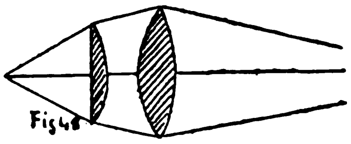
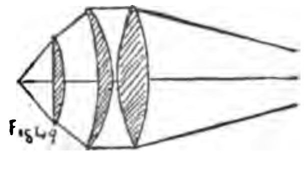


Fig 48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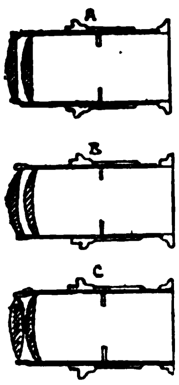


Fig 50.

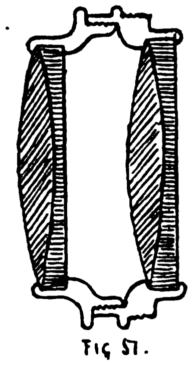
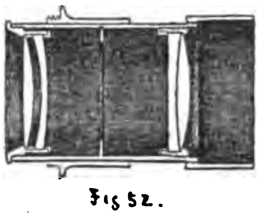


Fig 51.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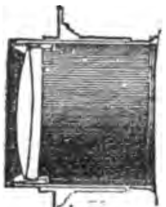
Fig 53

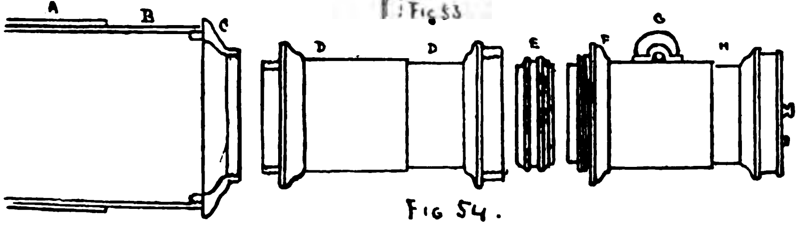

Fig 54.

ment that may be required will be made upon the bearing B, whose position in relation to the general mechanism may be varied a little.

Before, however, finally fixing the centres of the shafts it is necessary to settle the accuracy of the height N from the centre of A to the foot of the frame; and the allowance for machining on the planing strips H may be made a means, as it often is, of raising or lowering the centre of the shaft A in relation to its cored hole, in order to average its position with that of the shaft B. In the other, or horizontal direction O, the centre may be moved a little if required, because although the centre of A must correspond with that of the engine-crank, the whole frame can be moved $\frac{1}{16}$in., or even $\frac{1}{8}$in., upon its base, and bolted down to suit the position of the crank-shaft without affecting any important dimension.

Having the position of the centres and the base of the foot finally settled, the marking off will be done straight off. The edges of the planing strips will be scribed off on both sides of the frame, and on both frames, and also the centres of the shafts. The circles *f*, for the bored seatings for the brasses, and the lines *g* of the planed sides, for the caps to fit within, will also be scribed on both frames. It is not necessary to mark them on both sides of the frame, because when set upon the boring or planing machine, the automatic arrangements guarantee the parallelism of the work. Only in the rare exception of hand-work done with chisel and file, which would only happen in the case of stoppage of machinery, or in some amateur's tasks, is it necessary to mark work of this class on both sides of shallow frames. The case is, however, different with very deep bearings, long bosses, long facings, and so forth.

Upon each of the facings *a a*, and from the same centres from which the seating circles *f f* are struck, other circles *h h* of any radius will be struck. These are witness lines, which, remaining after the boring has been done, testify to its accuracy or otherwise.

In the figure the seating lines *f f* are intentionally shown out of centre with the rough cored holes *e e*. Occasionally they come almost concentric; but in large frames, and especially where the centres of three or four mutual gears are concerned, the want of coincidence shown in the figure is by no means exaggerated

The long boss F may now be marked off. Being long, it will be marked on both sides. Its centre is not important, so that the centre of the boss on the casting will be the centre for boring. If those portions of the boss which are on the opposite sides of the frame are not in line, then the centre for boring will have to be divided between the two. The height of the centre will be measured up from the planing strips on the shallow side *j*, and the scriber being set to that, will mark off both sides *j* and *k* in turn. The centre for the horizontal, or plan dimension, will be carried over at right angles to the frame by means of one of the transverse lines scribed upon the table's face. Since we set the edge of the bottom flange upon one of the longitudinal lines scribed upon the table, if we now make the boss centre parallel with one of the transverse lines scribed upon the table, it must be at exact right angles with the foot. Measurement will be taken with a square placed upon the line nearest it. Horizontal measurement will be taken from the edge of the square to the faces of the boss.

The hole in the boss G, supposed to be drilled in the solid, will be marked on one side only, and will be placed in the centre of the cast boss. The holes in the bosses, C C and D, for the hold-down bolts, also drilled, too, in the solid, are marked in the centres of their bosses, because they are quite independent of anything else. After they have been drilled, the corresponding holes are marked from them upon the base-plate. The hole, also, in the lug, E, is marked in the centre of the semi-circular end.

Observe that all the lines for machining are centre-popped to prevent loss of guidance in the event of the scribed lines becoming partially or wholly obscured with dirt or grease.

In my next I propose to show the lining out of an engine cylinder, and in the articles following, sundry miscellaneous examples. J. H.

THE OPTICAL LANTERN: ITS CONSTRUCTION AND USE.—VII.

By Chas. A. Parker.

The Condensers and Objectives.

HAVING detailed the practical construction of a biunial lantern in the preceding papers, it behoves us to direct our attention to the optical arrangements of the interior, commencing with the condenser. In the first place, it should be distinctly understood that the condenser has nothing whatever to do with the formation of the image on the screen, as some people erroneously imagine. A condenser is simply employed for the purpose of collecting and transmitting the rays of light emitted from the jet through the transparent slide in a converging form, the apex of this cone of light being the spot at which the objective should be situated. Without the use of a condenser, the greater proportion of the rays of light emanating from the jet would radiate in all directions, and be wasted, so that we should only get an indistinct and badly-lighted picture, owing to the body of the light passing through the slide in the form of a central bundle of bright direct rays, as shown in Fig. 43. By the use of a condenser, a greater proportion of the rays of light are brought together, or collected as it were, and then bent in a conical form, as will be seen in Fig. 44, towards the objective, instead of being wasted in illuminating the interior of the lantern.

It would be a difficult matter to fix any precise date in the history of the lantern when the necessity for a condenser became apparent, as an ordinary, common "bull's-eye," similar to that now fitted to the lantern of the nocturnal policeman, had to do duty until a comparatively recent date, and at the present time a single bi-convex lens of from 1½in. to 3in. in diameter, and about 2½in. to 3in. focus, is still in use for cheap toy lanterns, but beyond this size it becomes requisite to employ a compound condenser as a single lens; besides many other objectives must have a long focus to be of any use whatever. It is mainly on this account that a single lens is unsuitable, as it is of first importance that a condenser shall have a short focus, because the shorter the focus, the nearer we can get to the source of light, and this is a distinct gain, provided that the glass is not brought into sufficiently close proximity to the intense heat of the jet as to endanger the lenses.

Unfortunately we cannot shorten the focus of a single condenser without greatly increasing the thickness of the lens, which consequently renders it much more liable to fracture, besides making the curves so great as to cause serious spherical aberration; hence it is that two or more lenses are generally employed in order to make up a condenser of suitable curvature.

A simple form of compound condenser is formed by means of a couple of double-convex lenses of equal curvature mounted close together in a brass cell in the manner shown in Fig. 45, in order to give a combined focus of 2½in., each lens having a focal length of 5in. A condenser of this description, which should not exceed 3½in. in diameter, answers fairly well with the large flame of a hydrocarbon burner; but for a fine point of light, such as we get with the limelight, a condenser of this form is unsuitable.

The ordinary form of condenser as at present sold, which came into general use on the introduction of the "Sciopticon," consists of a pair of plano-convex lenses mounted together in a brass cell, so that the curved surfaces are presented to each other, and are almost in contact, as in Fig. 46. This combination will give a short-focus condenser of excellent optical qualities, which is capable of giving a very flat field, and for general purposes it will be found to answer very well, as it is only occasionally, when slides of microscopic detail are being exhibited, that the necessity for a more perfect condenser becomes apparent.

The lenses should be mounted in the cells with sufficient freedom to allow them to be readily revolved by means of the fingers: otherwise, if proper allowance has not been made for the expansion of the glass when heated, they will, in all probability, crack soon after the lantern has been lit up. The lenses should also be ground thin at the edges, as a needlessly thick edge to a condenser will increase its liability to fracture. It is likewise important to have a few small holes drilled in the periphery of the metal cell between the combination, in order to make provision for the escape of any vapour, which would otherwise be liable to condense upon the inner faces of the lenses on the lantern being lit.

Numerous other arrangements of compound condensers have from time to time been suggested as being capable of collecting a greater angle of light, one of the more important of these being the combination suggested by Sir William Herschel in the *Phil. Trans.* of the Royal Society for 1821. This form of condenser consists of a deep meniscus and a bi-convex lens mounted together in a brass cell, as in Fig. 47, with the concave side of the meniscus next to the radiant point. A condenser of this description having a combined focus of 3½in. measured from the centre of the combination will be found to be capable of giving excellent results. Fig. 47 shows the proper position for the lenses of this combination in relation to the source of light; but, strange to say, some lantern manufacturers have been known to mount them in a reversed position, presumably through a want of optical knowledge.

A few years ago the late Mr. J. H. Dallmeyer introduced an admirable form of two-lens condenser, which is shown in Fig. 48. This combination is composed of a plano-convex lens of flint glass and unequi-convex lens of crown glass, mounted together in the usual manner—that is to say, with the deep sides inwards. The great advantage of this condenser over the ordinary form lies in the fact that the sides of the second lens, having unequal curves, bring the rays of light to a point in front in a manner unobtainable by any other form of condenser. This combination is constructed of Chance's best glass, and is capable of giving the highest possible results, its only drawback being its cost, which is necessarily high.

The triple condenser is yet another combination, which is more popular in America than in this country. Condensers of this form may consist of a pair of lenses mounted together in the manner before described, with a third and smaller plano-convex lens placed nearest the light with the convex side towards the combination, from which it is separated some little distance. An excellent form of triple condenser was described by Mr. J. Traill Taylor in the *British Journal of Photography Almanac* for 1877. In this condenser a couple of lenses are mounted together in a similar manner to Herschel's arrangement before described, with a small plano-convex lens located between the surface of the meniscus lens and the light, in the manner shown in Fig. 49. By this means the focus is considerably shortened and a much greater angle of light collected.

With reference to the size of the condensers, a diameter of 4in. and a focus of from 2½in. to 3in. will be found to be the most suitable for the standard size of slides. With a smaller condenser there is a danger of some of the slides not being properly illuminated; but a condenser of this diameter will be found to be capable of fully lighting a 2¾in. square opening up to the extreme edges, and more than this we do not require with the standard slides now in use. It is a great mistake to imagine that the use of a large condenser will be any gain in illumination, as the length of focus of a large lens precludes the possibility of this, and, in point of fact, instead of being an advantage, it means a distinct loss of light. A small-size condenser, being of short focus, can consequently be brought nearer to the source of light, which renders it capable of transmitting a greater angle of light.

When the source of light is large, as in the case of a petroleum flame, the quality of glass of which the condenser is made is not of much consequence, as striæ, specks, or bubbles are scarcely perceived; but when the limelight is employed the condenser should be carefully selected, and if found to contain any of the above-named defects, it will be well to reject it, more especially so when the defects are present in the lens which would come next to the light when in the lantern. If the condenser is held up in the light and carefully examined, any defects will be readily discernible. Of course, one must not expect the same amount of perfection as an objective; but, at the same time, it is necessary to be particular, as an air-bubble in the condenser might mean a black spot on the screen, which would show as a great eyesore with certain pictures. Although it is usual for the general run of condensers to be made of a combination of crown and flint glass, the writer would prefer to have both lenses constructed of the finest white flint glass, in place of the green-tinted crown, which absorbs much more light.

With the limelight it is necessary to be especially careful to guard against any fracture of the condenser, as they are particularly liable to fly owing to their close proximity to the light. As all condensers are necessarily constructed of thick glass, it will be found a wise proceeding to warm them gradually before the commencement of an exhibition; otherwise, upon lighting up, the exhibitor may be startled by the cracking of the lens situated next to the light, more especially so when it is cold weather, or if the door of the lantern has been incautiously opened. For this reason it will be found advisable to warm the lenses before the lantern is fully lit up by slightly turning up the jet about fifteen minutes prior to the commencement of the exhibition, which will have the effect of dissipating any moisture that might otherwise form on the inner surface of the lenses. From the above it will naturally follow that it is inadvisable to suddenly turn out the light at the close of the exhibition, as the rapid cooling of the great thickness of glass renders it more liable to fracture than lenses constructed of thinner glass. If due attention is given to this slight matter, a broken condenser will be of very rare occurrence; but at any time that an accident of this kind happens, the cracked lens should not be thrown away until the extent of the defect is made apparent on the screen, as it sometimes happens that a crack straight across the diameter of the lens will not show if it is twisted round in its cell so as to stand perpendicularly.

In one respect it is a great advantage to employ a pair of similar plano-convex lenses for the condenser, as the operator, by carrying a third lens, is thereby enabled to immediately replace either element, should one of them happen to get broken at any time. In this case, however, it will be necessary to make proper provision for the easy substitution of another lens by fitting them into a suitable mount. This can be provided for by having the outer cell made of brass tubing of a sufficient size to take the lenses. A slight bezel should be turned up at one end of the tube on which one of the lenses may be supported, convex side upwards, when dropped into the cell. A brass ring, fitting close inside this cell, is then slipped into the latter, after which the second lens is placed, convex side downwards, resting on the upper edge of this ring, with an outer brass ring cap screwed over it, in order to clamp the whole securely together. It will be found advisable to have three or four ⅛in. holes drilled through the inner and outer cells, in order to allow for the escape of any moisture which might otherwise condense on the glass. The outside of the condenser mount will naturally require to be turned quite smooth, in order to allow of its being readily put into the collar of the stage plate, and it will also be necessary to secure it in position by means of the bayonet catch described in a previous paper.

Having become acquainted with the requirements of a good condenser, we must now turn our attention to the objective, by means of which the small picture illuminated by the condenser is magnified and projected upon the screen. The beauty and definition of the picture may be said to be mainly dependent on the objective, and as this forms the power, or magnifying element of the entire optical system of the lantern, it is needful to employ a lens which is as free as possible from spherical and chromatic aberration, in order that the picture thrown upon the screen may be clearly defined over its entire surface.

In some of the earlier lanterns it was usual to employ a single biconvex lens for the objective, similar to those fitted to the toy lanterns of the present day; but greater flatness of field was subsequently obtained by the substitution of a plano-convex lens with a stop in front; and as optical science still further developed, it was found that spherical aberration could be more thoroughly removed by the use of two lenses in place of the one hitherto employed.

An objective to be as near perfection as possible should be capable of giving a sharply-defined image with a flat field, in which the distortion of the marginal lines is reduced to a minimum. For all ordinary purposes a short-focus lens is generally required, in order to admit of the lantern being erected close to the screen; but at the same time, circumstances may occasionally arise in which it will be desirable to project the image to a considerable distance, as it may sometimes be convenient to erect the lantern in a gallery behind the audience, with the screen at the other end of the wall; and in this case it will be necessary for the operator to be provided with long focus to use in place of the others.

Prior to the introduction of the achromatic combination, a 1¾in. plano-convex lens of about 6in. focus used to serve the purpose of an object lens, which was generally mounted in a brass cell, with the convex side next to the source of light, and a blackened disc of metal or card placed at about 2in. from the flat side of the lens, in the manner shown in Figs. 43 and 44. A slight improvement on this form of objective was made by the combination of a pair of plano-convex lenses, as shown at A, Fig. 50, or a pair of meniscus lenses, as shown at B in the same cut. A still further advance on this form of simple objective was the combination illustrated at C in Fig. 50, in which a plano-convex and a meniscus were mounted close together, with the convex surfaces next to the source of light, and a small stop placed in front next to the meniscus. An objective of this form has a sufficiently short focus to enable the lantern to be placed at a distance from the screen about equal to the diameter of the disc to be shown, but, although it is capable of giving a well-defined image, the presence of the stop naturally tends to diminish the light to a certain extent.

The above description of objectives, which are termed single combinations, are only fitted to the cheaper kinds of lanterns; it is, therefore, usual for all the better-class of instruments to be furnished with double achromatic lenses, similar, if not identical, with the portrait combination of the photographer, as the chromatic fringes and distorted images given by single lenses are rendered glaringly apparent with the photographic slides now in use.

A simple form of short-focus achromatic lantern objective may be composed of a couple of achromatic plano-convex lenses, mounted close together in a brass cell, with the convex surfaces towards the source of light in a similar manner to Fig. 51. Each lens of this combination is formed by cementing a biconvex lens of crown glass into a concave lens of flint glass by means of Canada balsam.

In order to work well with 4in. condensers, each combination should have a focus of 9in., which will form, when mounted together, a double combination of 4½in. focus, the lenses being 1¾in. in diam. For an objective of 6in. focus 2in. lenses should be used, and for 7in. or 8in. focus they may be increased to 2¼in. or 2⅜in. in diam. This combination gives a flat field free from distortion, and forms a very good objective when the lenses are of sufficient diam. to include the entire cone of rays from the condenser. This form of lantern objective possesses an advantage over the ordinary portrait combination when used in a confined situation, for where we can get a 10ft. disc at 10ft. from the screen when using this lens, we should need to place the lantern at from 15ft. to 20ft. from the screen in order to get the same size disc with a portrait combination. When the distance between the lantern and the screen has to be increased considerably, it becomes necessary to increase the focal length of the objective in order to diminish its magnifying power. With a double combination portrait lens this can be done by removing the front lens and screwing it into the rear of the body tube in place of the back lens, which is removed for the purpose, so that the front lens only is used as a long-focus power. When it becomes desirable to increase the focal length of an achromatic objective of the description above referred to (see Fig. 51), it is needful to mount the lenses in a long-focus mount, or lengthening tube, as it is usually called.

A great many lantern exhibitors employ two or three long-focus achromatic lenses similar to the above, which, when combined in pairs by means of a lengthening tube, form very useful long-focus objectives. In this manner it is possible to quickly change the focus of the combination to suit requirements by another lens, and replace it in the lengthening tube, thus enabling the operator to show discs of varying diameter at the same distance from the screen.

The ordinary Petzval portrait combination of the photographer is a lens which is almost universally used at the present time as a lantern objective. An ordinary $\frac{1}{4}$-plate portrait lens having a focus of about $4\frac{1}{4}$in. forms an excellent objective, supposing that the operator is able to erect the lantern at a suitable distance from the screen. The front lens of the portrait combination consists of a biconvex and plano-concave lens ground in such a manner that the convex side of one lens can be cemented into the concave side of the other by means of Canada balsam. The achromatic power thus obtained is set in a brass cell, which screws into one end of a short tube working to and fro in an outer jacket by means of a rack and pinion. For photographic purposes the convex surface of the lens is turned towards the object to be taken; but when used as a lantern objective, the position is reversed. The back lens, which is a biconvex combination, is composed of a divergent meniscus of flint, kept a slight distance apart by means of a narrow metal ring from a double convex of crown glass, the whole being fitted into a cell which screws into the other end of the body tube. A metal or cardboard cap fits on to a metal hood, which is screwed on to the front end of the body tube, this cap being used by the operator in a similar manner to the photographer for covering and uncovering the lens, as may be required by the changing of the slides. A diaphragm or stop which takes the form of a disc of metal pierced with a central opening of varying size, is arranged to fit into a narrow slot situated in the middle of the body tube between the two combinations. These diaphragms (or stops) are used by photographers to increase the brilliancy of the pictures; but for use in the lantern the lens should be used at full aperture, which means that the largest stop should be inserted in order to pass as much light as possible. Fig. 52 is a section of a portrait combination, showing the disposition of the lenses for photographic purposes. A portrait combination is not, however, always a convenient lens to employ for lantern-work, owing to its focal length, which frequently requires the lantern to be placed at almost double the distance from the screen that would be necessary with a lantern objective; and then, again, if a combination of short focus is selected in order to escape this evil, it will often be found that the rays passing through the edge of the slide will not be projected upon the screen at all, as they do not pass through the objective. An excellent way of overcoming this difficulty is to use a portrait lens with a large-size back combination in order to collect all the marginal rays. Two and a quarter inches will generally be found a very useful size for the back lens when it is used in conjunction with $1\frac{1}{4}$in. front combination. A great many lanternists consider that in order to pass all the light from the condensers the front lens of the objective should have a diameter equal to the back combination; but as the front lens, when properly adjusted, is situated close to the apex of the cone of light emitted by the condensers, no possible advantage can accrue from having it of large diameter, as the cone of luminous rays, which are almost brought to a focus on the front combination, will only occupy but a small portion of the centre of the lens, and if the latter is capable of transmitting the whole of this cone of rays, there will be no need for any increase in its diameter. Dr. Monkhoven's modification of the ordinary Petzval portrait combination, employed for the purpose of enlarging, forms a lens which is eminently suitable for the requirements of the lanternist. The back combination of this objective is of just sufficient diameter to include the entire cone of rays from the condenser when they are brought to a focus on the front lens, by which means there is no loss of light nor diffraction blurs. A half-plate portrait combination forms a suitable lens for use in theatres or halls of great length, owing to its extra length of focus and large diameter. There is an old-fashioned make of portrait lens by Derogy, which is furnished with extra lenses for the purpose of lengthening the normal focus according to requirements. A lens of this description forms an objective which will meet all the wants of the peripatetic lanternist, although the first cost is rather heavy. Carte de visite portrait lenses are not, as a rule, of much use for ordinary purposes, as the focus is generally of too great a length, but when a short-focus lens of this description can be used, it will be found to answer admirably, as the corrections with this class of lens are made to include objects standing in nearly one plane. A short-focus stereoscopic lens is unsuitable for use as a lantern objective, as these lenses do not cover a 3in. slide.

Lantern objectives, similar to the ordinary portrait combination, are now to be had fitted with large-size back lenses, in order that they may take in the entire cone of rays from the condenser, and as the screw-threads of the cells in which they are mounted are made to the same gauge, it is possible to reverse the front lens and thus obtain a long-focus single objective, as shown in Fig. 53. In this case only the one lens is used, with a diaphragm placed in front. A great many of the ordinary portrait combination, notably those by Darlot, are also fitted with large-size back lenses mounted in cells of a uniform gauge, which enables the long-focussed front lens to be reversed in the manner above described.

Supposing that the lantern previously described is intended to be used at a uniform distance from the screen, the brass draw tubes of the front will be found of sufficient length when used in conjunction with a lens of suitable focus, and in this case the collar supplied with the objective will simply require to be soldered on to the end of the draw-tube of the front, or perhaps the size of the lens employed may render it necessary to provide the end of the draw-tube with a diminishing collar or adapter which must be furnished with a screw-thread to enable it to take the flange of the lens.

When it is desired to have the means whereby the focal length of the lantern objective may be altered to suit the room or hall in which the exhibition takes place, it becomes necessary to possess several lengthening tubes, and a set of lenses of varying foci. Lengthening tubes are formed of a couple of pieces of tubing fitting one in the other, something like a telescope. The larger tube is furnished with a thread which screws into the draw tube of the slide stage, and the outer end of the tube is provided with another thread to receive the flange of the outer jacket of the objective. Lengthening tubes of this description is, of course, only needed when a lens of long focus has to be employed. Fig. 54 is a section of a lantern front and objective, showing the position occupied by a lengthening tube as above described. A is the lantern front, B the draw tube, C the collar, D D the lengthening tube or adapter, E an achromatic lens in brass cell as Fig. 51, F outer jacket of objective, G pinion of rack, H inner sliding tube of objective, and I sliding shutter or flasher.

Some operators prefer to fit the lantern with rackwork telescopic lengthening tubes, which consist of a series of short tubes made to slide one within another—similar to a telescope. This is an arrangement that can scarcely be recommended, as the pinions are especially liable to wear loose, and finally miss the rack altogether, and then, again, even if the tubes are not provided with a rack-and-pinion adjustment, the weight of the objective will generally cause them to bend out of the optical axis as soon as they begin to move easily, owing to hard wear. The writer would personally prefer to have several brass lengthening tubes to suit the focus of the various lenses.

The objectives fitted to these long-focus tubes are of the ordinary double-achromatic combination, with the back lenses of large diameter, and, as a general rule, they are mounted in sliding tubes, which can be inserted in the rackwork mount of the objective without the latter requiring to be unscrewed from the lantern. When it is desired to test a lantern objective for flatness of field and definition before purchasing, nothing can be better than a photographic copy of a page of a newspaper in which the printed matter covers the slide all over from side to side. Any form of lens which will project a well-defined image of this, with all the lines of type perfectly parallel and crisp up to the edges, will fulfil all the requirements of the lanternist as regards defining power. Although for photographic purposes it is necessary that the visual and chemical foci are exactly coincident, the lanternist need only concern himself about the visual foci, for if this is correct, and the lens projects a picture with a perfectly flat field, it is needless to trouble about anything further.

When selecting an objective for lantern purposes, it will be found advisable to see that the front lens is perfectly clear and well polished, and entirely free from striæ or waves, which would only tend to confuse the image. An air bubble or a scratch is not of so much consequence on the objective, as it merely means a very slight diminution of the light. Condensers should never be bought second-hand, as it is absolutely necessary for them to be perfect and entirely free from any imperfections of surface. The reader is therefore strongly advised to obtain his condensers quite new from a reliable maker, as marks scarcely visible to the naked eye will become magnified to a painful extent when thrown on the screen. As a slight guide to the uninitiated it may not be out of place to mention the average prices charged for the cheaper forms of objectives. Very useful double combination achromatic objectives for lantern purposes, mounted in brass, with rack and pinion adjustment, can be obtained at prices commencing at 12s. each, or the same with large size back lenses and sliding shutter or flasher, 15s. each, and a lens the same as the last, with a double milled head to the pinion of the rack adjustment, and grooves in the hood to receive coloured glasses for the purpose of tinting the slides, 24s. each. All the best form of lantern objectives are now fitted with sliding shutters or flashers which take the place of the old-fashioned lens cap. A flasher takes the form of a circular disc of brass, which is hinged to the upper portion of the lens hood in such a manner that a slight turn to the right or left causes it to revolve, and thus uncover the lens. A better class of double combination, achromatic objective, specially made for lantern work, with large size back lenses, and rack-and-pinion adjustment, may be had for 30s. each. A double end to the pinion, and a milled head projecting on either side of the lens tube, will be found a source of great convenience to the operator, who will thus be enabled to adjust the focus of the lens from either side of the lantern. A reliable set of three achromatic lenses of large diameter, mounted in brass cells, with rack-and-pinion adjustment, can be obtained for 42s. per set. Lenses of this make will be capable of showing a disc 6ft., 12ft., or 18ft. in diameter without necessitating any alteration of the distance between the lantern and the screen. The prices quoted above are for one lens, or set of lenses for one lantern, and as the biunial is a twin instrument, in which everything is duplicated, it must be remembered that a double set of condensers and objectives will be required.

(*To be continued.*)

PRACTICAL PHOTOGRAPHY FOR AMATEURS.*

By S. R. Bottone.

§ 54. BEFORE proceeding to manipulate, it will will be well to glance over the arrangement of our dark room, and notice the condition of our camera and lens. To be able to produce satisfactory pictures, the dark room must be "roomy." If the operator is cooped-up, and obliged to keep in constrained positions for fear of knocking over bottles, or jostling against shelves, &c., he is sure to produce a very large percentage of failures. Another point, which is of great importance, is to be able to have light underneath the picture while developing, so as to do away with the necessity of holding the plate vertically in order to ascertain the progress of development. This object may be easily attained by the following contrivance:—

A small window (about 1ft. square) is made in the wall of the operating-room at about 2ft. from the floor. This is to be glazed with good orange glass. A flat board, about 18in. square, covered with white paper is suspended at the inside from the bottom ledge of this window, slanting at an angle of about 45°. The usual operating table is placed over this; a square aperture corresponding in position to the white-papered board, and about 1ft. square, is cut into it; over this hole is to be placed a glass-bottomed tray or dish, to catch the slops during development. This arrangement does not do away with the ordinary window, which ought to be a little above the level of the operating table; but this latter, besides being glazed with orange glass or covered, as previously advised, with cherry or ruby fabric, should be considerably darkened, or even altogether covered, in order that it should not interfere with the light reflected from below. All the operations which are performed in the dark room should be executed with the greatest calmness and without any "flurry." To this end the developing table should be entirely free from everything that is not absolutely required for the production of the picture and [illegible] bottle, glass, &c., should be kept religiously in its place. The following arrangement will be found extremely convenient:—The table should be about 4ft. long by 2ft. wide, and should stand close against the wall in which the window is made. In the centre stands the glass-bottomed developing dish (over the hole just described). To the extreme right is placed the vessel containing the nitrate bath. On the left is the supply of water for washing off the solutions, &c. This may consist either of an indiarubber tube, with stopcock, connected with the main, or a small cistern fitted with a stopcock. A pint jug with small spout must always be kept under this full of water. At the back of the developing dish, to the right, is placed the bottle containing the developing solution; in the centre stands the intensifying solution, and to the left is the fixing solution. Three beaker glasses, used respectively (and solely) for these solutions, stand immediately in front of their respective bottles. To the right, near the bath, is a small box containing slips of white blotting-paper, for putting in the angles of the carriers, to absorb superfluous moisture. A few clean cloths (washed in soda, but *not* in soap, and well rinsed), a few pieces of washleather, and a silk handkerchief complete all the necessaries for the operating room in the collodion process. The next point which claims our attention is the condition of the camera and lens. The former may be dismissed with a few words. Of whatever make the camera may be, the following are indispensable requisites:—No light must gain admission from any point, except through the lens; the interior must be blackened with some non-reflective material, to prevent the action of reflected light. The frame carrying the ground-glass screen must be so made that the screen falls *exactly* in the same plane as the prepared plate holds in the carrier of the dark frame (except when working with a lens, the actinic and visual foci of which are not coincident). As it is proposed to discuss fully the properties of photographic lenses in subsequent sections, the following points only need to be touched on here. Portrait lenses are extremely apt to give an image which is whiter in some parts than in others. This defect is technically known as "flare." Flare is generally caused by light reflected either from the thick edges of the lenses themselves or from the metallic ring which screws into the cell to keep them in their places. It is therefore well to blacken the ground edge of the lens with some dull black varnish, and to glue a piece of thick-pile black velvet round the inside of the ring. Although in a portrait lens, it is, from the very nature of things, impossible that the field should be perfectly flat, *id est*, that the edge of the picture should be perfectly in focus while the centre is so; yet preference should be given to that lens in which the marginal definition is good when the centre is in accurate focus. The focal length should not exceed 2¼ times the diameter of the front lens. The lens should be capable of giving a fairly-defined picture over the whole of the plate which it is intended to cover, without the use of a stop. If the marginal definition is bad, unless a small stop be used, the less is inferior. For views, the lens required will vary somewhat with the subject. For interiors, or cramped spaces, a wide-angle rectilinear is indispensable. For ordinary work in the open, nothing surpasses the old plano-convex achromatic combination; while for instantaneous views (of moving objects, waves, &c.), a quarter-plate portrait-lens is extremely handy. Having chosen our lens and camera, and fitted up the dark room, we may proceed to operate. We may conveniently divide the operations into eight stages, viz.:—1st, Cleaning the glasses; 2nd, Collodionising; 3rd, Immersing the plate into the bath; 4th, Exposing the plate; 5th, Developing; 6th, Intensifying; 7th, Fixing; 8th, Varnishing.

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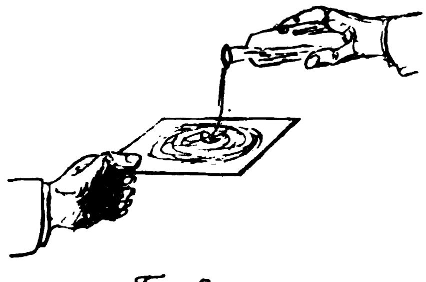

Fig 9.

§ 55. *Cleansing the Glasses.*—Having put about ¼oz. of sulphuric acid in a saucer, the operator takes a glass plate in his left hand, holding it by one corner between the first finger and thumb; he then dips the end of a large cork into the sulphuric acid, and rubs it all over both sides of the plate. This plate is then laid in a dish, and as many plates as are required for the day's work are treated in the same manner, the plates being laid over one another. When the desired number have thus been rubbed over with sulphuric acid, the heap of plates is turned upside down and the plates washed one by one in a stream of running water. Each plate, as it is washed, is to be carefully wiped with a soft diaper which has never known what soap is. The glasses are then to be stored in grooved boxes for use.

§ 56. *Collodionising.*—The operator takes from the box a plate, cleaned as above, breathing upon it and noticing if the breath evaporate in one sheet, or whether it shows lines or markings. In the latter case, he places it on a perfectly flat table, with a piece of washleather underneath, rubbing the surface briskly with a silk handkerchief (clean) until all lines or markings disappear on breathing. Then holding the plate perfectly horizontally, by its nearest left-hand corner, between the finger and thumb of the left hand, the operator pours on to the centre of the plate sufficient collodion to reach almost to the edges. (See Fig. 9.) Now, having placed the mouth of the collodion bottle under the nearest right-hand corner of the plate, he tilts the plate gently so as to cause the excess of collodion to run into the bottle, having previously caused the collodion to cover the plate by slightly inclining in the required directions. Having poured off the excess of the collodion without removing the bottle from under the plate, he brings the plate into a vertical position, and running the bottle along the lower edge of the plate, tilts this latter so that it may drain from the farthest right-hand corner. This latter motion is required in order to avoid the lines which will be formed on the film if the collodion were allowed to drain from one corner only. If the plates to be covered are very large, or if they are intended to be used as dry plates, it is recommended to cover them with a coating of albumen (white of egg), and to allow them to dry before collodionising; but this is seldom required for the wet process if the plates are carefully cleaned.

§ 57. *Immersion in the Bath.*—As soon as the lower end of the plate will take the impression of the finger without sticking to it, the plate is ready to be immersed into the bath, or be "sensitised." To this end the plate is taken to the dark room (the operation of collodionising is best performed in the light), the door closed, and the dipper lifted from the bath. The plate is then placed with its lower end against the ledge of the dipper, the collodionised surface being outwards, the plain glass resting against the handle. Now, with one steady sweep, the plate is plunged into the bath. No stoppage must be made in its downward course, for should this occur a line will be painfully apparent across the finished picture at the point where the stoppage or stoppages occurred. The plate must be left in the bath for about thirty seconds without being disturbed; it must then be lifted gently up and down (by means of the dipper) until all greasy lines (caused by the ether on the surface) shall have disappeared. A small piece of blotting paper is now placed in each of the inner corners of the carrier of the dark frame, or "back," the plate removed from the bath by lifting the dipper with the left hand, and taking the plate in the left hand by its opposite edges, the greatest care being taken not to touch the surface, which is extremely tender. It is allowed to drain for a second or two, and then placed collodion side downwards in the dark frame. The frame must now be carefully closed and the catches fastened in readiness for taking the sensitised plate to the camera for exposure.

HOW TO MAKE A VIOLIN.—VI.*

By W. Pickering.

The Varnish.

As I have endeavoured in the preceding papers to practise condensation as much as possible, I shall not now wax discursive on the matter of the Cremona varnish, preferring to leave the poetical and high-falutin' to those who can do it to perfection. Neither shall I lead my reader into the expense—to say nothing of the danger—of the Alembic, the Balneum Mariæ, and other appliances which are necessities to the professional varnish-maker, but may be dispensed with by the amateur violin-builder.

The field (of varnish) is one which opens even wider than that of the experiments on thicknesses which I suggested in the last chapter (page 189, Oct. 23), and with a few materials—such as gamboge, mastic, sandarac, aloes, dragon's-blood, and ordinary rosin, a bottle of turps, a ditto of methylated spirits, and another of wood naphtha, with some clean, wide-mouthed bottles, with corks to fit—the reader may commence a series of very interesting experiments with the object of producing a respectable covering for the instrument on which his time and skill have recently been expended. He may begin by gathering together the pieces of pine and maple which were cut away in arriving at the outline, and smooth them up for the purpose of trying his varnishes on them as he proceeds. For brushes he will find the larger size of what are called "wash-brushes," sold at artists' colour-shops at 1s. each, are probably the best to be employed. Three of these may be purchased, one for the oil (turps) and two for the spirit infusions, and they should be distinctively marked in order that he may not unwittingly dip the spirit-brush into the oil-pot, or vice versâ, or he may lose his temper. Each brush should be carefully washed after use in its particular solvent, a small bottle of each being kept well corked for the purpose.

There are two main divisions in varnishes, regulated by the solvent used — viz., spirit varnishes, which dry very quickly, and oil varnishes, which take a much longer time to set; indeed, the coating made by a well-known English artist over 100 years ago for his instruments is in some instances scarcely dry now.

There are also a few items which may be termed cardinal points, which I wish to impress strongly on the amateur varnisher. These are:

1. Never *stain* the wood.
2. Never use lac, unless you want to make the flinty varnish alluded to in a former chapter.
3. Never varnish in a cold room. Let the temperature always be over 60° F.
4. Do not be afraid of a number of coats.
5. Put each coat on as thinly as possible, and
6. Allow each layer to become thoroughly dry before the next is applied.

With regard to the first point, staining the wood utterly destroys any beauty it may possess, for it will be found that in a stained instrument the figure will not "flash," nor will the "nutmeg" glow, as will be the case if you put the colour into the varnish.

All the good makers of Italy sized or otherwise prepared the wood of their violins before varnishing, and a great many persons would very much like to know with what medicament they performed the operation. Anyhow, it had the effect of making a splendid foil for throwing up to advantage the beauty of the outer coating.

It will be well now to give an outline of the principal gum-resins which may be used in the experiments, and, to keep them in alphabetical order, I will commence with

Asphaltum, a bituminous substance, sometimes called Jew's pitch, owing possibly to it being found in the Lake Asphaltites in Judæa. It is very brittle—at least, it ought to be, as that which is sticky should be discarded. Judiciously mixed with socotrine aloes it gives a rich brown, something after the style of that used by the early Italian makers, Gaspar da Salo and Maggini.

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Benzoin, or *Benjamin*, is abundant in the East Indian Archipelago. A little of it gives toughness to varnish, but it may be easily dispensed with.

Canada Balsam, used also in mounting objects for the microscope, has an opposite effect, and imparts a quality of tenderness.

Dragon's-blood is a dark red, or reddish-brown resin; when very clean and clear, of a rich port-wine colour. It is seen in a variety of forms, but that in cakes, rolls, and sticks is to be shunned, and only that in tears adopted. It dissolves readily in spirits of wine.

Elemi is given as a constituent in most formulæ for violin varnishes; but I doubt whether, on account of its greenish tinge, any of the Cremona men ever used it, unless it were Lorenzo Storioni.

Gamboge is far more likely to have been one of the chief ingredients of the varnish of the "old masters." It comes from Siam, China, and other places, and is the inspissated juice extracted from a large tree by incision. In the state in which it reaches us it is dry, solid, and compact, of a vitreous appearance, and gives a bright yellow or yellowish orange colour. It imparts a golden effect to what are called "changing" varnishes.

Mastic is a well-known gum-resin in clear round tears, used in the East as a chewing gum (mastic-ation). It gives toughness, and is valuable for those varnishes in which colour is not required.

Olibanum, *Frankincense*, or *Thus* is of so soft a character that the merest pinch of it should be used, or the varnish will always turn sticky in a hot hand.

Resin is so well known that description is unnecessary. It is useful in very small quantities to reduce a varnish which may be too tough and hard, as it tends to soften, and also to give chippiness.

Sandarac, sometimes called *juniper*, from the tree of which name it is obtained, is a very useful gum. The best is in oblong tears from ⅛in. to ⅜in. in length. It dissolves freely both in spirits of wine and oil of turpentine, and not only contributes body to varnishes, but also great lustre. It is, however, very soft, and yields to the slightest attrition.

Several of the above-named substances have a pronounced colour of their own, particularly asphaltum, gamboge, and dragon's blood; but other materials are called into use in varnish-making for the sake of the colour they impart, such as turmeric, sassafras, saffron, annatto, madder, red sanders-wood, brazil-wood, sandal-wood, peach-wood, cam-wood, &c. The colours of these may be extracted by spirits of wine, and their combinations form ample field for the intelligent experimenter. It will be found that some of them may be greatly intensified by the addition of a little alum, cream of tartar, or potash.

I append a few of the old forms of violin varnish for the benefit of those who do not care, or who have not the time to spare, to experiment. In "Tingrey on Varnish," a standard work published in 1816, is given a varnish for violins as follows:—

Sandarac	4	ounces
Seed lac	2	,,
Mastic	1	,,
Benzoin	1	,,
Pounded glass	4	,,
Venice turpentine	2	,,
Spirits of wine	32	,,

It will be seen that lac is here specified; but I should prefer to leave it out, and reduce the Venice turpentine. It is hardly necessary to say that the pounded glass is used for the purpose of keeping the gums in a state of division and accelerate solution, and is not intended to add either transparency or brilliance to the mixture. Another form is:—

Venice turpentine	2	ounces
Elemi	2	,,
Sandarac	2	,,
Mastic	1	,,
Pounded glass	4	,,
Spirits of wine	24	,,

In both these cases frequent shaking of the bottle is necessary, and when the whole of the gums have been dissolved, the solution should be filtered through a piece of linen

In an old work published in 1755 is given the following "very fine varnish for a violin":—

"To do this in the best manner you must have three glasses before you. In the first put of the finest gum lacca 8oz., sandarac 3oz. or 4oz., both very finely pulverised; upon this pour of the best rectified spirit of wine so much till it stand 4in. above the ingredients; when dissolved, strain it through a cloth and place it closed up in a still place to settle; in a few days the top will be clear, which you are to decant off in another glass, and preserve it from dust.

"In the second glass, put of dragon's blood 5oz., and of red wood 3oz.; make a solution and extract of them with the same spirit of wine.

"In the third glass, dissolve of colophony 3oz., aloes socotrines 2oz., orlenium 3oz., and when the whole is extracted then pour the ingredients of the three glasses into one, stop them up, and let them settle; then pour off what is clear at top, and filter the rest through a brown paper. If you find the varnish too thin, exhale it a little over a gentle heat, and you will have a fine red varnish, which will gild pewter, and be of an excellent composition for varnishing of violins, &c."

Instead of "exhaling over a gentle heat," in which there is always an element of risk, more or less, I should recommend leaving the vessels uncovered, and allowing the spirit to evaporate naturally. It should be remembered that even the best spirit of wine will not take up more than a third of its weight of the resinous substances submitted to its action, and that, therefore, in a case in which the gum does not yield considerable body, the solution may be so thin that evaporation is indispensable, but it is only a matter of time for it to be done naturally, and without the risk attending the application of heat.

Pomet, an old French chemist, in his "Compleat History of Druggs," alludes to six kinds of varnish, but does not give the proportions. One of these, he says, is made of oil of spike, fine turpentine, and sandarac melted together; the second is called Venetian varnish, and is composed of oil of turpentine, fine turpentine, and mastic melted together; and the third is a spirit varnish, composed of sandarac, white karabe, gum elemi, and mastic. The fourth is golden varnish, made of linseed oil, sandarac, aloes, gamboge, and litharge of gold; the fifth is China varnish, which is gum lac, colophony, mastic, and spirits of wine, and the sixth common turpentine dissolved in oil of turpentine.

The same writer says that gamboge, treated with lime-water, gives a blood red.

With, however, the gum-resins and colouring matters I have enumerated, the experimenter may, by the innumerable combinations possible, accompanied with care and cleanliness, arrive at some very interesting results, and I would particularly adjure him that he keep an exact record of weight, or bulk, or both of the ingredients used, in order that he may either avoid repeating what may turn out to be unsuccessful, or, if he is lucky enough to make a hit, that he may be able to reproduce it.

It is not advisable to use varnish immediately it is made. The longer it is allowed to stand the brighter it will become, and therefore, while the gums are dissolving, he may fill up the interval by getting the "white" violin ready to receive its jacket.

The instrument may be lightly washed with a sponge and warm water, and put before the fire to dry, as the French polishers do. This will not only remove any stains or thumbings it may have received in the trials for tone, but will bring out the softer parts of the wood, which may then be operated upon by the finest glass-paper. After this, if it is wished to bring up the grain of the belly so as to be very conspicuous (as some prefer to see it), it will be found that burnishing the wood with a piece of ivory—the handle of a knife or tooth brush—will produce the desired effect.

I purpose treating of the foil or size in the next chapter.

SCREW-CUTTING GAUGE.

THE following note on a screw-cutting gauge may be useful to some of our readers. It is contributed to the *American Machinist* by a "Lathe Hand." The illustration represents a device he says he has used on a 16in. Putnam lathe for several years, and, having seen nothing just like it in use elsewhere, he thinks it may perhaps possess merit enough to find space. It differs from the usual screw-cutting gauge in that the screw A is provided with a check nut D, which holds the screw solid in the tool-slide. The knurled nut B is operated in the usual way—turning it back a little at each cut—and by arranging to have it strike the fixed collar A′ on the screw when the correct depth is reached on the screw being cut, any number can be cut a uniform depth without calipering, &c. By changing the block C and nut B to other side of collar A′, as shown at Fig. 2, internal threads may be cut in the same manner.

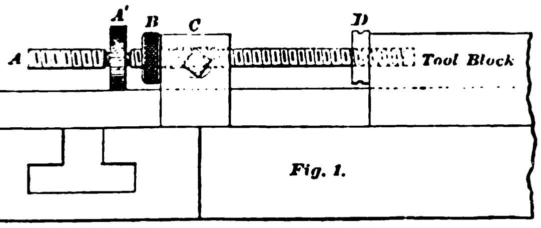


Fig. 1.

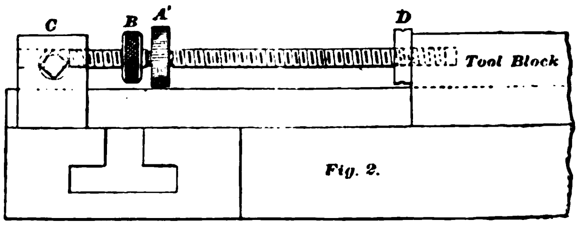
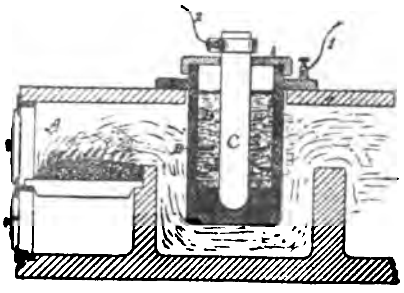


Fig. 2.

EDISON'S CARBON BATTERY.

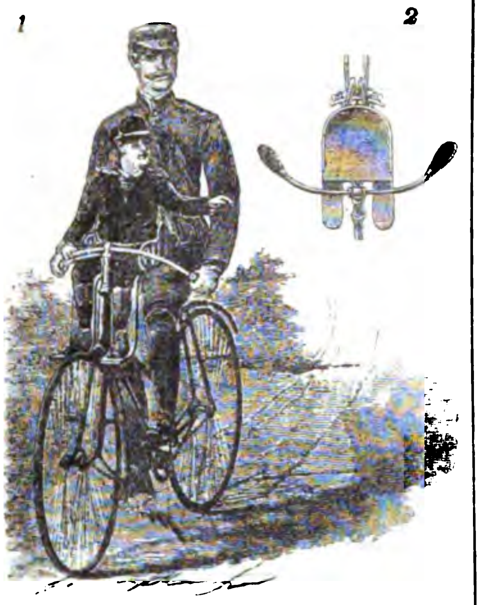
ACCORDING to the *Electrical Review* of New York, Mr. Edison has been recently granted a patent for a rather unusual type of battery, in which carbon is substituted for the zinc ordinarily employed as the soluble or active electrode in galvanic batteries. The electrolyte used is an oxide which is maintained in fusion by externally applied heat, which by raising the temperature of the carbon, enables it to absorb oxygen from the oxide and develop current. A battery invented by Jablochkoff operated also on this principle. Jablochkoff used for his electrolyte nitrate of potash, which is maintained in fusion by the burning carbon, the carbon being first raised to incandescence, the nitrate of potash being fused in a conducting vessel and the piece of ignited carbon plunged into it.



The nitrate of potash furnished oxygen to support combustion, which continued as long as the carbon and nitrate lasted; the chemical reaction developed the current, which was taken off from the carbon and the containing vessel. Mr. Edison's battery differs from this in several material particulars. His arrangement is illustrated in the accompanying illustration, wherein A represents a furnace over which is supported an iron vessel, B, provided with fireclay block *a* on the bottom, on which is supported a block, C, made of powdered bituminous coal mixed with a little tar and compacted and coked. The electrolyte is formed of oxide of lead, to which a flux may or may not be added. This is illustrated at B. The heat of the furnace fuses the oxide of lead and raises the carbon to a red heat, when it is acted upon by the oxide, forming carbonic acid and developing by the reaction current, which may be carried off from the two poles 1, 2. Mr. Edison's application upon which this patent was issued was filed in May, 1882.

A SEAT ATTACHMENT FOR BICYCLES.

THE illustration represents an extra seat attachment for bicycles, which may be readily put on or removed, adapting the vehicle to hold a child in front of the rider in such a manner that it cannot fall out, and will not unbalance the machine, while it may also be adjusted to suit children of different sizes. This improvement has been patented by Messrs. Louis Rastetter and Crist Siebold, of Fort Wayne, Ind. The child's seat may be placed on any common form of bicycle, being shown attached to a safety of the usual style, and it is supported at the back by the spring of the main seat, a cleat passed through the front coil of the spring being secured to the back of the attached seat, from the lower front portion of which braces extend downward and forward, and are bolted to a support secured to the steering-fork and the main frame. Fig. 2 is a plan view of the attached seat and its supports, the foot-rests extending in a nearly horizontal position on each side of the fork, and the rear portions of the foot-rests being bent upwards and clamped to depending hangers, the clamp being adjustable to suit children of different sizes. The handle-bar extends around the front of the seat, forming a secure guard to prevent the child from falling out, and when the child is not to ride the seat may be easily removed, and the bicycle used in the ordinary way. By this method of attaching the seat, the child has a foot on each side of the fork, and has the same swinging motion as the operator, the weight of both coming together upon the saddle, whereby the child fully partakes in the healthfulness of this form of exercise.—*Scientific American.*



LESSONS IN THE DIFFERENTIAL CALCULUS.—II.

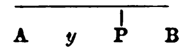
By RICHARD A. PROCTOR, B.A., F.R.A.S.

Author of "Other Worlds than Ours," "Sunviews of the Earth," &c., &c.

BUT even at this stage, it will be well to illustrate the application of the differential calculus.

Suppose we had this problem given:—

The length of the line A B is a; where must a



point P be taken in order that the rectangle under A P, P B may be as great as possible? Since A P is y, P B is $(a - y)$, and the rectangle under A P, P B (which call x) is $y\,(a - y)$; that is

$$x = a\,y - y^2.$$

We want x to be as great as possible. Now the differential coefficient of x with respect to y is the rate at which x increases with increase of y (from 0 to a); and so long as x is increasing x is not as great as possible. We must find, then, when x ceases to increase, or when its rate of increase (or its differential coefficient) is reduced to nought. Now we have seen that when

$$x = a\,y - 2\,y,$$

$$\frac{dx}{dy} = a - 2\,y.$$

Putting this equal to nought, we have the equation

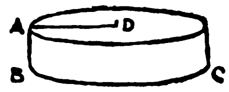
$$a - 2\,y = 0,$$

$$\text{or} \qquad y = \frac{a}{2}.$$

So that P must bisect A B, in order that the rectangle under A P, P B may be a maximum.

Here is another problem:—

A O is a cylinder constructed to fulfil the condition that its height A B added to A O, the radius of a circular face, is equal to a fixed length a.



Required the height of the cylinder in order that its curved surface may be as great as possible.

Put A B $= y$; so that A O $= a - y$.

Then the curved surface, which call x, is represented by the rectangle under the height and the circumference of a circular face. That is (representing the ratio of the circumference to the diameter as usual by π),

$$x = 2\,\pi\,(a - y)\,y = 2\,\pi\,(a\,y - y^2).$$

Here, as before, we must have the rate of increase of x with increase of y (or the differential coefficient of x) *nought*. But if we went through the process for determining the differential coefficient as above, we should readily get

$$\frac{dx}{dy} = 2\,\pi\,(a - 2\,y),$$

and the equation

$$2\,\pi\,(a - 2\,y) = 0$$

gives

$$y = \frac{a}{2},$$

or the height of the cylinder must be equal to the radius of its base.

Suppose that instead of requiring the curved surface to be a maximum, the problem required the whole surface to be a maximum. Then taking y as before, and representing the whole surface by x, we have to add to the curved surface or $2\,\pi\,(a\,y - y^2)$, the two circular faces, each having an area of $\pi\,(a - y^2)$. Hence

$$x = 2\,\pi\,(a\,y - y^2) + 2\,\pi\,(a - y)^2$$
$$= 2\,\pi\,(a^2 - a\,y).$$

Now to find the differential coefficient of x, we have

$$x = 2\,\pi\,(a^2 - a\,y) \ldots\ldots\ldots\ldots\ldots \text{(i.)}$$

$$x + \Delta x = 2\,\pi\,(a^2 - \overline{a\,y + \Delta\,y\,|}\,) \ldots\ldots \text{(ii.)}$$

and subtracting (i.) from (ii.) we have

$$\Delta x = -\,2\,\pi\,a\,\Delta\,y.$$

$$\text{Hence} \qquad \frac{\Delta x}{\Delta x} = -\,2\,\pi\,a,$$

$$\text{and} \qquad \frac{dx}{dy} = -\,2\,\pi\,a,$$

Now we cannot make this coefficient vanish by giving any value to y, for it is independent of y.

What is the meaning of this result? And, again, what is the meaning of the negative value obtained for the differential coefficient?

Since the differential coefficient of x with respect to y is the quantity representing the rate at which x increases with increase of y, and since in this case the differential coefficient is *negative*, we infer that the increase of x is *negative*, or in other words that *x decreases as y increases.* We obviously cannot get a maximum value for the surface, then, by increasing y, but have the greatest value at starting, or when y is nought. In other words, the surface is greatest when the cylinder is a mere circular *lamina* of radius a: and its surface continually and uniformly diminishes as its height increases and the radius of its base diminishes.

But getting a differential coefficient which cannot be equated to zero means in reality that the problem is insoluble. And, as a matter of fact, the expression $2\,\pi\,(a^2 - a\,y)$ has no maximum value, for by taking y negative we may make the expression as large as we choose.

The reader may be inclined to ask whether this peculiarity has a geometrical interpretation. It has; and we touch here on a very valuable feature of the differential calculus, and generally of the application of algebra to geometry. Peculiarities are pointed out by algebraical methods which the geometry of our problems would not always indicate. It is for this reason I have at this stage introduced this particular problem.

In this case we can have a negative height y for our cylinder, and $a + y$ for the radius of the base: only we must then *subtract* the curved surface from the sum of the two circular faces. And our result tells us that the greater we take this negative height the greater will the resulting difference be. There will be no true maximum then.

In the next paper, after exhibiting the rules by which the differential coefficient of any expression can be determined, I shall proceed to discuss with greater freedom of selection other problems to which the calculus is applicable.

We are now to consider the differential coefficient of certain familar expressions, and to lay down rules by which the differential coefficient of any expression can be readily determined.

In the first place, let me note that, for convenience the quantity whose differential coefficient is to be determined is commonly called either y or u; and the quantity whose variation causes the former to change is commonly expressed by x. I select y for the former and retain x for the latter purpose. Let it be remembered that there is no real necessity for any fixed practice in this matter. In the last lesson, for example, I used in one case s and t instead of y and x, while in the other examples I interchanged x and y.

Let me repeat that the differential coefficient of one quantity y with respect to another x, is an expression indicating the rate at which the former *increases* as we increase the latter. I advisedly use the word *increase* as respects y, even though increase of x may cause decrease of y. For in such a case the differential coefficient will come out *negative*, and a negative increase is the true algebraical equivalent of decrease.

And now for the differential coefficients of the simple function.

If $y = a$, or is constant, its differential coefficient with respect to x is of course 0.

Let $y = x^n$, where n is a positive whole number. In this case we will go through the process for finding the differential coefficient. We increase x by $\Delta\,x$ and assume that y is thus increased by $y.\Delta$[*] Then—

$$y + \Delta\,y = (x + \Delta)x^n$$

$$= x^n + n\,x^{n-1}\,\Delta\,x + \left\{\begin{array}{l}\text{a finite number of terms}\\ \text{involving } (\Delta\,x)^2,\ (\Delta\,x)^3,\\ \text{\&c.}\end{array}\right.$$

and $y = x^n$

Therefore subtracting

$$\Delta\,y = n\,x^{n-1}\,\Delta\,x + \text{terms involving higher powers of } \Delta x \text{ than the first.}$$

Hence,

$$\frac{\Delta\,y}{\Delta\,x} = n\,x^{n-1} + \text{terms involving } \Delta x \text{ and its powers.}$$

Now suppose Δx, and therefore Δy, to become indefinitely minute, calling them respectively $d\,x$ and $d\,y$, and we have

$$\frac{d\,y}{d\,x} = n\,x^{n-1} + \text{a finite number of indefinitely minute quantities.}$$
$$= n\,x^{n-1}.$$

The extension of this proof to the cases where n is fractional or negative, or both, would not suit these columns. Let it suffice that for all values of n

$$\text{if} \qquad y = x^n$$
$$\frac{d\,y}{d\,x} = n\,x^{n-1}.$$

But let us remove this result from the region of algebraical expressions for a moment, in order that its significance, and the significance of sequent results, may be fully recognised. Take x to be 10, and n to be 4, then

$$y = 10^4 = 1{,}000.$$

Try now the effect of adding some small quantity, say 1-100th, or ·01. Then instead of 10^4, y becomes $(10{\cdot}01)^4$, and if we calculate the value of this, we find it to be

10040·06004001.

The effective part of the increment of y is the 40, and the proportion it bears to the increment of x (or 1-100th) is 4,000. This is four times the cube of 10, or

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[*] It is most important to remember that $\Delta\,x$ is a single quantity, not Δ multiplied by x, but the increment of x. In the old notation of fluxions a simple expression was used; but in advanced applications of the differential calculus the notation of fluxions fails totally, and the $d\,x$'s and $d\,y$'s alone serve the mathematician's purpose.

$n x^{n-1}$. And so in any case the reader may care to try; whenever $y = x^n$, a minute increase in the value of x gives to y an increase $n\,x^{n-1}$ times as great.

The general result enables us to at once express the differential coefficient of all such quantities as $\sqrt{x}$, $\sqrt[3]{x}$, $\frac{1}{x^2}$ and so on. It is only necessary to write these (or conceive them written), in the forms $x^{\frac{1}{2}}$, $x^{\frac{1}{3}}$, x^{-2}, to see that the respective differential coefficients are $\frac{1}{2}\,x^{-\frac{1}{2}}$, $\frac{1}{3}\,x^{-\frac{2}{3}}$, and $-\,2\,x^{-3}$, which we may write respectively $\frac{1}{2\sqrt{x}}$, $\frac{1}{3\sqrt[3]{x^2}}$, and $-\frac{2}{x^3}$. Anyone who has become at all practised in applying the differential calculus would, of course, write down these results at once. It is plain, too, from the mode of proof that if $y = a\,x^n$, where a is constant, $\frac{d\,y}{d\,x} = a\,n\,x^{n-1}$.

The next simple function I shall take is the sine of an angle. And having in view the importance of the reader's obtaining clear views of the nature of a differential coefficient, I shall, in this case, show a geometrical way of finding such a coefficient.

Let the angle x be represented by A O B, Fig. 1; then, using the arc measure and making the radius unity, we have

$$x = \mathrm{A\,B},$$

and $\sin.\ x = \mathrm{B\,F}$, where B F is perpendicular to O A, $= y$ suppose.

Now let angle A O B receive the small increment B O C, and call the arc B C $\Delta\,x$; then, completing the figure, the corresponding increment of the sine is C D. Hence

$$\frac{\Delta\,y}{\Delta\,x} = \frac{\mathrm{C\,D}}{\mathrm{C\,B}}$$

Now it is clear that as C is brought nearer and nearer to B, the figure B C D approaches more and more nearly to the figure of a triangle similar to B O F, and, therefore, the ratio $\frac{\mathrm{C\,D}}{\mathrm{C\,B}}$ approaches more and more nearly to the ratio $\frac{\mathrm{O\,F}}{\mathrm{O\,B}}$. Hence when C so moving is *just upon* B, in which state of things call B C $d\,x$, and C D $d\,y$, we have

$$\frac{d\,y}{d\,x} = \frac{\mathrm{O\,F}}{\mathrm{O\,B}} = \cos.\ x.^{*}$$

We have then, if

$$y = \sin.\ x,\ \frac{d\,y}{d\,x} = \cos.\ x.$$

Let us study this result a little.

Remembering that the differential coefficient of a quantity expresses the rate at which the quantity is increasing, we see that the above result implies that as we increase the angle the sine increases, until x is a right angle or $\frac{\pi}{2}$. But after x has passed this value cos. x is negative. This implies that the sine thenceforth diminishes; and we know, as a matter of fact, that the sine does diminish as the angle passes the right angle.

SCIENTIFIC SOCIETIES.

THE LANTERN SOCIETY.

THE annual general meeting of this Society was held on Nov. 9th, at 20, Hanover-square. A loan collection of 100 slides lately received from America in exchange for 100 slides recently sent there by the Society, were then passed through the lantern, the opinion of the members being that the collection was one of high excellence. The landscapes especially were of fine quality, and showed not only photographic skill, but also artistic merit in the selection of the view. In some, stereoscopic effect was conspicuous in a marked degree. The views were those of cities, rivers, mountains, cañons, forests, &c. It is quite impossible to say more about them than that they were grand pictures of a grand country. Among those pictures that were of a funny or remarkable character, the following may be noted:—A fine photograph of a flash of lightning. "Her First Offer," a Chinese doll on bended knee popping the question to a demure little dolly. "We Met, 'Twas in a Crowd," two locomotives in collision. Two yachts in collision. This was a very remarkable photograph, as the two vessels were in the act of colliding. There were also several children's tea parties and washing days, which formed pretty scenes.

Roast and Baked Meats.—The very general adoption of the close range or "kitchener" in place of the open grate has necessarily caused an abandonment of the method of roasting our meat before the open fire, and the substitution of the process of baking in a close chamber or oven. No doubt the latter method is the most convenient and the most economical, but it may be questioned whether it is the most wholesome. In baking, the meat is, as it were cooked in its own juices; the vapours exhaled from the warm meat are confined in the close oven, and do not escape into the atmosphere, adding no doubt to the flavour and also to the richness of the food. At the same time, the joint surrounded by this dense vapour does not yield its juices so freely as when roasted in an open atmosphere, as can be seen by comparing the yield of dripping obtained in the dish in which a leg of mutton has been baked with the amount which a similar joint gives to the dripping-pan when roasted. That a very large quantity of the more oily portion of the fatty matters, especially of the fat distributed between the muscular fibres, does not leave the meat when baked, can be shown by examining a slice of baked meat and comparing it with a similar slice of roast meat, when it will be seen that in the former minute oily globules are abundantly distributed among the fibres, whilst in meat that has been well and thoroughly roasted they are comparatively unnoticeable. Moreover, the gravy from baked meat when cut always yields more grease than does that from roast meat, though, as above stated, the yield to the dripping-pan is less with the former than the latter. It is this retention of the volatile aroma and unctuous juices that renders baked meat so popular, and no doubt with persons of strong stomachs it is not harmful; but when digestion is feeble, we are convinced it is highly injurious, and that its continued use not only aggravates but also induces indigestion, and that in many instances very considerable benefit has resulted from the advice of the medical man to the patient to order his meat to be roasted instead of baked. Our knowledge at present regarding the respective digestibility of different fats is very imperfect; still, the general and popular opinion is that the more oily fats are less digestible and more "bilious" than the solid, and it is these fluid fats which form the grease of cooked meats. Much the same may be said regarding the mode of cooking bacon. Thus in the North of England thick slices of bacon are placed in shallow tins and cooked in the oven, whilst rashers are usually fried in a pan over the fire. In both cases, however, the bacon is cooked in its own "dip," or most oily portion of its fatty matter. It has long been pointed out that bacon cooked by either of the above methods is a "bilious" article of diet, whereas when bacon is toasted it is not apt to disagree even with decidedly "bilious" people, the reason being that the oily portion of the fat or "dip" is removed, and only the more solid fat left. We have no wish to raise a panic with regard to the useful and economical "kitchener," but would merely suggest that baking may in some instances be the unsuspected cause of indigestion, in which case a return to the use of the roasting-jack and the open fire would, we think, prove to be a step in the right direction.—*Lancet.*

SCIENTIFIC NEWS.

THE position of Wolf's Comet on Dec. 1 will be, according to Dr. Berberich's ephemeris for Berlin midnight, R.A. 4h. 24m. 13s., S. Dec. 13° 21·8′; brightness 7·55 as compared with unity at time of rediscovery, An ephemeris by Dr. Thraen differs slightly in the "seconds." The greatest south declination is reached on December 18-19.

For all useful observational work the lunar eclipse of Nov. 15 seems to have been a failure in this country, owing to the cloudy skies. Neither at Greenwich nor at Mr. Common's observatory at Ealing was anything really visible. At Paris, and throughout France, the eclipse was rendered more or less invisible by fog; but telegrams from Madrid, Lisbon, Bermuda, and Halifax report a clear sky and excellent observations of the contacts and other phenomena.

Two papers by Mr. J. E. Gore, F.R.A.S., read before the Royal Irish Academy, have been reprinted from the *Proceedings*. They are "Observations on the Variable Star, Mu Cephei," which is described as sometimes remaining "for several months, with little or no perceptible change," and "On the Orbit of the Binary Star 35 Comæ Berenices."

The death is announced of Prof. Henry N. Moseley, LL.D., F.R.S., one of the most distinguished naturalists and biologists in the country, at the early age of 46. As a member of the English Government Eclipse Expedition to Ceylon and Southern India, in 1871, he made successful observations near Trincomali. Appointed one of the naturalists to the *Challenger* Expedition, Dr. Moseley served on board that ship during the entire voyage round the world, from 1872 till May, 1876. On his return he was elected Fellow of Exeter College, and resided there several years, working out some of the scientific results of the expedition, and preparing for the press his work entitled "Notes by a Naturalist on the *Challenger*, 1879." A large portion of these notes was reprinted in the narrative volume of the official work on the scientific results of the *Challenger* Expedition, of which he was joint author with his colleagues on the scientific staff. For two years Dr. Moseley was assistant registrar to the University of London, but vacated that position on his election, in November, 1881, to the Linacre Professorship of Human and Comparative Anatomy in the University of Oxford. He became a Fellow of the Royal Society in 1877, and was a member of the council for several years before his death. In 1884 he was president of the section of biology at the meeting of the British Association at Montreal, when the M'Gill University conferred on him the degree of LL.D. During the *Challenger* Expedition Dr. Moseley undertook the entire collection of plants at the various regions visited. Prof. Moseley was a Fellow of the Royal, Linnean, Zoological, and Asiatic societies, and contributed many valuable papers to their Transactions.

Mr. George Henry Haydon died the other day in his 70th year. He was one of the earliest explorers of Australia, and his two books on his experience of 50 years ago are rare and valuable. He at first settled in French Island, but later went to the mainland and made the first crossing from Melbourne to Gippsland.

The death is announced of Mr. Wharton Jones, F.R.S., at Ventnor, where he had been retired for some time engaged in the study of his favourite subject, the state of the blood and blood vessels in inflammation. Mr. Jones was in his 85th year.

The following is the list for the Council of the Royal Society to be elected on the anniversary, St. Andrew's day, Nov. 30:—President, Sir W. Thomson; treasurer, Dr. J. Evans; secretaries, Prof. M. Foster and Lord Rayleigh; foreign secretary, Sir A. Geikie; other members of the council, Capt. W. de W. Abney, W. T. Blanford, Prof. A. Crum Brown, Prof. G. C. Foster, J. W. L. Glaisher, F. D. Godman, J. Hopkinson, Prof. G. D. Liveing, Prof. J. Norman Lockyer, Prof. A. M. Marshall, Dr. P. H. Pye-Smith, W. C. Roberts-Austen, Prof. E. A. Schäfer, Sir G. G. Stokes, Bart., Prof. S. H. Vines, and General J. T. Walker.

The medals in the award of the council of the Royal Society have been distributed as follows:—The Copley Medal to Prof. Stanislao Cannizzaro

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[*] The reader should very carefully note that this is not an approximate result, but exact. In all these cases, where limits are dealt with, we are compelled to consider approximate *cases* in order to learn the nature of the final state of things; but our *result* refers to that state of things, and not to any intermediate state, *however near.* The reader has missed the essential point of the method of limits if he fails to see this. We have not to deal with approximate *results* at all in thus applying the method of limits. Perhaps the beginner may recognise this truth more clearly if I apply the method to solve a well-known problem. Let it be required to determine the angle A B T, included between a radius, A B, of the circle B C F (Fig. 2) and the tangent B T at B. Take C a point near B, and draw the secant C B D. Then conceive that C approaches B, carrying the secant along with it. Obviously when C has thus moved up to B, the secant will occupy the position of the tangent B T. Now in any antecedent position, as C in the figure, we have the triangle A B C isosceles; and the equal angles A B C, A C B together, differ from two right angles by the angle A. Hence A B C falls short of a right angle by half the angle A, so that A B D (which together with A B C makes up two right angles) exceeds a right angle by half the angle A. Now when C moves up to B the angle A diminishes, and ultimately vanishes. Hence the difference between A B D and a right angle ultimately vanishes; so that when the secant C B D has become the tangent B T, the angle A B T is a right angle. We know this to be not approximately but exactly true; but the reader must not be satisfied until he sees that the line of reasoning given has *proved* it to be so.

FIG. 1.

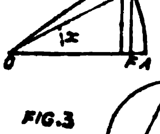


FIG. 2.

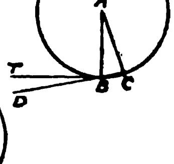


FIG. 3.

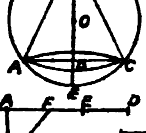


FIG. 4.

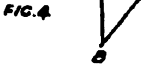
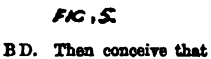


FIG. 5.



for his contributions to chemical philosophy; a Royal Medal to Prof. Rücker, for his researches on liquid films and his contributions to our knowledge of terrestrial magnetism; a Royal Medal to Prof. Lapworth, for his researches among the older rocks of Britain; and the Davy Medal to Prof. Victor Meyer, for his researches on the determination of vapour densities at high temperatures.

The Christmas lectures (to juveniles) at the Royal Institution will be delivered by Dr. J. G. McKendrick, F.R.S., professor of physiology in the university of Glasgow, who will take for his subject "Life in Motion, or the Animal Machine"—a very suitable subject for juveniles.

The Geological Photographs committeee of the British Association, which was appointed for the collection, preservation, and systematic registration of photographs of geological interest in the United Kingdom, point out in a circular that about half the counties of the United Kingdom are not yet represented in the collection. The secretary of the committee will be glad to receive copies of suitable photographs, and will forward the circular and other particulars on receipt of requests therefor addressed Mr. Osmund W. Jeffs, 12, Queen's-road, Rock Ferry, Cheshire. Photographers in various parts of the country should take note of this circular.

It is stated that Mr. C. Dawson, F.G.S., has discovered a mammalian fossil in the Wealden near Hastings. The fossil consists of a single tooth of an animal apparently allied to the well-known Plagiaulax from the Purbeck formation of Swanage. It has been forwarded to the British Museum, and was exhibited at the meeting of the Zoological Society.

A process of lead "galvanising" or galenising iron is being introduced into this country from America, we believe. Probably the principal feature of the process consists in the method of "pickling" or cleaning the iron in a bath containing, besides hydrochloric acid, a certain per-centage of hydrofluoric acid. The articles are then immersed in a bath of lime-water to remove the acid, and are then placed in a tank containing solutions of the chlorides of tin and zinc, whence they are taken to the bath of molten lead. The coating of lead is said to be durable and adherent, and to preserve the iron better than the ordinary processes of galvanising and tinning. It remains to be seen how far lead will protect iron by the new galenising process.

Some time ago (May 1, 1891, p. 205) one of our correspondents gave a short account of a remarkable exhibition of what, for want of a better term, was described as "physical" force phenomena. The exponent or exhibitioner was a Miss Mattie Lee Price, and the scene San Francisco. A few weeks later Mr. Saml. Haigh, of Santa Clara, California, gave an account (see p. 502, July 31, 1891) of what he had seen Mrs. Annie Abbott do, and that lady gave on Saturday afternoon last at the Alhambra, Leicester-square, an exhibition of her remarkable powers before a critical and invited assemblage of medical men, scientists, and pressmen generally. She performed all the feats described by Mr. Haigh, and fairly puzzled all the eye-witnesses. It appears that Mrs. Abbott, who does not weigh 100lb., cannot exercise her power on dead and inert matter; but she certainly seems to do as she likes with living matter in the shape of half a dozen men, who cannot take a billiard cue from her when loosely held in her hands, nor hold up a chair when she touches it. On the other hand she, when she so wills, can drive them all over the stage, and topple them out of a chair even when their hands are placed between her hands and the woodwork of the chair. Mrs. Abbott is also easily lifted from the floor when the hands of the lifters are covered with some insulating material—say silk handkerchiefs—but she is immovable when their hands touch her bare arms. She can also transmit this immovability to another person by a "connection," which is merely a silk handkerchief. A full account of the "feats" was given in the *Weekly Times and Echo* of last Sunday, and whatever may be the explanation, the performance is certainly most puzzling and inexplicable.

A new mineral, which has been named boleite, is stated to have been found in the mines of Boles, Mexico. It is described as a fine blue crystal of cubical form, and is found among the clays in the carbonate of copper ores worked in the mines.

Prof. Billroth, lecturing recently, said that, if the new rifles were used in war, the ambulance department of the Austrian army would be absolutely inadequate to deal with the vast number of wounded in a great battle.

Mr. Stuart A. Russell's new work on "Electric Light Cables and the Distribution of Electricity" will be issued shortly in Messrs. Whittaker's Specialists' Series. The work, after considering the laws relating to temperature and pressure, and the effect that they have on the determination of the sectional area of the conductor, goes on to describe the various methods of insulating. Chapters follow on the testing of cables, on external wiring, underground work, and the methods of distribution of our various supply companies; to which are added notes on testing circuits in daily use, and on the localising of faults in conductors.

The Continuous Brakes Return for the first half of the present year, just issued, contains details of 671 faults or failures. Thus there were due to automatic vacuum, 411; to Westinghouse, 244; to simple vacuum, 15; to chain brakes, 1; total, 671.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor *of the* English Mechanic, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> "I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
> —*Montaigne's Essays.*

SATURN.

[32909.]—Will any of your readers who may have had the good fortune to see Saturn on Sunday morning, Nov. 1, between the hours of 5 and 6 a.m. (civil time of Greenwich) oblige me by reporting to you whether they were then able to see any trace of the edge of the ring on either side of the disc of the planet? An eminent Dutch astronomer has very kindly informed me that "once for a moment he fancied he saw the ring at 5h. 10m. a.m. G.M.T. between passing clouds, with a refractor having an aperture of 9⅓ P. inches; power 114." This may mean old Pau's measure. Unfortunately, that Sunday morning was overcast here so as to render observation impossible. But on Saturday, Oct. 31, 6h. 30m. a.m., Saturn had no visible ansæ, and on Monday morning, Nov. 2, 5h. 30m. a.m., the ansæ were quite easily visible, having a vivid electric-blue colour streaked with white along the brighter portions of the inner and outer rings [o.g. 6in.; power, 180.] **A. Freeman.**

Murston Rectory, Sittingbourne, Nov. 13.

BRILLIANT METEOR, 11TH OCTOBER.

[32910.]—Mr. Denning (letter 32892) is quite right, so far as the Dublin observation is concerned, in his surmise that the initial altitude given is too high. I since visited the place from which the meteor was seen, and found it would be better represented by, say, 30° instead of 45°. From other replies which I received low altitudes at beginning and end are fully confirmed. I may mention that I kept a three hours' watch (12 till 3 a.m.) on the night of the 13th inst. for the Leonids, but without result.

Dublin, Nov. 15. **W. H. Milligan.**

[32911.]—In reply to Mr. Denning, I beg to say that I am not at all clear as to the angle the meteor made with the horizon, and the elevation as given by me might be incorrect, though all the particulars I furnished to the "E.M." were endorsed by a friend who was accompanying me to service, and who (though not an astronomer), is more than ordinarily acute and accurate. With regard to Mr. Richards's criticism of Mr. Cope's account, I should not have forwarded it to your journal had I not been struck with its evident care and fidelity.

Llanelly. **Arthur Mee, F.R.A.S.**

THE LATHE INDEX.

[32912.]—When I had a lathe (ornamental) made to my specification I was so horrified at the smallness of the division when 360 were required that I schemed out two circles of 180 each, intermediate the one of the other, so as to make 360, which is a very useful number for the holes. This, of course, required the index finger to be properly adjusted, so as to lie right for each circle and to divide equally. This was done, and the comfort in "reading" was great. **Z. Y. X.**

[32913.]—In a P.S. to my paper, now I believe in the printer's hands, I have testified to the efficiency of the pillar and spring. With regard to stiffness, this must, of course, be secured by making all parts as strong as possible. Taking the pillar as 4½in. to 5in. high, it should not be less than ¾in. to 1in. at base, and taper slightly to ⅝in. at the top, so that the inner sliding pillar may be ½in. diameter—all being steel. The spring is, of course, short compared to the ordinary one, and the inner rising pillar or spindle which carries it will never project more than about 1in. If wheel-cutting is contemplated, or any work trying to such index, I would make the pillar 1in. at base, tapering to ⅝in., or even cylindrical without any taper. It will not, even at that, appear clumsy. It is for use, not ornament, and being at the back it is by no means conspicuous. So much depends in these cases upon the intended work, that a light affair may be all that is needed for one person, and a specially stiff one for another. There is no great strain in ordinary ornamental turnery, because in deep cutting the tool has to be advanced very gently, revolving cutters declining deep penetration.

With regard to the numbers on the pulley, I believe I spoke of 360 as the outer one. If so, I was wrong, and 360 is a very close bit of drilling on the pulley of a 5in. lathe. Mine are 180, 144, 132, 120, 108, 96, 52, 7—eight in all, and of these, as H. L. Howell says, about two or three will generally serve. Yet, still, I like to have them all, though if I had not chanced to have the old plate, I should probably have been content with the original three circles on the face of the pulley as purchased, 180, 112, and 100, of which the latter came in for most of the work. Only once in another lathe did I use 360, and cut at each division. **O. J. L.**

INCUBATORS.

[32914.]—Since you published the drawings of the incubator that I constructed I have had many inquiries about them, one from Russia, all the way. I replied to them all, except one, who wanted me to send plans to the "E. M." how to make an incubator to hold eleven or twelve eggs. My advice to that party is to get one of So-and-So's incubator and rearer combined; one can get them for about a half-crown, but they won't work with paraffin oil. Laying all joking aside, it is useless making an incubator to hold less than fifty eggs. For the use of anyone wanting to make an incubator, I insert a few rules or instructions. If adhered to, anyone will be able to make an incubator that will hatch eggs. 1st. If you want to make one, say, for 50 eggs, put that number within a square. Well, that will be the size of your drawer. Make your tank the same size, but not less than 5in. in depth. 2nd. Have bottom of drawer 4in. below bottom of tank. 3rd. Put air-holes, ⅜, eight in number, and 2in. below bottom of tank. 4th. Fill the seal or regulator with 15 drops ether and 10 spirit of wine.

Bottom of drawer is made of perforated zinc, with a piece of bathroom towel put in for the eggs to lie on. Make the drawer 5in. in depth; but the bottom is only 2in. from top. Also cut out part of back of drawer, so much that it will slide over top of water tray. The latter, which is less a little than inside of drawer and 1½in. in depth, is made of zinc. I will, with Editor's permission, send sketch of frame, drawer, and tray next letter, and should anyone be building an incubator, banish the idea of making one to be filled morning and evening with boiling water—it won't do.

J. Fraser Cottoun.

Glencarse, Perth, N.B.

[32915.]—I should like to take this opportunity of thanking "Incubans" and "Fraser" for their valuable letters on the above subject, and I think, after what they have written, no ordinary mechanic would have any difficulty in making an incubator; but the very important subject of a "thermostat," or heat regulator, seems to have been barely touched, the one described by "Incubans" (32855) having many objectionable features, one of which is sufficient in this variable climate: it regulates the heat of the water only, and not that of the egg-chamber. The one described by "Fraser" (32834) is far better to my thinking; but I, for one, would be glad of a few more particulars of how to make the regulator itself; for instance, I should be greatly obliged to "Fraser" if he would tell us what gauge brass he found to answer best, how to go about filling the space between the two brass plates (are the two plates flat?) with ether, how to solder it up hermetically with the ether inside, and what seems at first sight most important of all, how, if the ether "boils" at 90° and opens the ventilator, how the temperature is kept stationary at about 12° or 14° *higher* than that point.

So much for an apparatus heated and worked by an oil-lamp. To those who are fortunate enough to have gas available, the difficulties of heat regulating are far less. I have made one for myself on the same principle (or nearly so) as that described by "Incubans" in this week's issue of the "E. M.," but very different in construction, but I do not think it worth while to take up your valuable space by fully describing it (unless any of "ours" may particularly wish it), as, since making it, I have found that the same thing can be bought cheaper than you can make it, in two or three forms. There is Page's gas-regulator (2s. 6d.), Reichert's ditto (5s.), and Bunsen's ditto (6s.) I think Reichert's is the best, as it is provided with a screw adjustment for regulating the temperature at which the rising of the mercury cuts off the gas supply. Messrs. J. Griffin and Sons, 22, Garrick-street, Long-acre, supply either of them.

I have by me a work, the "Illustrated Book of Poultry," by L. Wright (published by Cassell, Petter, and Galpin). It belonged to my father, and was published, I think, about twenty years ago, and it contains a very exhaustive chapter on "Artificial Hatching," and describes very fully quite a number of incubators, all of which have been used with more or less success, and some of which have been put on the market commercially. The heat regulators of several are described and illustrated very fully, and their merits, or demerits, pointed out. If any of "ours" think that the reproduction of the whole, or a portion of the chapter in question would assist them, it is, with the Editor's permission, very much at their service, drawings and all. The same chapter also contains a very good and plain account of the routine work of an incubator.

Threesquare.

[We should have no objection; but you must obtain the author's permission first, of course. He is an old contributor to "Ours," and may possibly see this and respond.—Ed.]

MAGIC SQUARES.

[32916.]—In some, if not all, magic squares the arrangement of the numbers forms a regular pattern when they are joined consecutively by straight lines. Thus, in Mr. Truscott's square of 64 numbers, on p. 244, the first eight, when joined, give a symmetrical figure, and the last eight give precisely the same figure, but upside down, and so with the second and seventh sets of eight, &c.

This property may not be of any use in arranging the numbers at first, but gives the means of comparing different kinds of squares, and might enable one with a fair memory, who can keep the pattern in his mind, to write down the arrangement of the numbers offhand.

G. H. S.

[32917.]—The square of eight by J. H. Truscott, F.R.S.N.A. (letter 32883), is comprised in the set of squares of which the last in my letter (32885) is an example. Mr. Trustcott's square, dressed in the same garb, presents the following appearance:—

8*	2	6*	4	5	3*	7	1*
9	15*	11	13*	12*	14	10*	16
17	23*	19	21*	20*	22	18*	24
32*	26	30*	28	29	27*	31	25*
40	34	38	36	37	35	39	33
41	47	43	45	44	46	42	48
49	55	51	53	52	54	50	56
64	58	62	60	61	59	63	57

This method is not only applicable to all squares the root of which is evenly even, such as a square of 32; but it may, with a slight modification, be applied to the construction of any oddly-even square, such as one of ten. In these last squares, however, the two middle rows contain complements *vertically* opposite except in the two middle columns. These rows contain the $\frac{n}{2}$th and the $\left(\frac{n}{2}+1\right)$th set of n numbers which may be first written down consecutively, the upper row from left to right, the lower in reverse order, and then $\frac{n}{2} - 1$ inversions must be made—namely, the 1st and $\frac{n}{2}$th pair, and as many other opposite pairs—that is, pairs equally remote from the middle—as will make up the required number, as indicated in the following preparation for a square of ten, where 41, 42, 45, and 49 are marked for inversion:—

8	2*	9*	6	4*	5*	3	10	7*	1
11	17*	20*	13*	15	14	16*	19	12*	18
29*	27	23*	25	21*	28*	24	26*	22	30
40*	32*	36	34*	38	31	35*	33	37*	39
41*	42*	43	44	45*	$\overline{46}$	$\overline{47}$	48	49*	50
60	59	58	57	56	55	54	53	52	51
62	64	68	66	70	63	67	65	69	61
71	79	75	77	73	80	76	78	74	72
83	89	82	85	87	86	88	81	84	90
100	94	91	98	$\overline{96}$	$\overline{97}$	95	92	99	93

To render the sums normal in all the rows, it is only further necessary to exchange one number in each of the five pairs of opposites in the first four rows for the number vertically opposite the same; but it is convenient, if possible, to leave the symmetrical arrangement in the diagonals undisturbed, and this is always possible when the sum of the diagonal numbers in each row is equal to that of another pair of opposites in the same row, since we may then exchange *both* numbers in one of these pairs for their vertical opposites, and *neither* in the other pair. In the above, for example, 1 + 8 being equal to 2 + 7, both the latter are marked for inversion, whilst in the second row 17 + 12 = 11 + 18, and the former pair only are marked.

One further condition must be satisfied, in consequence of the necessity of transposing two numbers in the middle of the fifth row, so as to make the sums normal in the diagonals. This transposition, of the sums in the middle columns are to be normal, must be accompanied by a transposition of another pair of numbers, vertically above or below them, and having the same difference as the former pair. Now we have 97 − 96 = 47 − 46, and the latter pair have accordingly been chosen for the middle pair. The other eight numbers of the fifth row may take any order we choose, provided their complements remain vertically below them. The following is the completed square, as above marked out:—

8	94	91	6	97	96	3	10	99	1
11	89	82	85	15	14	88	19	84	18
71	27	75	25	73	80	24	78	22	30
62	64	36	66	38	31	67	33	69	39
60	59	43	44	46	47	56	48	52	50
41	42	58	57	54	55	45	53	49	51
40	32	68	34	70	63	35	65	37	61
29	79	23	77	21	28	76	26	74	72
83	17	20	13	87	86	16	81	12	90
100	2	9	98	4	5	95	92	7	93

Errata.—(1) In letter 32885, the sentence which follows the third square should end thus:—Is only one of a vast number which may be similarly treated. (2) The 8 at the head of the sixth column in the last square of the same letter should be marked with an asterisk. (3) After the word "random" insert:—Provided the sum of the two numbers lying in the diagonals, together with two others of the same row, equal that of the remaining four.

J. Willis.

DID THE ANCIENT EGYPTIANS USE STEEL?

[32918.]—Your correspondent (letter 32900) has started a most interesting inquiry, and I hope that some of "ours" may be able to throw more light on the subject than we yet possess.

I have repeatedly put the question as to the tools used at lectures on Egypt; but not got much information.

It seems very strange that, as thousands of men were employed, using thousands of tools, they are not frequently found. Surely some must have been lost at times, and long ago as it is, they cannot have rotted away. What we want is to find some of these.

At a recent meeting of our Archæological Society a number of iron tools found among the Roman remains at Chichester were on view. These, although buried some 800 years, had scarcely a speck of rust, and a hone would quickly have put the cutting tools in good order.

I pointed this out to a large manufacturer of iron present, who said there was no such iron made now; that the same made of recent metal would have rusted away in 100 years, and that the Roman tools were about equal to steel.

Of course, iron in those days was not smelted as now, and we may readily imagine that the ancient Egyptians, with their wonderful knowledge of the arts, were able to produce steel, or its equivalent.

One of the most useful finds Egyptian explorers could make would be some of the tools; it would settle this question, and perhaps touch something of value to us of the 19th century A.D.

Matlock. E. G.

GREAT NORTHERN GOODS ENGINES.

[32919.]—This company has recently built so me six-wheel coupled saddle-tank engines, with an entirely inclosed cab, similar to the 761 class passenger tanks—a great improvement when shunting in wet weather, as in the older ones the men had to put a tarpaulin to protect them when running bunker first. Some of them are fitted with the automatic vacuum brake and pipes, and a re, therefore, available for heavy passenger traffic.

Sekon.

L. & N. W. RAILWAY'S ENGINE "GREATER BRITAIN."

[32920.]—As there have been frequent inquiries in the query column about the above engine, I thought the following details and dimensions might be of interest to your readers.

The engine, which is most aptly named the "Greater Britain"—for she is the handsomest and largest engine I have ever seen—is carried on eight wheels, the leading and trailing wheels all being fitted with radial axle boxes, and the high and low pressure driving wheels are placed directly under the boiler in advance of the firebox. The principle of compounding is the same as that of Mr. Webb's former engines. The high-pressure cylinders of the "Greater Britain" are not fitted with Joy's valve gear, as is the case in the former compounds, but with the ordinary curved link, the valve gear being arranged inside the frames, not outside, as formerly. The valve gear of the low-pressure cylinder is the same as in his former engines. The boiler, which is a special feature of the "Greater Britain," has been made with a very long barrel, but the tubes are divided into two lengths by a combustion chamber, which has an opening at the bottom large enough to give ready access to the tubes when required, and this opening is fitted with a valve for the discharge of ashes. The valve can be operated from the footplate, and is kept in its normal position of closed by a balance weight. The tractive power of the engine is practically equal to a non-compound engine having cylinders 21in. by 24in. stroke. I append full dimensions:—Length of boiler, 18ft. 6in.; diameter (mean), 4ft. 3in.; height of centre from rail level, 7ft. 10¼in.; thickness of plates, ⅝in.; No. of tubes between firebox and combustion chamber (copper), 156; length between firebox and combustion chamber tube-plates, 5ft. 10in.; No. between combustion chamber and smokebox, 156 (brass); length between combustion chamber and smoke-box tube-plates, 10ft. 1in.; length between combustion chamber tube-plates, 2ft. 8⅝in.; diameter of tubes (outside), 2⅛in. Firebox—length, 6ft. 10in.; extreme depth, 5ft. 1⅜in.; grate area, 20·5sq.ft. Heating surface—fire-box, 120·6sq.ft.; combustion chamber, 39·1sq.ft.; tubes (front), 853sq.ft.; tubes (back), 493sq.ft.; total, 1505·7sq.ft.; pressure of steam, 175lb. per square inch. Cylinders—diameter of high-pressure (two), 15in.; diameter of low-pressure (one), 30in.; stroke of all, 24in.; distance between high-pressure cylinders, 6ft. 6in.; length of high-pressure connecting rod between centres, 8ft. 3in.; ditto, the low-pressure connecting-rod 6ft. 3in. Frames: thickness, 1in.; distance apart, 4ft.; length of engine-framing over buffer plates, 32ft. 5½in. Wheels: diameter of leading and trailing-wheels with 3in. tires, 4ft. 1½in.; diameter of high and low-pressure driving wheels with 3in. tires, 7ft. 1in. Wheel-base: distance between leading and low-pressure driving wheels, 8ft. 5in.; distance between low and high-pressure driving wheels, 8ft. 8in.; distance between high-pessure driving and trailing wheels, 7ft. Total wheel-base, 23ft. 8in. Weight of engine in working order: on leading wheels, 12 tons 16cwt.; low-pressure driving, 15tons 10cwt.; on high-pressure driving, 15tons 10cwt.; trailing, 8tons 6cwt. Total, 52tons 2cwt. Weight of tender in working order, 25tons. Total of engine and tender, 77tons 2cwt.

The "Greater Britain" made her maiden trip on the 4th ult., taking 25 empty carriages, or a gross load of 382tons 9cwt. 2qr., including engine and tender, between Crewe and London, in 4 hours 2min., with a stop at Rugby of 21min., with a consumption of ·34lb. per mile of coal, including 10cwt. used in raising steam before starting. The average speed between Crewe and Rugby was 41·18, the speed never falling below 30 or rising above 49·41. Between Rugby and Euston the average was 44·59, the highest-speed 55·38, the lowest 38·22 miles per hour. **North Western.**

CHOOSING A PIANOFORTE.

[32921.]—In all cases (query 75826) a full-compass pianoforte has seven octaves. There are many very good ones with 6¾. The grand piano is the best, but the most inconvenient. You ask which is the best—a cottage or an upright? When you tell me where I can find a horizontal cottage, I shall be able to answer. The chief points in a good piano are round, full, mellow tone; freedom from all mechanical noises; perfect equality of touch; a good soundboard; rapidity of action; strength of wrest-plank and pin wrest. An iron frame will generally stand better than a wooden frame, though something will depend on the wood of which the wrest-plank is made being well seasoned. A trichord theoretically should give a fuller tone than a bichord. Practically, if the hammers are not heavier in proportion, there is not much gained by having three strings. If the piano is bichord up to middle C of 512 vibrations, and trichord from that point upwards, the balance of tone will be fairly well maintained. Common pianos have the felts only glued to the hammers, good pianos have them riveted. **S. Bottone.**

[32922.]—In reply to 75826, I think a cottage pianoforte should not be less than 4ft. in height. It is a mistake to buy a Pianette, even for children, although some people think them good enough to practise on, not knowing that children, by the use thereof, acquire a bad touch, of which they cannot rid themselves in after years when the toy piano is of no further use to them. The sustaining quality of sound is of great importance. When the loud pedal is used and chords are struck the tone should be heard for 45 seconds, and if the tone be not sustained for that length of time, it may be taken that the soundboard is wrongly constructed. It should be iron-framed; no frame can be constructed of wood with sufficient strength to resist the tension of the strings, which is, in a trichord cottage, about 14 tons. Then, again, instruments with the wooden frame are always more or less out of tune, being powerfully affected by any slight change in the temperature; on the other hand, the iron frame expands or contracts (according to the change in temperature) with the strings, and is consequently less liable to get out of tune. It should be trichord down to the loaded (bass) strings, because in a trichord the tone is always fuller. The check action is a *sine quâ non*, for without the check action the repetition is exceedingly imperfect. The keys should be bushed in the holes with cloth or leather, with oval pins to work in. The height of the keyboard should be such that the performer may use the ordinary chair. When the keyboard is of such height that a special stool is required, it may be assumed that it has been so constructed by the manufacturer for the purpose of utilising a cheaper action—*i.e*, without prolongs. It should be cross-strung. By this arrangement the strings are of greater length, the bridge is also longer, consequently the strings get more spread over the soundboard and leave a greater space between each note on the bridge, and, what is of great importance, the strings are several degrees out of a vertical line, bringing them near in position to those in a grand piano. All modern full-sized cottage pianos have a keyboard containing seven octaves. However, more than one of our sometime best and largest manufacturers have stooped to make "toy pianos" containing 6¾ octaves. They must be aware that they cheat the public with such things. Indeed, they have been doing this all along, probably unwittingly, by keeping the art of pianoforte making back, because if a manufacturer in a small way made or adoped any improvement, he could not sell his instrument, simply because the larger manufacturers had not adopted it, and the public supposed that they—i.e., the larger manufacturers knew best. They have thus brought it about that the foreigner, usually considered to be less civilised, not only supplies our colonies, but swamps (if I may be allowed the expression) all England with his pianos. It is a misfortune to any nation that where it produces a clever man, his less-gifted descendants reap the benefit of the good name their father left behind him, but not through any original merit of their own, nor for the inferior article they may, and generally do, produce.

J. H. Schucht.

[32923.]—As to choosing, in my opinion the various forms of actions, systems of framing, and cross-stringing are of no importance as compared with the quality of materials and workmanship, and these are points on which none but an expert can possibly give any opinion worth having. It may be taken that a German-made piano is, for music, and capability of rendering the player's meaning, far better than an English one at the same price. Possibly a good English make will last longer than any other; but the safest way for one who is not an expert is to go to a dealer who has a good reputation at stake, and trust him to select. Where a medium price is paid, I believe that the instruments made by Neumeyer are the best value, and the most responsive to the soul of the player—i.e., there is more music and more reasonable wear in an instrument by this maker than in any other for the same price, although an experienced professional player might not select one for his own use. Of very old instruments which have had 25 or 30 years' hard wear, those which have come out best are, in my opinion, Hopkinson's; but I know nothing of their recent manufactures. **999.**

NATURAL DRINKS.

[32924.]—In reply to 75845, I think nothing as a natural sustaining beverage can equal warm, pure milk, fresh from the cow, and not from the milkman; also koumiss prepared from milk—in a late number of "E.M." the preparation is described. My favourite drink from childhood (as I dislike milk in any shape) is balm-tea. The balm of English gardens is a Melissa, so named from the Greek word meaning a bee, those insects always haunting the plant, which will grow in any garden, but should be cut and dried for winter use in a paper bag kept in a dark room, and then packed in an air-tight canister. Put a handful of stems and leaves in a quart jug, with half the juice of a lemon, and a shred of peel, adding a little sugar. Pour on boiling water from a kettle, and let the tea cool. This will be found very fragrant and refreshing. The tisanes of the French people are all pleasant and emollient, particularly marsh-mallow, and the foliage of a small orchid (Angræcum) they call Fame now nearly extinct in the islands of Bourbon and Mauritius, by its popular consumption. In India, where I could not get balm, I used the aromatic lemon-grass (Cymbopagon) grown by everybody, being a sudorific and thirst-assuaging draught of great value. It should be dried by an expert, and introduced into Europe, being delightfully odoriferous, resembling our Aloysia in perfume. I have used the fruits and berries of many lands in the concoction of drinks. Having carefully picked over, and selected the desired kind, pour boiling water over them in a jug, bruise and strain, adding sugar and lemon-peel to your taste, or add orange juice and peel as a variety. A mucilaginous solution very far superior to any European emulsion, is used by the poorest of the poor in India, and highly commended by British practitioners. The seeds of Dracocephalum Royleanum are sold in most native drug shops under the vernacular name of Tukhm Balungoo. On immersing a teaspoonful of these small, black grains in cold water, a gelatinous mass is rapidly produced. Semi-transparent, and of agreeable flavour, the addition of a little sherry and sugar rendered this cheap liquid jelly to me inimitable as a soothing mixture in coughs and colds. Why this very cheap and abundant product of India should not yet have arrived in England, surprises me. Where grapes are plentiful, the juice, expressed in any simple manner, then strained, and a large wineglassful taken two or three times daily, is a remarkable purifier of the system, and a renovator of the blood; it is a thirst-subduing fluid in febrile disorders.

Eos.

Ozokerite, or mineral wax, is a substance which can be used for almost every purpose to which beeswax is put; and is especially useful to electricians as an insulator. Until 1888, when deposits were found in Utah, our supplies had come exclusively from Galicia, but now a fresh deposit has been found in Southern Oregon. The new wax is of a yellowish white colour, and burns with a dense smoke, but no smell. It has the advantage of being very light, and seems to be purer than that of Utah.

The Production of Extreme Cold.—According to a notice in the *Monthly Magazine of Pharmacy*, M. Raoul Pictet, who has for many years been working upon the subject of the liquefaction of oxygen, hydrogen, and other gases, has recently found that when a mixture of the anhydrides of sulphurous and carbonic acids is liquefied by cold and pressure, the fluid thus obtained is more manageable than the carbonic acid ether mixture. It produces by its rapid volatilisation an extremely low temperature, and for purposes of this kind is now known as "Pictet's fluid." Aided by a mechanical pressure of from four to ten or twelve atmospheres—for most purposes one of about nine is amply sufficient—gaseous nitrous oxide is readily liquefied by the cold resulting from the evaporation of "Pictet's fluid." Then, by the use of this liquid nitrous oxide, a yet more intense cold is obtained, and under pressures of from 120 to 200 atmospheres hydrogen, oxygen, nitrogen, and common air are rendered fluid. Fluid air, the temperature of which is not much above 200° C., is described as a blue liquid; and on letting a little escape, a distinctly blue cloud is formed, disappearing very quickly as the vapour diffuses in the air.

REPLIES TO QUERIES.

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*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75237.]—**Photographic Blue Prints.**—I do not think that there is any satisfactory way of converting blue prints into black. Infusion of nutgalls has been proposed; but the result, I have found on trial, is rather smudgy, the white parts being also partially blackened, owing to the fact that tannate of iron is partially soluble in water. **A. E. B.**

[75249.]—**Japanning Round Wire.**—Take the articles to be enamelled and clean them from rust and grease; coat them over with japan, and then place them in a hot chamber. For your purpose a piece of light tube, sufficiently long and wide enough, placed vertically over a gas-bracket, or a large oil-lamp; suspend wires inside for three or four hours till quite dry and hard (place tube on lamp instead of glass). Enamelling simply consists of burning or stoving the enamel upon the surface of articles. Heat is all that is required. About 350° for three hours; or articles soldered, 200° for four or five. I do lots of small articles inside an ordinary oil-stove. If well done, it will stand lots of rough use and knocking about. Experiment for yourself. **Country Mechanic.**

[75346.]—**Tamarind Wine.**—This I know not, though I lived amid tamarind-groves half my life! But "tamarind beer" I manufactured years ago, and my friends enjoyed it. I have quite forgotten the proportions, but here are the ingredients:—Clean a quantity of fresh ripe tamarinds from seeds and skins on a hair sieve; pour boiling water over the same into a large glazed milkpan; add a little ginger powder (I always used the green condiment from my garden), rub a fresh lemon with two or three lumps of loaf sugar, add these to the liquor. When nearly cool, put a little yeast into the pan (I employed a dessert-spoonful of ripe bottled ale as ferment). In cool weather, bottle-off in strong pint bottles after 48 hours; in the warm season 24 hours will do. **Eos.**

[75400.]—**Buzzer.**—Old Field Service Sounders used in the "C." troop R.E. were converted into vibrating sounders and a telephone receiver inserted in the line, either up or down or in both. The patterns now in use are much better instruments, the resistance of the coils not being so high. They are connected as a shunt to the line, and when a current is sent to the line it makes and breaks contact with extreme rapidity; thus each current is broken into a succession of currents, and a musical note is sounded in the telephone of long or short duration, according as a dash or dot is signalled. It has worked well through bare wire laid on the ground, and even when part was in water. Vibrators and telephones have worked well through 70 miles of line with only five cells. **M. C. B.**

[75413.]—**Slojd Work.**—To "T. L."—You finish your reply on page 268 on the above subject by saying: "It is practically useless to teach boys a trade they may never follow." You seem to forget that to teach a boy to use a hammer, knife, or chisel is to teach him something he will be thankful for for the rest of his life. "Slöjd" is the Norwegian name given to the branch of manual instruction given to all children in that country, and this instruction is what has brought that country to the fore of late, and the want of it in this country is the cause, or one of the causes, of our back-sliding.

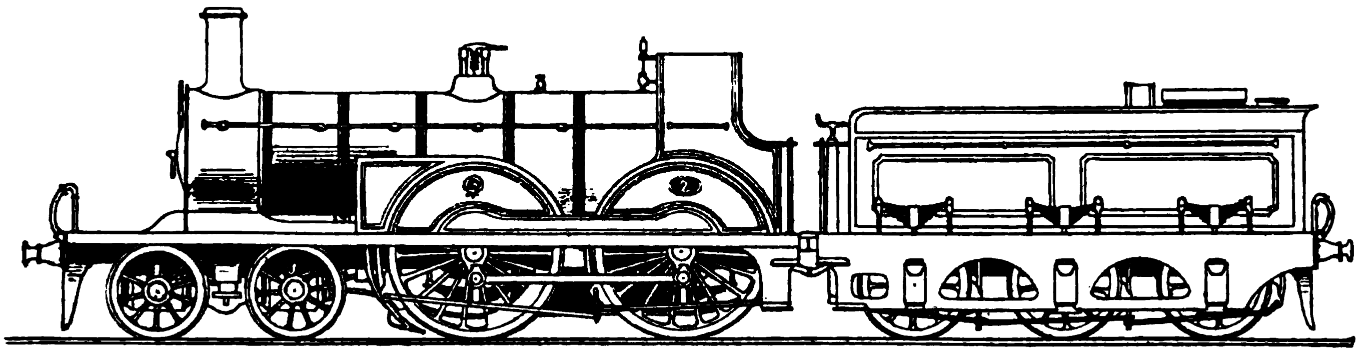
Blackburn Technical School. **A. M. B.**

[75440.]—**Registering Earth's Magnetism.**—The daily irregularities of the magnetic needle used to be registered by periodical and systematic observation; this, it is needless to say, entailed an immense amount of tiresome attention. It is, I believe, done now by photography. A small mirror is fixed at the end of the needle, on this a pencil-like ray of light is thrown, and from it is reflected upon a travelling sensitised surface; the arrangement so as to give the hours and correct reading being matters of detail. **A. E. B.**

[75442.]—**Enlarging Lantern.**—You could enlarge with your ½-plate camera by blocking up a window and using daylight, up to any size. If you use a paraffin lamp, then you will need a condenser of sufficient size to cover a ½-plate, and proceed as with a magic-lantern. But a condenser of that size is an expensive article for an amateur to attempt to mount. **A. E. B.**

[75458.]—**Altering Halse's Medical Battery.**—You do not state what type of battery this is—whether Leclanché, for use medically for current electricity; or chromate, for use with an induction coil. Until this information is forthcoming it is difficult to advise you. If, which I should think would be the case, they are Leclanché, they are already suitable for bells. **A. E. B.**

[75460.]—**Iris Diaphragm.**—"Efil" would see at once, if he examined an iris diaphragm, and



understand better than it is possible to explain. The diaphragm consists of a number of thin plates which slide over one another, and are so shaped that they always keep a more or less round orifice in the centre. As the ring containing them is turned round the orifice is increased or diminished in size. He could see one at any shop where photographic appliances are sold. T. L.

[75462.] — **Cool Chamber Without Ice.**—There is no difficulty in keeping a room cool without ice, provided expense is no object. The processes, both with compressed air and the ammonia method, have been fully described in back volumes, and are explained in a general way in the circulars issued by the makers of the apparatus. There is no difficulty in keeping the temperature of a closed room down to 30° Fahr. even in the height of summer. Nun. Dor.

[75468.]—**Hot-Air Engine.**—There is much information in back volumes as to the construction of hot-air engines; but unless the querist has patterns or can procure castings, he will find it very much cheaper to buy an engine completed by the makers. The querist can get a good idea of what a hot-air engine is like by referring to p. 103, Sept. 30, 1887, and he will then see that it is not a thing to be made off-hand. Nun. Dor.

[75473.]—**Salt Bath.**—There is a preparation in the market which answers very well for all purposes of salt baths, and several railway companies deliver sea-water itself in large towns where there is a demand for it. Borax is not "too drying" when in natural proportion. But what is the object of the salt bath? Is it for some special purpose, or to "benefit the health"? If the latter, it won't. R. S.

[75483.]—**Metallic Compound.**—I suppose the metal fitting of gasogenes is simply pewter; but its strength would depend on its composition. Glass, as is well known, will stand a very high pressure indeed, and yet fractures directly if scratched—water-gauges, for instances, on steam boilers. M. L.

[75487.]—**Detective Camera.**—The querist can find several descriptions of "detective" cameras in back volumes. Say, for instance, p. 255, Nov. 22, 1889. W. H.

[75490.]—**Pitch of Leading Screws.**—It is much a matter of opinion as to the pitch of leading screws; but perhaps some of your readers will express their opinions as to the best pitch, and give reasons. It might lead to an interesting discussion. L. M.

[75492.]—**Cement.**—I should think that the common mastic or shellac cement would answer in this case, or plaster of Paris mixed in alum-water. L. T.

[75499.]—**High Pressure.**—How can anyone answer such a query as this? If the querist gave details of the arrangements of the boilers and pipes, no doubt some reader of the "E. M." could give him useful information; but although the querist doubtless thinks he has given a full description, there is absolutely no information whatever beyond the bare statement—and a puzzling one, too—that there is a high and low-pressure boiler. H. W. E.

[75505.]—**Steam Tricycle.**—There are so few steam tricycles about that no one can form much of an opinion as to their capabilities. There are a few fitted with Serpollet boilers in France, which are stated to run at about 20 miles an hour, and to be practically smokeless and noiseless—on smooth roads. "Smokeless" can always be managed if visible smoke is meant. Cyclometer.

[75510.]—**Model Electro-motor.**—If you will kindly refer to page 86 of my book "Electro-motors: how made and How Used," you will find figured and described the form of motor you require. S. Bottone.

[75512.] — **South-Eastern Railway.** — Herewith I beg to send a sketch, and the following particulars of Mr. James Stirling's express locomotives on the above line of railway. The engine illustrated, No. 2, was built at Ashford Works in 1886. The principal dimensions are as follows: cylinders 19in. diam., 26in. stroke, four slide-bars to each crosshead. The link motion is used. The steam ports are 1ft. 4in. by 1½in., the exhaust are 1ft. 4in. by 3½in.; the centres of cylinders are 2ft. 4½in. apart. The driving and trailing wheels are 7ft. diam. The bogie wheels are 3ft. 9⅝in. diam. The total wheel base is 21ft. 2½in. divided as follows: centres of bogie wheels 5ft. 4in., centre of trailing bogie wheel to driving wheel 7ft. 4½in., centres of coupled wheels 8ft. 6in. The centre of the driving axle is 10ft. 0¼in. from centre of bogie. The frame plates (single) are steel, 1in. in thickness and 4ft. 1in. apart; total length of frames 28ft. 0½in. The boiler is constructed of steel. Length of barrel 10ft. 4½in., diam. of ditto, outside smallest ring, 4ft. 4in. Thickness of plates $\frac{9}{16}$in., ditto of tube plate ⅞in. firebox casing 5ft. 9in. in length, and 4ft. wide at bottom; the centre of boiler from rails is 7ft. 5in.; copper firebox, plates ½in. thick, tube plate ⅞in. thick, length 5ft. 0⅝in., width at top 3ft. 6½in., width at bottom 3ft. 3½in. There are 202 tubes, length between tube plates 10ft. $\frac{1}{16}$in., diameter, outside, 1⅝in.; heating surface of tubes 917sq.ft., heating surface of firebox 103·5sq.ft., total 1·020·5sq.ft; the grate surface is 16·78sq.ft.; the chimney is cast iron 13ft. 4in. height from rail, 1ft. 4in. diameter. Weight of engine in working order:—Bogie 13tons 8cwt., driving wheels 15tons 5cwt., trailing wheels 12tons 17cwt., total 41tons 10cwt. Tender:—Capacity of tank 2,650 gallons, coal space 4 tons; the wheels are 4ft. diameter, the centres are 6ft. apart; the framing is outside with outside axle-boxes, springs, &c.; distance between frames 6ft. 7½in., thickness of frames ⅞in. Weight in working order:—Front pair 10 tons 6cwt., middle pair 10 tons 1cwt., rear pair 10 tons 3cwt., total 30 tons 10cwt. James F. Vickery.

[75511.]—**Sign-Writing.**—There is a useful little book published, I think, by Lockwood and Son which may help this querist; but what is there to learn? I suppose the querist understands the art of mixing paints and laying them on, and can also draw. Then, if he means by "sign writing" painting names on *facias* or "ornamenting" wood to hang outside publichouses, perhaps the less the beaten track is followed the better. Even a simple name on a door-post can be made artistic if there is skill and art at the other end of the brush. G. M.

[75514.]—**Lighting Show-room.**—In the conditions given, the Wenham gas-lamp is about the best thing to use. S. R.

[75520.]—**Electrical Indicator.**—Several indicators of the kind for showing the height of the water in a reservoir, within certain limits, have been given; but as to which is best adapted to the special case it is difficult to say. Would recommend querist to look through back numbers. S. R.

[75524.] — **American Organ.** — The courteous remarks of "Organon" on p. 247, demand from me a reply of a similar character. I firmly believe that my friend knows well the particulars of the "improvements" I have previously referred to. It is quite evident to other readers, as well as to myself, that "Organon" thoroughly understands the subject on which he constantly writes, although correspondents differ in their opinions on certain points. It would certainly be of no use to describe "patented improvements" to amateurs. They could not use or copy these "improvements" (except in one instance, and only then for their own individual use), if I did so. It would be a very easy task for me to describe them; but of what general good would it be? To describe these "improvements" to "Organon" would be like trying to teach him what he already knows, and I am positive that our friend knows as much (if not more), than I do, with regard to the modern construction of American organs. The instructions in Vol. XXVI. are good and reliable; but are, nevertheless, vague when we compare his instructions there given with the methods of construction adopted by the best manufacturers of the present time. Improvements in organ construction (of any value) are generally patented, and these improvements are chiefly effected by manufacturers of good repute, whose constant aim is to make the American organ as well and as perfect as skilled labour can produce it. Practical Organ Builder.

[75525.]—**Boring Holes through Glass.**—Use an ordinary right-angled drill with soapy water; or, if large holes are wanted, a bit of copper tube notched on the edge and supplied with emery and oil. S. R.

[75526.]—**Lung Protector.**—Breathe through the nose, and "blow" it frequently. Otherwise, use Prof. Tyndall's fireman's respirator. By the way, the atmosphere of a flour-mill is in rather an "explosive" state when charged with fine dust. That is one reason why the electric light has found so much favour in flour-mills. Nun. Dor.

[75612.]—**Interest.**—The repayment on capital, the interest being constant, at the rate of 30+10 = £40 per quarter, it seems that the interest for the first quarter being £10 for the use of £150, is 6·65 × 4 = 26·64 per cent.; second quarter, 10 on £120, 8·33 × 4 = 33·33 per cent.; third quarter, 10 on £90, 11·11 × 4 = 44·44 per cent.; fourth quarter, 10 on £60, 16·66 × 11 = 66·64 per cent.; 5th quarter, 10 on £30, 33·33 × 4 = 133·33 per cent. per annum. But, as by compounding, both capital and interest could have been paid in a lump sum at the end of the third quarter, the mean rate of interest is 44·44 per cent per annum. Proof: £150 at 44·44 per cent. = £66·66, less three months or one quarter, remains £49·995 interest for nine months. Marienberg.

[75612.]—**Interest.**—You have my views (letter of October). I affirm that the interest is over, or just above, 57 per cent. Now interest is at "per annum"; but if the borrower does not have the entire loan for one year, he ought only to be debited with the interest at per annum for the period which the borrower has the money. Now, assuming the borrower kept to his bargain and made his payments regularly, he never had the whole sum of £150 for 12 months.

He only had	£150	for 3 months	at 5p.c.	£1	17	6
" "	£108	"	"	1	7	0
" "	£67	"	"	0	16	0
" "	£26	"	"	0	6	6
				£4	7	9

Or if he only paid 5 per cent. per annum, he only would have had to repay the £150 plus £4 7s. 9d., or £154 7s. 9d. But he had to pay £200 so that he paid as bonus £45 12s. 3d., besides the real interest of 5 per cent. per annum. Now this bonus is within a trifle 11½ times the amount of the interest at 5 per cent. per annum, and therefore when paid he will have paid at the rate of nearly 57 per cent. per annum for the loan. This is rule-of-thumb, and not algebra. But where is the rule-of-thumb wrong? Z. Y. X.

[75627].—**Magnetised Steel Wire.**—Two replies to this query have appeared, but neither is satisfactory. The longer piece causes greater deflection than the short one, and is therefore the stronger magnet. J. T. M.

[75670.] — **Contents of Gasholder.** — Thanks to Mr. Ridout. You say 3H.P. Otto gas-engine will drive pump referred to. At present it requires two Crossley's gas-engines, stated to be 7H.P. indicated, to drive the pump, and nothing to spare, as gas explodes every stroke (Dowson's gas). Dimensions: Diameter of cylinder, 7in.; stroke, 16in. What would be the nominal horse-power of gas-engines this size? Any further information will greatly oblige. Kentish Jolly.

[75670.]—**Gasholder.**—When I wrote the other day I could not put my hands on the rule for ascertaining the cubical contents of a cylinder. It is as follows:—Take the square of the diameter, multiply by the height, and divide by ·7854. Thus, 12 × 12 = 144, multiply by 8 = 1,152, divide by ·7854 Result, 904·7808. The ·7854 is of great use to remember as being the relative contents of a square and a circle. Z. Y. X.

[75673.]—**Broken Electric Wire.**—First of all find whether the bell is connected with the zinc of battery or the carbon, and connect a wire with that zinc (or carbon) and the bell, and if the bell will ring, then that is the wire which is broken. If the broken wire is not yet found, connect the two wires connected with the push anywhere along the two lines, and if the bell rings, then the one or other line is broken between that connection made and the push. Continue these connections along the two lines towards the bell, until you find where the line is broken. If these two lines (connected with push) are close together, you can connect them with a knife by cutting through the insulation, but making sure to touch the two wires at the same time. I shall be glad to help you, gratis.

ALFRED TAYLOR.

96, Plough-road, Wandsworth.

[75680.]—**Falling Bodies.**—The force of gravity does not increase at a constant rate, but inversely as the square of the distance. Hence the equation of motion is—

$$\frac{d^2 x}{d t^2} = - \frac{\mu}{x^2}$$

Multiplying by $\frac{dx}{dt}$ and integrating in the usual manner—

$$\tfrac{1}{2}\left(\frac{dx}{dt}\right)^2 = \mu\left(\frac{1}{x} - \frac{1}{a}\right)$$

$$\therefore \frac{dx}{dt} = - \sqrt{2\mu}\sqrt{\frac{a-x}{ax}},$$

the particle being supposed to start from rest at a distance a from the origin. The negative sign in the last negation is taken because t increases as x diminishes. This may be written—

$$\frac{dt}{dx} = - \sqrt{\frac{a}{2\mu}} \cdot \frac{x}{\sqrt{ax - x^2}}$$

$$= \sqrt{\frac{a}{2\mu}}\left[\tfrac{1}{2}\,\frac{a - 2x}{\sqrt{ax - x^4}} - \frac{a}{2}\;\frac{1}{\sqrt{ax - x^2}}\right]$$

Integrating

$$t = \sqrt{\frac{a}{2\mu}}\left[\sqrt{ax - x^2} - \frac{a}{2}\operatorname{vers}^{-1}\frac{2x}{x} + \frac{\pi a}{2}\right]$$

which gives a relation between the time and the distance through which the particle has fallen. The formula $t = \sqrt{\frac{2hk}{g}}$ has been found upon the assumption that the force of gravity is constant.

W. R. COOPER.

[75686.]—**Bell and Telephone Connections.**—If "R. R. B." connects up his instruments in the following manner he will have overcome his difficulty:—Make two springs of sheet brass, A B. Then make out of a stout piece of wire a hook C D, upon which to hang the receiver when not in use. Attached to the lever C D ought to be a small spring G, so that C D may make contact with A when the receiver is lifted off the hook. A circuit-key will be wanted, which is shown in Fig. 2. It consists of a bar of wood, G D, pivoted between two wooden uprights, K, which are screwed to the base M P. A spring, S, is placed near the centre of G H. Four terminals (or metal contacts) are placed as shown at 1, 2, 3, 4. Now connect one terminal of E to A, the other terminal of E going through the transmitter F to earth. The line wire is joined to C D. The bell is connected to the circuit-key as shown, and B is joined to terminal 2 of the key, the battery J being used to ring the distant bell. Unless the receiver be hung on the hook D, no signal can be received from the distant station. To call the distant station, press the circuit-key so as to make contact at 2—4.

C. M. PLAYFAIR.

R. M. Academy, Woolwich.

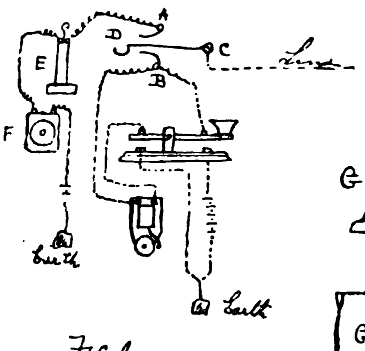
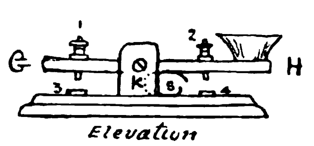
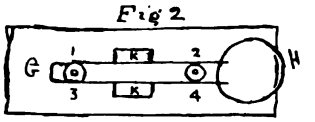


Fig 1.



Elevation

Fig 2



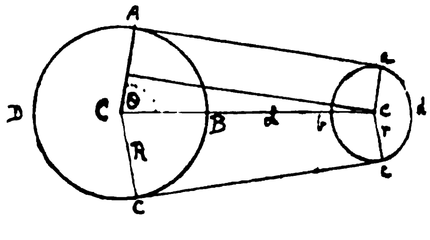
Plan

[75697.]—**Heating Workshop.**—I should recommend "Thermo" a class of circulating stove made for firing with coke. It consists of a regulating furnace surrounded with fire-brick casing, and above this of a series of cast-iron stages provided with crossing passages at suitable angles for the fire gases, and of corresponding portholes or air passages on all four sides for the heating and circulation of the air. The circulation is so powerful that a candle is extinguished by the air currents entering the inlet ports, and as these latter are numerous and on all four sides of the stove, the air from all parts of the shop is brought into action and heated. The size for "Thermo's" purpose, adapted to raising the temperature in shop 18°, would be 6ft. 8in. high by 21in. square at the base, price about £9. These stoves are made in three sizes for respectively 1,500, 2,500, and 5,000 cubic yards of space. If "Thermo" will advertise his name and address in "Ours," I will send him prospectus. M.

[75705.]—**Reed-Voicing.**—As this query, addressed to a "practical" man, does not seem to have met with a very practical reply, I may perhaps, without being considered discourteous, give a few hints which will be useful. It may be quite true that if you give a boy an English Dictionary he may not be able to string the words together as Ruskin does; but still he has the words, and it rests with him to put them together how he can. It is the same with a violin master: there is the fiddle, the bow, and the rosin; but without the something at one end of the bow there is precious little music. Now, as to voicing reeds, if it can be said that "theory is no earthly good," it does not follow that the facts on which the theory is based are "no earthly good" too. Herewith, then, a few facts. It has been known for many years that a free reed vibrating through a "block," as it is called, makes a sound the quality of which depends to a great extent on the environment of the block, to a small extent on the quality of the material of which the reed is made, and to a considerable extent on the skill which is brought to bear in regulating the speech of the reed. Let us take the tenor C reed of an American organ from the 8ft. or diapason set, and examine it. If it has been voiced by a skilled workman, we shall find that the vibrator has been not only bent, but twisted. It has most likely been filed—on the free end, at least—though net unlikely the mill-marks are still left at the rivet end. The vibrator, it will be observed, stands slightly above the block, with the right-hand corner dipping more closely to the block than the left-hand corner of the free end, or the tip. Left-handed voicers may possibly reverse the position; but the rule is for the diapason or round tone to bend the free end of the vibrator for two-thirds of its length in a gentle curve, and to twist it so that the upper surface of the lower side is just about level with the surface of the block as the under surface of the upper side is entering the slot in the block. The wind which sets the vibrator in action is drawn down above the vibrator, through the slot into the windchest, and it may be understood that the vibrator, from its bent and twisted shape, cuts it much in the same way as scissors act. That shape of vibrator gives the round tone. To get the softer tone, commonly called viola or flute, the bend is less, and the twist is not so definite; but it is there, and the vibrator is set a little closer to the block. That is the whole of the mechanical detail of voicing for a two-row American organ; but there must be the artist workman at the "other end" of the bending tool. The reeds must be filed up (if necessary) to something above pitch before bending, because bending flattens them, and no workman cares to file after voicing if he can avoid it, especially filing near the rivet end. To get different tones of voice, differences in the form of bend are adopted; for instance, instead of the gentle curve for two-thirds of the length, a comparatively sharp bend near the free end is made—something like this —⌒, with more or less twist longitudinally. That will give a tone of a different quality, and so will leaving the reeds straight but twisted, and straight but not twisted. So far as a start; but the way to learn is, if you have an American organ, to procure some odd reeds and experiment, for there is more to be learnt in this matter from one hour of actual trial than from a page of print in the "E.M."; but get good reeds, not the rubbish which I am informed is now on the market, and which will not stand much bending and rebending without breaking. If readers express any desire I may return to this matter; but they must remember that even Mustel did not achieve his success in a day.

ORGANON.

[75724.]—**Arc of Contact.**—I do not know whether there is a practical rule for this, but, considered mathematically, a formula is at once obtained. Let the centres of the pulleys be at a distance d apart, and let R r be the radii of the



pulleys. Then, referring to the figure, the angle A C B, or θ, is given by the equation:

$$\cos\theta = \frac{R - r}{d}$$

Hence arc of contact $a\,d\,c = 2\,r\cos^{-1}\frac{R-r}{d}$ and

arc of contact $A\,D\,C = 2\,R\left(\pi - \cos^{-1}\frac{R-r}{d}\right)$

W. R. COOPER.

[75742.]—**Dry Battery.**—To MR. BOTTONE.—Electric-light carbons are graphite; but you surprise me when you say you cannot get graphite. Go to the nearest gas-works and ask the retort men to give or sell you some "retort scurf."

S. BOTTONE.

[75743.]—**Value of One Second of Longitude.**—Distance on parallel = distance on Equator × cos. latitude. Distance on Equator for 1″ = $\frac{6{,}080 \times 21{,}600}{24 \times 60 \times 60}$ = 1,520ft. Where 6,080 = No. of feet in nautical mile, and 21,600 = No. of nautical miles in circumference of earth.

∴ Dist. on parallel (M) = 1,520 × cos. 42° 53′
log. M = log. 1,520 + L. cos. 42° 53′ − 10
= 3·1818436 + 9·8649504 − 10
= 3·0467940 = log. 1113·8

∴ Dist. on parallel of 42° 53′ for 1″ of longitude = 1113·8ft.

H. C. T.

[75748.]—**German-Silver Wire.**—This is to be done by passing between steel rollers made for the purpose. The process of flatting would also harden the wire. S. R. BONNEY, Electroplater, &c.

[75749.]—**Nickel-Plating—Correction.**—For grain read *grammes*, in the sentence, "The weight of Ni deposited per amp. hour is 1·0953 grain."

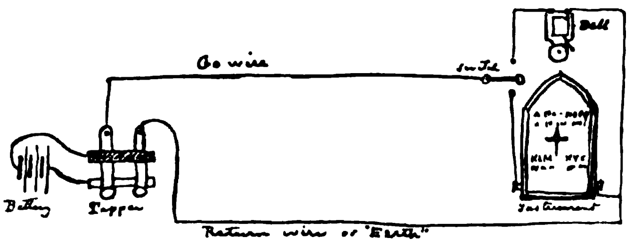
A. D. S.

[75749.]—**Nickel-Plating.**—To prepare iron first boil in potash, and rinse well in clean water, then immerse in a pickle of sulphuric acid and water, ½lb. acid to each gallon of water; time to remain in this pickle should be about 30 minutes; remove, and well rinse; scour with sand. Cast-iron articles will nickel easier if first coppered in a cyanide of copper bath, especially if any cavities have to be filled in with lead; in this case, again rinse and well scratch-brush. Nickel-plated articles that are required bright must have a good polish before plating. To make a good solution, procure the double sulphate of nickel and ammonia; make up this as given last week (75695); battery power required about 4½ ampères at 4 to volts pressure. You can fit up your Bunsen for this work by using in the outer cell sulphuric acid 1 part, water 10 parts; in the inner cell, equal quantities of sulphuric acid and water, to which add an ounce of nitric acid. Be careful to mix the sulphuric acid with the water—not acid first.

S. ROBERT BONNEY, Electroplater, &c.

[75758.]—**Telephones.**—To MR. BOTTONE.—It is indifferent. You may put more wire in, as your bobbins will admit of it, and you will gain in being able to speak farther. S. BOTTONE.

[75747.]—**Single-Needle Telegraph.**—To MR. BOTTONE OR OTHERS.—The annexed sketch shows



the proper way of connecting up the battery to tapper, and thence to switch, bell, and instrument.
S. Bottone.

[75761.]—**Throat.**—The writer, like "Throat," was once under a specialist for several weeks for what he pronounced as catarrh of the throat, but did me no good, so went to another doctor, who said I had a very relaxed throat. With that I referred at once to an old back number of the English Mechanic and found this, which cured me with only three or four applications; but if first dose does not cure, repeat in three or four days. Pound very fine a lump of saltpetre the size of a walnut; pour a gill of boiling water on it; when cold, pour the clear liquid into another vessel to keep out the dust. Last thing at night, and first thing in the morning, take one mouthful and gargle your throat, well throwing the mouthful back into your throat as far back as you can without swallowing it two or three times.
James Booth.

[75761.]—**Throat.**—When I was a little boy my father's sisters—fine women of 12 to 16 stone weight—were wont to make pious pilgrimages from their city homes to the land of their birth, in order to be bled by the hand of their sister's husband, an M.D. of much local celebrity, who had been the succeeding residential M.D. in the household of the 5th Earl of Oxford, to Mr. Bickersteth, ultimately Lord Langdale, of judicial renown. The infallible (?) medical profession had, years before, issued the dogmatic mandate that "bleeding was essential to each and every human being as a prophylaxis or safeguard against disease generally." Hence their said pilgrimage, induced by fear. Where is the modern M.D. who bleeds even in disease now? When the studies and researches and experiments of the then humble German student, Hahnemann, had early in the present century resulted in the proof to the world that bleeding was in all cases injurious, and that in all inflammatory diseases aconite, that most beautiful blue flower to be seen in most cottage gardens, not only promptly removed the inflammation, but avoided the long stage of weakness invariably following recovery after bleeding; then the dogmatic profession conceived and uttered the abominably lying hypothesis that human disease generally had suddenly so changed its type and nature as to render bleeding no longer necessary (how good of Dame Nature thus to oblige them!) But in the present and recent era nature has been forced by man's perverse interference with her laws to give ample evidence in a countless host of families of her type of health having now become to a considerable degree changed to a disease hereditary from the fathers and mothers of a past generation acquired by them constitutionally from, and by, persistent mercurial slow (more or less) constitutional poisoning—i.e., a chronic diseased condition (roused by atmospheric, &c., changes every now and then to an acute form), affecting chiefly the internal mucous membranes, of a type such as described by "Troubled Throat." The M.D. above alluded to gave to my father, in his early adult life, a mercurial prescription (as one of his—the M.D.'s—prophylactics?), one or two of which pills my father, owing to his blind, confiding faith, and his medical ignorance, swallowed every night during 40 years of his life. In each of his numerous children mercurial-hereditary disease appears in some form or other. Numberless similar instances have come under my notice—personally, as well as in medical literature. And where, and by what means, pray, is this mischief anent the genus *Homo* to have an ending? Well, just as the Reformation—Tyndal's translation into the tongue of the people and the Press—placed the Bible within the reach of the poorest, and thus broke their thraldom (this meant fear of the loss of Absolution, &c.) under priestcraft, so in the present era the placing within the reach of the poorest the means of the knowledge of the injury (specials general) of drug action generally, and consequently the source of self-medical salvation by means of homœopathic works and a free Press, may have any influence thereto; but the power of class interest is an awkward, all-potent antagonist. The querist would find his symptoms and their remedies described here and there in "The Uses of the Sixteen Principal Medicines of Homœopathy," or in "The Dictionary of Homœopathy," by Dr. Clark. Belladonna, pulsatilla, sulphur, calcarea, potassium, iodine, mercury, ammonia salts, nitric acid are those probably calculated for the case.
The Lydney Dispenser.

[75770.]—**Magnetised Watch.**—I have had many a watch that has been magnetised within the last few years, but how they have been magnetised I do not know. The best way to cure them is to get a non-magnetic hairspring fitted to it, as the fault in a magnetised watch lies in the coils of the hairspring being magnetised and sticking together, and causing the watch to gain, and then you might regulate it to go slower, and then the coils may get loose from each other, and the watch go too slow. I think myself that you are liable to get your watch magnetised by riding on electric car, or going too near an electric machine, if the watch has a steel hairspring.
G. B.

[75771.]—**Influenza.**—The homœopathic medicines—*Arsenicum*, No. 6 strength (after each meal), *Nux vomica*, No. 3 (twice at night), *Belladonna*, No. 3 (in the morning early, twice before rising)—would probably be a suitable treatment for ten days. Allow their action to continue for a week, then *Sulphur*, No. 3, four times daily for a week, then *Calcarea*, No. 3, four times daily for the next week. You will then have gone through a course which may be repeated when required. If you are observant you will have found out those which are of the greatest and most prompt remedial value for each special symptom or condition, while each would no doubt have a special influence on the constitutional tendencies. There are, however, many others of value in such conditions as you describe. Why not devote a little study to the system of homœopathy? Spend 2½d. on the two pamphlets or Homœopathic League tracts—i.e., No. 24, "The Economy of Homœopathy," and No. 30, "How the Powers of Drugs were Determined" (Bale, 87, Great Titchfield-street, London, W.)
The Lydney Dispenser.

[75772.]—**Leclanche.**—I have had charge of some thousands of Leclanché cells, which were only used four days at the most in the year (and very hard worked too). When finished with, the zinc rods were taken out of the solution and wiped clean and dry; the porous cells were examined and washed in clean water, the tops wiped dry; the outer cell or earthenware jar was also cleaned; some of the solution was drawn off, and a little water added to weaken it. The porous cell was then left in the weak solution till required again, then placed in a dry place, and where there could be a dry draught of air passing over them. Cells treated like this have been in use this last seven years. If the porous cells are left dry, they will become dry and hard, and their resistance will be considerably increased, and perhaps useless in time.
M. C. B.

[75782.]—**Electro-plating Bath.**—Fill up bath with distilled water; wash down from sides of vessel any salts that may have crept up. Having done this, filter the whole through calico two or three times, washing the calico after each filtration. If this does not make it fit for work, add a little cyanide of potassium. There should be no difficulty after treating in this manner. Are all connections clean, and battery in order? The silver may be recovered by evaporating to dryness and fusing. S. Robert Bonney, Electroplater, &c.

[75788.]—**English Lever Watch.**—I think one of these faults will be the fault in your case: Jewel-hole cracked; endstone cracked or broken; pivots too short, so that the shoulder rests on the jewel-hole; jewel-hole or endstone loose in the setting; jewel-hole too large for the pivots; or pivot-end too sharp, so that it cuts the endstone. See that your jewel-holes are good fits to the balance pivots, and the pivots just come through the pivot-holes; that the endstones are good; and that jewel-holes and endstone fit tight in their places. Now see that the hairspring is flat and free, and that balance has just end-shake, and you will be all right, I think.
G. B.

[75796.]—**Sizing.**—Making is a special trade. Would advise "J. & F. A." to advertise in the *Leeds Mercury*, *Bradford Observer*, or *Huddersfield Examiner*.
F. B.

[75798.]—**Induction Coil.**—Your coil should work with two layers of primary wire. The core is too long for wire space; you must either have very thick flanges or the core projects too far beyond them. Anyway, you would have done better had you left nearly another ¼in. for your wire by having thin flanges and the core about $\frac{1}{16}$in. (one-sixteenth) beyond front of coil; still, it should act. I think your connections must be wrong. Have you taken one end of primary to one terminal, and the other end to clapper spring, and connected the other primary terminal with contact screw pillar? I think you will find the fault lies there. If not, there is a break somewhere in the wire of primary. Let us know how you succeed. Of course, you must connect the battery to the primary binding screws.
J. Lamb.

[75800.]—**Cleaning Copper Utensils.**—A large proportion of the culinary vessels in Anglo-Indian kitchens being composed of beaten copper, requiring careful tinning, an itinerant workman regularly calls at the house once or twice a month, to execute the operation. He is a rough, semi-nude native, with few appliances; bellows constructed of two goat-skins tanned, a pair or two of iron tongs, a bunch of cotton rags and cotton wool, a gallipot of salammoniac (muriate of ammonia) and some thick strips of soft solder, of which the alloy ought to be two parts tin, one part lead. A primitive fire-hole is soon constructed in the ground, and having been shaped with stiff clay, the neck of the double bellows is attached to the hollow, and this being filled with hard charcoal, the blast is soon set going by a boy who dextrously opens and shuts the skins alternately by holding one in each hand as he squats before the fire. The workman's attention is solely devoted to the copper vessel. For a very dirty and long-neglected one, some vegetable acid (usually tamarind pods) is boiled with water therein, then the water is thrown away, and the interior scrubbed with wood-ashes and sand till the metal shows itself clean. It is well rinsed with fresh water, and put on the fire, face downwards, and the bellows worked till the pot is nearly red; a piece of rag is then taken up thickly covered with cotton wool, which is plentifully sprinkled with the pulverised salammoniac. The pot is held off the fire by tongs, while the workman briskly rubs the surface of the whole interior with the above salt, and without delay drops into it three or four pieces of solder, working them about until they fuse and a coating adheres to the copper. To equalise the thickness, he again puts the pot on the blast, and, judging by the amount of smoke given off, again gives the interior a rubbing as before, and quenches his work with cold water. Where much cookery of made dishes is carried out, twice monthly tinning is requisite, but generally once will suffice. The simplicity and cheapness of this process must be seen to be appreciated. About 2s. 6d. a score in the current coin is the regulated charge for tinning cooking vessels, large and small, and the same rate for their covers—shallow pieces, like soup-plates, of various sizes. For any kind of copper objects there is no chemical for cleansing purposes equal to salammoniac, of which a small piece dissolved in water forms a good liquid for the removal of dirt and verdigris.
Eos.

[75802.]—**Tangent Galvanometer.**—When the above does not give equal deflections on each side of the zero line for equal currents, it is a sign either that the pointer is not truly at right-angles with the needle, or that the needle is unequally magnetised, or that there is some friction on one side of the pivot which causes a lesser deflection. A silk fibre suspension is the best of all, and is used in all high-class instruments. The passage of the current through the coils, far from weakening the needles, actually strengthens them.
S. Bottone.

[75802.]—**Tangent Galvanometer, &c.**—1. Bend the pointer so that it is 0° when no current is flowing. 2. A fibre suspension of unspun silk has far less friction than any pivot support, but the instrument must have levelling screws, and the needle must be lowered until it rests on the dial when the galvanometer is moved. Carefully balance the pointer, which should be made of aluminium, on account of its lightness, and avoid a violent deflection which is apt to twist the fibre, unless you have "stops" to prevent the needle swinging beyond a certain limit.
A. D. Southam.

[75802.]—**Tangent Galvanometer.**—If the zero line of the cord is exactly at right angles with the plane of the coil, then the fault is with the pointer, which is not at right angles with the needle. To correct this, draw two lines at right angles to each other on a piece of cardboard, place the needle over one, and carefully bend the pointer until it coincides with the other. But in exact measurements the readings should be taken on both sides of zero, and the mean taken, which entirely eliminates any error from this source. As regards fibre suspension, the only objection I know of is the absence of portability; levelling screws are also necessary. The advantages are cheapness and great increase in sensitiveness. Unless very strong currents were used, I do not think the magnetism of the needles of an astatic galvanometer would be seriously influenced. Certainly the "accuracy and delicacy" of such an instrument is not affected by the currents used in ordinary testing.
Student.

[75802.]—**Tangent Galvo.**—Send battery current through coils first in one direction and then in the other, getting deflections of, say, 47° to left, and 44° to right. Now turn galvo on its centre in the direction of lesser deflection, and let the pointer stand at 1° to the left, say. Again, send currents through coils getting deflections of 46° L. and 45° R. Now, since the pointer started from 1° L., the true deflections of needle are, respectively, 46° − 1° L., and 45° + 1° R., or 45° L. and 46° R., so that we see that the error lies now on the other side, the left deflection being smaller than the right since we have turned the instrument too far round. Turn the coil back a little, so that when no current passes the pointer is at, say, ½° L., and send again reverse currents of equal strength through the coil, giving deflections of 45½° L. and 44½° R., which, corrected for initial zero error, corresponds to equal deflections of 45° to either side. If, without altering the position of the instrument, we now bend the pointer until it stands at 0° when no current passes, the galvo. will give correct readings of the currents that may be passed through it. A galvo. is better with fibre suspension than with needle on a pivot for weak currents, as there is less friction, but with fibre suspension the galvo. requires to be carefully levelled. In an astatic galvo. both magnets are acted on by the same current strength, so that though it may alter their magnetic strengths, their relative strengths will not be changed; hence the accuracy of the instrument will not be affected.

J. A. Paisley.

[75803.]—**Red Heat of Iron.**—Incipient red, 500° to 600° C.; dark red about 700° C., incipient cherry 800°, and cherry red, 1,000° C. A. D. S.

[75803.]—**Red Heat of Iron.**—Dull red, visible in the dark, 1,000° F.; dull cherry red in daylight, 1,450° F.; bright cherry red, 1,800° F.; yellow heat, 2,000° F. Thos. Fletcher.

[75804.]—**To F. C. Allsop.**—The transmitter, receiver, and batteries are all placed in series—i.e., the circuit runs thus:—Transmitter of No. 1 instrument, receiver, battery, line wire; transmitter of No. 2 instrument, receiver, battery, and return wire to transmitter of No. 1 instrument. See also Fig. 36 of "Telephones: their Construction and Fitting," which is a diagram of these connections.

F. C. Allsop.

[75805.]—**Centring Short Lengths of Steam Pipe.**—You want a pair of pipe centres for your lathe. Get two cast-iron cones about 3in. diam., have a piece of iron bar about 3in. or 4in. long cast or tapped into the base of each cone, knock the points off the cones, centre and put into the lathe, turn the iron tail pins up to fit the centre holes of your headstock, and turn the cones to an angle of 70° or 80°. When finished use the centres to turn your pipes on. Nemo.

[75806.]—**Hydraulics.**—

$$W = 4{\cdot}71 \sqrt{\frac{D^5 H}{Lf}} \qquad G = \sqrt{\frac{(15\,D)^5 H}{Ly}}$$

Where W = cubic ft. of water discharged per min
D = diameter of pipe in inches.
H = head of water in ft.
G = number of gallons per hour.
Lf = length of pipe in feet, and Ly ditto in yards.
H = P (in lbs. per square inch) × 2·307.

A. D. Southam.

[75806.]—**Hydraulics.**—The following formula from Molesworth should suit your case—

$$G = \sqrt{\frac{(15\,D)^5 \times H}{L}}$$

Where G = gals. per hour.
D = dia. of pipe in inches.
H = head of water in feet
L = length of pipe in yards.

Of course the "head" of water is obtained by dividing the pressure in pounds per square inch by the constant ·43. J. A. Paisley.

[75806.]—**Hydraulics.**—Either of the following will enable you to calculate what you require:—

Let D = diameter of pipe in inches.
H = head of water in feet.
L = length of pipe in feet.
W = cubic feet of water discharged per minute.

Then— $$W = 4{\cdot}71 \sqrt{\frac{D^5 H}{L}}.$$

Or by Hawksley's formula—

$$D = \frac{1}{15}\sqrt{\frac{G^2 L}{H}}. \qquad G = \sqrt{\frac{(15^{\circ})^5 H}{L}}.$$

Where G = gallons delivered per hour.
L = length of pipe in yards.
H = head of water in feet.
D = diameter of pipe in inches.

Pressure per square foot = H 62·4.

Wm. P. Miller.

[75807.]—**Reflector for Incandescent Lamp.**—The form shown on page 253 in this week's number (Fig. 57) seems to be the one most commonly employed in offices, &c. A. D. S.

[75807.] — **Reflector for Incandescent Lamps.**—The simplest and about the best shades for hanging incandescent lamps are those known as opal glass conic, although these shades can also be obtained in enamelled iron. F. Askew.

[75807.] — **Reflectors for Incandescent Lamps.**—See page 253 of "Ours."

Micklethwaite.

[75807.]—**Reflector for Incandescent Lamps.**—You will find the ordinary opal shade quite sufficient for most purposes. You can, however, get a silvered glass shade, which would throw down the light more. F. C. Allsop.

[75807.]—**Reflector for Incandescent Lamps.**—This is a matter of opinion. I prefer the opal shade to any, as you get a soft, white light.

H. H. Headworth.

[75807.]—**Reflector for Incandescent Lamp.**—This is a matter of opinion and individual taste. If the light is to be diffused, I prefer a rather wide-angle opal shade. If the light is to be concentrated in one spot, a silvered copper reflector, concave, will be found the most effectual. S. Bottone.

[75808.]—**Batteries for Arc Lamp.**—Twenty-five cells of the double-fluid chromic acid type will give a good light. F. Askew.

[75808.]—**Batteries for Arc Lamp.**—You will need 20 or more chromic-acid cells to give you an arc light: under this number gives merely a spark.

H. H. Headworth.

[75808.]—**Batteries for Arc Lamps.**—The best and cheapest battery for such a lamp would be the fire, or if you wish to spend money buy a 20-cell Grove or Bunsen. Micklethwaite.

[75808.]—**Batteries for Arc Lamp.**—No arc lamp will give a true arc with an E.M.F. of less than 39 volts; hence the least number of cells that can be used will be 20 bichromate or chromic-acid type. If pint cells are used you will be able to run the lamp for about three hours with one charge, and get from 1 to 200 candle-power, according to the dimensions of the carbons used.

S. Bottone.

[75809.] — **Single - Stroke Bell.** — Leclanché battery would suit you best; but the number of cells depends on distance you want to ring. Morse key would do, but push would be simplest.

Micklethwaite.

[75809.]—**Single-Stroke Bell.**—Three to six cells, according to distance. Whether you use a Morse key or ordinary electric-bell push depends on how you intend to arrange the bell, and whether you require to signal both ways. Figs. 113 and 114 in "Practical Electric-Bell Fitting" show how to connect the bell and batteries to be able to signal both ways. F. C. Allsop.

[75809.]—**Single-Stroke Bell.**—The Leclanché battery is as good as any for bell work, and, if anything, the cheapest. The number of cells required all depends upon the cell and amount of wire used. I should say that, taking an ordinary bell, and say, 100ft. of wire, three No. 2 would do the work very well. You could use which you like, either Morse key or push; but I should prefer Morse key. A. B. G.

[75811.]—**Motor for Model Electric Railway.**—A Manchester-type motor, with armature 2½in. in diameter, 1½in. deep field-magnet cores, ¾in. in diameter, 2½in. long, of wrought iron, with cast yokes, will do very nicely. Reckoning that you will require about one man-power, you should employ 25 volts and 5 ampères to get the needed 125 watts. If you were to use only 6 volts you would require 21 ampères to get the same number of watts, and this would necessitate using a very coarse wire, say, No. 12, on the armature, &c., besides running down the battery very quickly. With 12 small chromic-acid cells you could drive the above motor easily, if you wound the armature with ¾lb. of No. 20, and the field-magnets with 3lb. of the same wire.

S. Bottone.

[75812.]—**Electrical.**—The best charge for box battery, carbon and zinc, consists in chromic acid, 3 parts; sulphuric acid, 3 parts; chlorate of potash, ⅛; water, 20 parts. The single-fluid battery is the better for short runs not exceeding 3 hours; the double-fluid for runs exceeding 3 hours up to 12 hours. S. Bottone.

[75814.]—**Chloride of Silver Cells.**—To Mr. Bottone.—I cannot recommend these for any purpose: they are difficult to construct, they soon get out of order, the resistance is high, and consequently the current small. S. Bottone.

[75815.] — **Hand Camera.**—You will find a 5 by 4 camera rather clumsy if you make it on the principle I understand you to propose—viz., the dropping of the used plate into a box below, and the screwing forward to focus-point of the next fresh one. For my part, I would recommend rather the velvet-bag system, where, after the first exposure, the half-lid of the outer shell is lifted, the used plate lifted out by finger and thumb (all the plates being always light-tight inside the black velvet cloth) placed in the back notch, and the next plate is now lifted to the front notch ready for exposure. Note, if you work with twelve plates, always have fourteen notches, so as to leave a clear "feelable" space between the used plates at the back and the unused plates at the front. For focussing, I think the mirror at 45° reflected on to ground glass at top of camera is much better for "sharp" work than the fixed focus system. The lens should be fixed, but supplied with the old rack-and-pinion adjustment common on portrait lenses for focussing, the pinion shank made extra long, so that the button or knob works outside the camera; a thin metal shutter working in an india-rubber slit should be put in front of the plates when focussing, and pulled out and put in the pocket when that is completed, and the mirror raised up to the horizontal position. As for lens, Taylor, Taylor, and Hobson, who advertise in "Ours," make one that would suit you. Their D lens, 6in. focus, price £3 10s., covers a 5 by 4, and works at F/8. If you decide on this form of camera, I will give you what help I can, on writing to address given below.

19, Hyde Park-road, Plymouth. B.Sc.

[75816.]—**Torsion.**—The force tending to turn a deflected magnet into the meridian is always proportional to $H \times ml \times \sin \alpha$. Where H = horizontal force of earth's magnetism at place in question; ml = moment of magnet; and α = angle of deflection.

$$\therefore \text{Force}_{90^\circ} : \text{Force}_{30^\circ} :: H.ml.\sin 90 : H'.m'l'.\sin. 30 :: (\text{H's cancel})\ 3 \times 1 : 2 \times \tfrac{1}{2} :: 3 : 1$$

But torsion for 30° = (180° − 30°) = 150°

$$\therefore \text{Force}_{90^\circ} : \text{Force}_{30^\circ} :: 3 \times 150^\circ : 1 \times 150 :: 450 : 150$$

But turning of torsion head includes deflection,

$$\therefore \text{No degrees turned} = 450^\circ + 90^\circ = 540^\circ.$$

H. C. T.

[75817.]—**Cement for Lamps, &c.**—Nothing is superior to good fresh plaster of Paris mixed with sufficient water to make a stiffish cream. Some add a little alum to the water, but I find that the addition of anything detracts from the setting power. S. Bottone.

[75817.]—**Cement for Lamps, &c.**—Soak gum-arabic in a little water for 18 hours, drain off any superfluous liquid, and add calomel (poison) to form a sticky paste. Mix well, and use at once. Let it set for 48 hours, and use only the best materials. A. D. Southam.

[75817.]—**Cement for Lamps.**—I have used the following composition for fixing glass tubing into metal sockets:—Dissolve some gum in water to about the consistency that you would use carpenters' glue, and mix sufficient plaster of Paris to the gum to form a paste, and then apply, first roughing thoroughly the surface of glass with a file or other means to give it a better grip, and leave till set. E. G. H.

[75817.]—**Cement for Lamps.**—Plaster of Paris is the cement used by lamp manufacturers for fixing the brass collars and sockets to the fonts of lamps. A better plan is to fill the collar with powdered alum, and stand on a hot stove until the alum is pasty, then fix on the lamp. The great advantage of this plan is, that should the lamp bowl be broken by placing on the stove the alum will yield sufficiently for the collar to be withdrawn and placed on a new bowl, whereas if plaster of Paris had been used, it would have to be filed off.

H. Fentum Phillips.

[75817.]—**Cement for Lamps.**—All smooth cylindrical objects with polished surfaces require preliminary treatment by scratching and roughing. No cement, however adhesive, will hold very long on a slippery substance. When metal, glass, and porcelain are previously grooved or furrowed in the seat of union, a firm hold is obtained and not easily dislocated. I found a hard file, or coarse corundum powder wetted and applied on a stick, of considerable use in corrugating hard materials previous to joining them. A small lathe would do such work far more efficiently. Most of our known cements will succeed, if applied to junctions as recommended by me. Surely the glassblowers and pottery artisans could turn out their articles ready grooved! Eos.

[75818.]—**Ink.**—If "Casenham" wishes his ink to dry quickly he must not mix it with olive or almond oil, which will not dry at all. Let him take some raw linseed oil, and enough driers (procured at any oilshop, price about 3d. per lb.) to make it, when stirred up, about the consistency of cream; stand in a warm place, and stir occasionally for three or four days; let the driers settle, and pour the clear oil off for use. Mix in a mortar with lamp-black to the consistency required. The more intimately the two are ground together, the longer will the black remain suspended in the oil without settling. A. E. B.

[75819.]—**Incandescent Lamps.**—To Mr. Bottone.—Not only 8, but 800 or 8,000 lamps of 5c.p. can be lighted by a current at a pressure of 9 volts, provided the voltage of each individual lamp (that is to say the hot resistance) does not exceed 9 ohms. Taking the case of 8 lamps, if the resistance of each lamp were 9 ohms, and the lamps were run—as they should be—in parallel, the resistance would fall to $\frac{1}{8}$th of 9 ohms, or $1\frac{1}{8}$ ohm. But—and this is a good big but—the 8 lamps will take 8 times the current that the single lamp would take; hence, if the single lamp would absorb only 1 ampère, the 8 lamps will absorb 8.

S. Bottone.

[75820.]—**Condenser for Coil.**—If your condenser makes a clicking noise, it is a sign of short-circuit. But even with a good condenser, if there is any break in the insulation of your secondary, you might hear the clicking noise. So also would you if there were a want of continuity in the wire itself. S. Bottone.

[75823.]—**Electrical Temperature Indicator.**—You can use either an electrical thermometer alarm or could make one of the ordinary metallic ones. These are connected to the bell and battery in your bedroom. Several forms of these electrical temperature alarms are shown in "Practical Electric Bell Fitting," and also diagrams of connections.

F. C. Allsop.

[75823.]—**Electrical Temperature Indicator.**—Fix an ordinary trembling bell in your room and battery of two Leclanché cells in a cupboard or other favourable position. Connect up with 18 B.W.G. wire g.p. covered, and line to orchid house. Now obtain a differential mercurial thermometer fitted with adjustable electrical contacts, and attach to end of line. F. Askew.

[75823.]—**Electrical Temperature Indicator.**—All that is needed is a Sixe's maximum and minimum thermometer, into the two tubes of which are inserted platinum wires, reaching to the two limiting points of temperature. When the mercury reaches these, contact is made between the battery and the bell, and the latter rings. A simpler form, which may serve your purpose equally well, consists in a light spring made of two dissimilar metals playing between two studs. The spring bends to the one side with an increase of temperature, and to the other with a decrease, and the studs can be so regulated, as to distance from the spring, as to make contact only when the limits of temperature are reached. S. Bottone.

[75824.]—**Incandescent Light.**—I have never found this injurious to water-colour paintings, or heard it put forward before. F. C. Allsop.

[75824.]—**Incandescent Light.**—I was not aware that the incandescent light has any injurious effect on paintings, and should imagine that you are misinformed. The arc light has, like daylight, a strong actinic or fading power, for though the primary origin of the two electric lights may be the same, their effects are widely different.

A. E. B.

[75824.]—**Incandescent Light Injurious to Paintings.**—The person who told you this must have been drawing largely upon his imagination. All lights cause most colours to fade; but the incandescent light is certainly not so injurious in this regard as the arc light or sunlight, and, with regard to its freedom from sulphurous emanations, is far less detrimental than gas. S. Bottone.

[75827.]—**Rusty Kettle.**—From what I can understand from your letter, it seems the interior of the kettle has become rusty because of the iron being left bare, while the outside has a coating of Brunswick black. What I recommend is to drain every particle of water from it, and to let it get thoroughly dry. Having made that secure, the next thing is to rub off the rust with coarse sand-paper; then, as the outside is coated with Brunswick black, I recommend the inside to be coated with the same, and letting it stand till it has got quite hard. J. A. B.

[75830.]—**Dead Black.**—Make a solution of nitrate of copper by dissolving pure copper in nitric acid, then add about three times as much water as solution; then get the brass article and heat the same, and then dip in the solution, then reheat over a Bunsen burner or blow-pipe flame until it goes into a dead black. F. W. Bernard.

[75830.]—**Dead Black.**—I have used the following for some years with success: Take two grains of ivory or lamp-black, add a drop or two of gold size, and thoroughly mix the two together; then add 24 drops of spirits of turpentine and thoroughly mix. Apply with a thin camel-hair brush, and when it is dry the article will have as fine a dead black as can be turned out by any optician.

Wm. P. Miller.

[75830.]—**Dead Black.**—I think the recipe has been given before. Purchase some black pigment already ground in oil; wash the oil out with turps, and allow the black to settle; pour off the turps and oil, and mix the sediment with gold size and turps. Warm the brasswork (which ought to have a dead, unburnished surface) to as high a temperature as the hand can comfortably bear, and apply the black with a camel-hair brush. A. E. B.

[75831.]—**Pyrography.**—For the finer work, the Vulcan wood-etching machine is the best. I do not know the name of the maker, but it can easily be bought. This has a platinum point, and the heat is obtained from benzoline. For the coarser work, Fletcher's self-heating soldering-iron is commonly used, the end being shaped as required. This is heated by gas, and is slower in working than the Vulcan for each mark made; but it will cover a large surface much more quickly if a large, coarse pattern is required. 999.

[75832.]—**Photo-Micrography.**—Your ½-plate camera could be adapted to this purpose, though not to the ½-plate size, which would require a very long exposure indeed. You will need to take the lens from your camera and fix the microscope objective in its place, and fix the whole arrangement of camera, slide, holder, &c., securely to a board so as to give sufficient rigidity for inserting the dark slide without shifting the object out of focus and field. A. E. B.

[75832.]—**Photo-Micrography.**—Yes, a ½-plate camera with long and short extension suits very well. Your microscope must work on a pivot; the tube is turned to the horizontal position, and the eyepiece end (without the eyepiece) put into the lens opening in the camera, and surrounded with black cloth. You will find Swift's $\frac{1}{12}$in. objective at £5 5s. the cheapest in the market for bacterial work. Of course, if you can afford it, get a Zeiss. For light a 50 candle-power "Veritas" or "Belge," with a reflector at back, and a 3in. condenser between the lamp and microscope suits very well.

Plymouth. B.Sc.

[75832.]—**Micro-Photography.**—"J. P." will not find the fitting-up of an ordinary camera for photo-micrography a difficulty, but his troubles will not end there. I advise his commencing with biggish objects requiring low powers. The chief difficulty in fitting up the apparatus is the necessity of having some means by which the fine adjustment of the microscope stand can be manipulated from the back of the camera, as the long extension of the camera needed for enlarging when the objective only is used puts the microscope quite out of reach. The microscope must be mounted (the tube taken off) opposite the centre of the camera (any size), and, for the best results, there must be a substage condenser, with a diaphragm (iris, if possible) between the light and the condenser. The centre of this condenser must be very accurately made to correspond with the centre of the focussing screen of the camera. I use a very low power, and focus the picture of the smallest size of the diaphragm on the screen, and centre it very precisely; getting also the best part of the flame of the lamp opposite the diaphragm. I use one of Beck's microscope lamps. I have been told that the eyepiece can never be used in photo-micrography with the best effect, but the long extension required for the use of the objective only is such an objection when using ordinary cameras, that I have been led to put the tube on the microscope, and use the "Ramsden," or micrometer, eyepiece with the objective. This gives a flatter field than the ordinary eyepiece, and seems to correct the focus of the objective, making the visual and photographic focus of all the objectives equal,—I mean, the two planes the same, not the focus of all objectives equal,—and one requires a very moderate extension, besides the advantage of getting the same amount of enlargement with a low power and the eyepiece that one does with a far higher-power objective without it. One of Lancaster's "Extra Special Long-Extension ¼-Plate" cameras makes an excellent photo-micrographic camera, when thus used with the eyepiece; its utmost extension, added to the length of the microscope tube, is enough for most purposes. A very small diaphragm is best to get good definition, the length of exposure being no object. If "J. P." cares to communicate with me, I shall be pleased to give him details of my photo-micrographic table, and to show it to him, if he is able to call on me. Gerard Smith.

Craigholm, Upper Clapton.

[75837.]—**Best Iron for Field-Magnets.**—The best iron for the cores of field-magnets for dynamos is undoubtedly Swedish wrought bars, and these, in conjunction with malleable iron castings for the yoke and pole pieces, will give the best results. S. Bottone.

[75838.]—**Sand Balls.**—Try mixing the sand with liquid silicate of soda. F. W. B.

[75838.]—**Sand Balls.**—This is a very vague query. Use cowdung, tar, silicate of soda liquid, or many other things. 999.

[75839.]—**Old Bracelet.**—Tests for gold and silver: (1) HNO_3 has no action on pure gold or platinum, but if HCl be added (aqua regia), the metal is dissolved. (2) Place the weighed sample of silver in a cupel, and heat for 30 minutes in a muffle furnace; if Pb is present it will be oxidised, and a globule of pure Ag will be left.

A. D. S.

[75840.]—**Microscopical.**—The French objectives supplied with students' microscopes are of no use for the phase of photo-micrography chiefly in vogue—viz., bacterial work; not because they are French, but because they are students' microscopes, and the highest power is usually ¼in. (see my reply to 75832). For photo work a rack and pinion is handier than the sliding adjustment. For general work they are equally the same to me, at all events. The most useful powers for beginners are 1in., ¼in., and, if you go in for bacterial work, $\frac{1}{12}$in. homogeneous.

Plymouth. B.Sc.

[75840.]—**Microscopical.**—There is no society or club specially for a beginner in microscopy; but if you will write me to say the part of London that will suit you best, I will endeavour to tell you the nearest micro. club. You will find all beginners will have a hearty welcome in most clubs. French objectives are of no use for photo.-micrography, unless specially constructed for the purpose. Those supplied with students' microscopes are certainly of no use. A rack and pinion—that is, a good one (not the average rack and pinion supplied with the £3 3s.)—is not exactly a necessity; but you can get on much better with one than without; it makes manipulation easier. The most useful powers for a beginner are a 2in, 1in., and ¼in.—only get good ones. R. G. Mason, Manufacturing Optician.

69, Clapham Park-road, Clapham.

[75842.]—**Relation between Electro-Magnet and Wire.**—Whatever be the gauge of the wire used, and this depends upon the amount of current to be carried, the proper quantity to be laid on to the core is such as shall increase its diameter threefold. That is to say, if the diameter of the bare core be 1in., the diameter of the wound core should be 3in. I have recently given in these pages a table of the safe carrying-capacity of copper wires, and reference to any of the wire merchants' lists will give you the resistance per lb. of the different gauges. Here I need only say that for the smaller currents you will use the finer wires, and for larger currents, larger wires. S. Bottone.

[75843.]—**Grinding Edges of Glass Discs.**—To Mr. Bottone.—After having mounted them on the spindles, rotate them gently against a piece of wet brick, on which you have sprinkled a little fine silver sand, also kept moist. S. Bottone.

[75844.]—**Four-lobed Clover Leaves.**—To "Eos."—Over 100 species of the genus *Trifolium* are distributed over the four quarters of the world, and very distinct by their trifoliate foliage. On the table lands of the Himalayas above Kashmir, I have seen the most luxuriant forms in a wild state, and the horses of the Ruler were sent annually to these happy pasture lands to attain good condition. I have never in any part of Europe, Asia, or Africa noticed a specimen of the four-leaved you describe. Is it a true "clover" or an "oxalis"?—the flower will settle that point. If the former, I can only attribute the distinction to "evolution" or "variation." I have seen some wonderful instances of vegetable changes, one of which I will mention: Hibiscus mutabilis, a tropical shrub, of which the large, gay flowers constantly change from white to red, and the foliage, naturally "tricuspidate" (or three-pointed), to "acuminate" (one-pointed), and "cuneiform" (or wedge-shaped); hence its designation of "mutable." I could name other plants of like tendency. Nothing in nature surprises me since I came across a family of Madras natives with the hereditary acquisition of six fingers—i.e., a thumb and five digits. Your "trefoil" is possibly a lusus naturæ capable of reproduction. "Cinquefoils" (or five-leaved plants) are known as the genus "Potentilla," of which at least 150 species exist (some in all climes). Eos.

[75844.]—**Four-lobed Clover Leaves.**—I have to ask "B. H." to kindly pardon me not answering before this; but, owing to severe illness, and also the death of my brother, I have not had the opportunity of finishing my examination. Your specimens came duly to hand, but am sorry to say that they were stuck fast together; also the letter had been roughly handled, and, of course, the specimens were in a bad condition. I have examined them as far as possible under the circumstances, but am unable to give the name, not being able to make the various parts out properly, the specimens being so very much disfigured, and partly destroyed. As far as I can make out, they may be either Trifolium repens, Trifolium procumbens, or Trifolium minus, but should not like to say positively without a good specimen of the whole plant; but I think it more likely for it to be a hybrid. If the plants have been growing in a bright light and open situation, with not too much wet or drought, it is a sufficient reason for the four lobes to appear, as a position of that kind tends to increase the size of plants, and also heighten the colour of the flowers. It is not a very uncommon thing to meet with a specimen at the foot of a hill, and after mounting to a higher elevation, find the same kind of plant either diminished or enlarged in size, or the leaflets diminished or increased in number, as the case may be (according to the situation and soil). Will "B. H." please send me his address?

Wakefield-road, Dewsbury. O. H. INGHAM.

[75845.]—**Natural Drinks.**—If an "Old Reader" can invent a pleasant, desirable, unfermented, or slightly fermented drink, he may be rich beyond the dreams of avarice. Nothing is more universally desired by rich and poor alike, and although I, myself, having more money than I can spend, am actually "beyond the dreams of avarice," I would begin once again if I could discover such a thing as a universally-desirable pleasant drink, which was in every way unobjectionable. Some of your readers may recommend me to try the pump; but experience shows that water alone is not always pleasant or safe, and the most assertive water-drinkers generally use it adulterated with tea, coffee, sugar, cocoa, and other things, on which they ring the changes to evade its use alone. 999.

[75847.]—**Glycerine and Turpentine.**—Glycerine, if perfectly free from lead, is not injurious, but acts very much like sugar or starch on the system. Turpentine is a powerful diuretic, and should only be taken under medical ordination.

S. BOTTONE.

[75848.]—**Jam.**—A lady advises "Lever" to pot and seal the jam when boiling, and afterwards preserve in a place not only dry, but well ventilated.

ARTHUR MEE.

[75848.]—**Jam.**—Keep covered loosely while cooling. Put on top of each pot a teaspoonful or so of whiskey, then cover air-tight with the gummed paper.

Plymouth. B.Sc.

[75848.]—**Jam.**—"Lever" does not say how much sugar she added to the fruit. If anything near the usual proportion (which is a great deal more than is necessary), it was probably not sufficiently evaporated. The great object in making jam is to *get rid* of the excess of water. By "skimming off a good deal of the juice," she wasted the best part of the jam. Let her put the jam back into the pan and evaporate until thick enough to set firm when cold. Next time she would do well to try my plan, which has been proved by years of experience. Evaporate thoroughly ripe fruit in a steam bath until the liquid begins to get stiff; then add 5oz. of loaf-sugar for every pound of the original weight of fruit; continue the evaporation until the jam is stiff enough to set thoroughly firm when cold. Whilst hot, pour into hot pots. I have kept jam made thus nearly two years, when it was as good as when first made. If too stiff when required to be eaten, a spoonful of boiling water stirred into it will soften it. If "Lever" has not a proper steam-bath, she can improvise one with a large basin on the top of a saucepan half-full of water. It obviates the risk of burning and the necessity of incessant stirring.

EXIGUUM SACCHARI.

[75849.]—**Scarf-Pin.**—Gilt work can be stripped in strong nitric acid, to which has been added a little dry common salt.

Brighton. T. C. SMITH.

[75849.]—**Scarf-Pin.**—Try this: Put the pin in the usual gold bath, and connect to the + (positive) terminal, and see if the deposit will be taken off and redeposited on the negative plate. In other words, reverse the current until the deposit is removed. A. D. SOUTHAM.

[75852.]—**Castor-oil Plant.**—This is an annual, raised from seed each year. It is very easy to grow in ordinary soil, and if the leaves fall off, they only do so under such treatment as would kill most other plants. 999.

[75855.]—**Vacuum Tubes.**—To MR. BOTTONE.—Not having had practical experience in their manufacture, I would rather not advise.

S. BOTTONE.

[75857.]—**Plating Solution.**—Dip a slip of clean brass into a warm solution of nitrate of silver ($AgNO_3$) and cyanide of potassium (KCN).

A. D. SOUTHAM.

[75857.]—**Plating Solution.**—The solution you saw the man use was not a silver-plating solution, but probably a solution of mercury in nitric acid, termed by practical electro-platers "dipping-acid." The mercury deposited on the metal by this process will not remain clear for any length of time, but soon oxidises on exposure to the air.

J. A. PAISLEY.

[75857.]—**Plating Solution.**—A solution made as follows will deposit silver on brass, German silver, &c., without the aid of battery:—Dissolve 1oz of silver nitrate in about a quart of distilled water, then add hyposulphite of soda until the brown precipitate first formed becomes redissolved; a moderate excess of hyposulphite should then be added. But it is very likely that the "plating" you mention is not silver at all, but mercury, and the solution used is what is termed "quicking," and is made from cyanide of mercury.

Brighton. T. C. SMITH.

[75875.]—**Plating Solution.**—The following recipe for solution, guaranteed by an individual to plate without a battery, was given to me some years ago. I have not tried it; if you do, you might write and let our numerous readers know if it is worth anything:—Oxide of gold, 1 scruple; cyanide potassium, ¼oz.; bichromate potash, ¼oz; distilled water, 10oz. Dissolve cyanide and bichromate in water, and filter; add oxide of gold. Take 22-carat gold, 1 penny-weight; nitro-muriatic acid, 3 drachm; dissolve the gold in the nitro-muriatic acid; mix solutions together. To use, pour out into a glass vessel, put in a plate of copper about 1in. square, wrapped round with three thicknesses of platinum wire. Soon as effervescence takes place, apply solution to article with a piece of flannel; wash and finish with chamois leather. Take out copper and put solution in bottle for future use. I must repeat I am in no way responsible for the above. I give it you as I received it, only I gave a little for the information to a supposed electro-plater from Sheffield.

R. G. MASON, Manufacturing Optician.
69, Clapham Park-road, Clapham.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75274.	Steam-Engine for Boat, p. 73.
75278.	Cut-out, 74.
75279.	Coil Boiler, 74.
75290.	Electric Clock, 74.
75300.	Dutch Bogie Expresses, 74.
75467.	Continental Trains, p. 163.
75471.	Self-Toning Photo. Paper, 163
75475.	Diffraction Spectroscope, 163.
75478.	Tea Culture, 163.
75481.	Reversing Gear, 163,
75485.	Byng Coil, 163.
75494.	Glass-blowing with Oil-lamp, 163.
75501.	Hydraulic Pump or Ram, 163.
75509.	Telescope Optics, 164.
75512.	South-Eastern Railway, 164.
75521.	G.N.S.R. Locomotives, 164.
75528.	Taking Out Quantities, 164.

QUERIES.

[75861.]—**Protroleum Engine.**—Will any reader oblige with a sketch of valve arrangement, &c., for a small benzoline or petroleum engine, about ½H.P.?—W. H. H.

[75862.]—**Dynamo.**—To MR. BOTTONE.—What size of armature and field-magnet should I have for a 60c.p. Manchester type dynamo; also what quantity of wire, and gauge?—A. T. BRADFORD.

[75863.]—**Electric Shop-Bell.**—I wish to fix a continuous-ringing electric bell in the second story of my house, which should be set ringing by the opening of my shop door on the ground floor. When once set ringing, it should continue to ring until stopped by simply pushing on a button fixed under my shop counter, and then the bell should be ready again for action without further adjustment. Could any of "ours" inform me if this could be done by a peculiar arrangement of the bell or the circuit? Any information will oblige.—LEBOGUST.

[75864.]—**Hardening Steel.**—Will any of your readers tell me how to harden pure Seimens-Martin soft steel, which contains 0·20 to 0·25 per cent. carbon, as I am in doubt as to whether it will harden otherwise than case-hardened?—MAURICE B. O'CONNER.

[75865.]—**Mesmeric Sailor.**—Can any of your readers tell me about the trick of the "Mesmeric Sailor." Seeing it at a conjuring entertainment, I thought I should like to know how it was done. It was a cardboard figure of a sailor, which danced at command. The hand of the conjuror, when waved over it, caused it to rise and fall. There was apparently not any connection between the conjuror's hands and the figure.—H. A. GRACE.

[75866.]—**Copal Varnish.**—Will some reader please say how this may be made? I find it dries cloudy if dissolved in methylated spirit. Is there some other ingredient wanted? Will this be suitable for coating work in the lathe? I want to finish something like that on pushes for electric work.—COPAL.

[75867.]—**Lighting Fairy Lamp.**—I use a small 4-volt twice a week about one hour each time from pocket secondary battery—the charging is troublesome. Can I have a primary battery for pocket? Please give instructions for construction? Cannot find where to purchase.—FAIRY LAMP.

[75868.]—**Check Valve.**—I have placed back-pressure valve of feed-pipe of injector about ½ the way up the firebox, but below the top level of the coals. I have been told that it is too near the fire for safety, the water injected into the boiler being cold. If so, how high up should it be placed? The boiler is vertical, the feed is rain water, and the firebox is 14in. high.—ANXIOUS ONE.

[75869.]—**Bichromate Battery.**—Can any reader tell me how many watts will be yielded by a battery which dissolves 1lb. of zinc per hour? Also cost of depolariser per hour in a battery of this size?—X.

[75870.]—**Crucible.**—Being desirous of refining a small quantity of gold, I did so, as recommended in reply No 75389, of Oct. 2nd, melting the precipitated "red mass" in one of Morgan's fireclay crucibles, in a common coke furnace, and found that a quantity of gold had worked through the crucible during the operation. The crucible does not appear to be cracked, though the outside and bottom are covered with small grains of gold. Can you kindly inform me of the probable cause, and also of the safest description of crucible to use for such operations?—CRUCIBLE.

[75871.]—**Division-Plate.**—I wish to add an 8in. division-plate to my watchmaker's lathe, for dividing in general, and watch-wheels in particular. I find circles of 360, 300, 240, 190, and 112 divide up well, but whether they are the best I can use, and what others I had better add, I do not know. Can someone assist me? I can divide the plate on both sides?—DELL, Watlington, Oxon.

[75872.]—**Sleep Disease.**—Has any case of this disease (known on the West Coast of Africa as "adavan") ever been known to occur in Europe? A case bearing its description occurred near this lately:—Swelled head and neck; no pain; irrepressible sleep; good appetite; speaking little. After five months, took permanently to his bed; lost the use of his limbs; got paralysis on one side. Finally death, eight months after commencement of illness. Just before death, tried to communicate with his father, but was unintelligible. Illness not apparently recognised by the medical men who saw him. Does erysipelas ever bear this description?—R. O'H.

[75873.]—**Saint Martin's Eve.**—Can anyone give me the meaning of a curious custom here in the West of Ireland, viz., that of killing a cock on St. Martin's Eve. The villagers, from whom I inquired the reason, say they don't know, but that it is necessary, and wanted me to do it.—R. O'H.

[75874.]—**Induction Coil.**—To MR. BOTTONE.—I have made an induction coil as per instructions contained in your book "Electric-Instrument Making for Amateurs." ¾lb. d. silk copper wire on primary, and ½lb. d. cotton copper wire on secondary, with two cells Bunsens I can get a good current through primary, but can only notice slight current by tongue through secondary. Tried a 4-cell Groves battery, and can get a powerful current through primary; but the secondary same as with Bunsen's battery, unsatisfactory. I took secondary wire off, tested same, and reduced the insulation to single-covered cotton wire for first wrap only, the other wraps as before. The wire will pass a current in test: but cannot get but a very slight one indeed—even with the Groves battery. I will thank you for assistance to cure defect. Also what quantity of primary and secondary wire is the best for the coil to be worked by a 2-cell Bunsen battery? Your favour will oblige.—J. P. H. HULME.

[75875.]—**Electro-Magnet.**—Will Mr. Bottone please tell me which pole of an electro-magnet has the greatest attractive power? Does it matter which is towards the hammer in a coil?—N.

[75876.]—**Faulty Cable.**—Will some reader of "ours" kindly give best methods of testing above with the Wheatstone bridge? It runs under water for a few hundred yards, and gets faulty with the action of the sea. I want insulation and earth tests without return wire in the latter case.—H. S. P.

[75877.]—**Bicycle Fitting.**—Will some kind reader give a few hints on the above—getting lengths of spokes, truing up, &c. I think a short article would be welcome by others as well as—BIKE.

[75878.]—**Phonograph.**—To MR. GILLETT.—Will you kindly say what the pieces of brass are for that are sweated on the ends of the guide-rods? Would not a short piece of brass tube do as well, and let the rods come through the standards both ends alike. I notice one hole is 5-16ths and the other ⅜ths. Is that right? In winding the armature ring, how am I to overcome the gaps in the wire, caused by the brass spider? And what is the best means of keeping the sides of each coil in place till finished; should there be anything between them? And what is the best size for field-magnet cores, ½in. or ⅝in. round iron?—this is not stated in drawings. Perhaps Mr. Gillett will kindly give particulars of the governor, and how it acts on the speed of the motor? I feel sure there are many readers of the "E.M." would like to know this.—J. R.

[75879.]—**Distances from the Equator.**—On the 18th September last, you kindly inserted my inquiry concerning the actual distances from the Equator, measured along a meridian to the different normal or geographical latitudes, as taken by sextant observations. On the 2nd of October, an answer, for which I thank him, appeared, signed by "F.R.A.S.," that I should find the information in Loomis's "Practical Astronomy." On referring, I find there a table of vertical angles, which, being the differences between the normal and geocentric angles, gives no idea of the distances required. Perhaps a glance below will explain my inquiry:—

Ex. 1.—Ellipsoid, with major axis, 2; minor axis, 1.

Then Normal latitude	69° 39′ 18″
Geocentric „	34° 0 0
Vertical angle	35° 39′ 18″

Ex. 2.—Ellipsoid, major, 4; minor, 1.

Then Normal latitude	80° 52′ 12″
Geocentric „	21° 15′ 0
Vertical angle	59° 37′ 12″

Calling distance from Equator to Pole 90°, the distance from Equator is about 45°, or half-way to the pole in each of these cases. Wanted, rule and example to find the distances accurately, with any ellipticity given. Or, for obtaining the sine, or cosine, of the distance of either normal or geocentric from Equator.—GEO. COLLINS.

[75880.]—**Hardening Steel.**—I should feel greatly obliged if any of our readers would kindly inform me the best way to harden cast steel in long pieces without producing water-cracks in the steel, which I have found very difficult to overcome?—STEEL.

[75881.]—**Central-Valve Engine.**—Will someone kindly explain Willans' and Robinson's patent central-valve engine? A sketch would oblige.—F. J. B.

[75882.]—**Steam Steering-Gear.**—Will someone kindly explain to me what kind of valve is used in steam steering gear? What is the position of eccentrics, for I lately noticed that each engine only had one, but could reverse at will? I am almost sure that they were fixed. —F. J. B.

[75883.]—**Brasswork.**—How can I give brass the appearance of gunmetal?—Henricus.

[75884.]—**Electrical Nomenclature.**—I read in published price lists of electric motors such terms as the following, and should be obliged by explanation of their meaning: Brake horse-power, say, 1, volts 100, amps 10. The H.P. is plain, but what information does the volts and amps convey? Then, wound either "series," "shunt," or "compound." What is meant by these terms? Commutator—What does this appliance mean? Highest E.M.F., 100 volts; lowest E.M.F., 40 volts; difference of potential in volts, 50; approximate current in ampères, 20; continuous and alternating currents. It would be agreeable also to be shown how one or the other is arrived at from any given conditions.—A Working Engineer.

[75885.]—**Electrical.**—Is there any danger connected with, or special knowledge required, in putting down and setting to work of electrical mining plant? I want to put down a pump, driven by an electric motor, to be fixed underground in a colliery, to be driven by a dynamo fixed in engine-house at surface. The motor and the dynamo would of course be supplied by the makers ready for cable attachments, and it is just this I want to know—how these attachments are made, and if carryoutable by a person unacquainted with electrical plant? As to the cable, must it be double, and for what reason? And how is it to be supported down the shaft and along the galleries? In the case of hauling plant by electric motors, how are the drums reversed? Is it done by stopping and reversing the motor, and in what way? Can a motor be suddenly stopped, or its speed reduced at will?—A Working Engineer.

[75886.]—**Dissecting Leaves.**—I wish to know a process of dissecting natural leaves as objects for the microscope. I have read of a process in the "E.M." for October 16. Having repeated it to a friend of mine, he recommended me not to carry it out, as he thought it was rather a dangerous process; therefore, I wish to know of a process where there is no danger in carrying it out.—J. A. B.

[75887.]—**Sundials.**—Will any fellow reader tell me where I can get full instructions for setting-out sundials in any position and for any place? I have got Weale's book on instruments, but it does not go into the matter with sufficient detail or clearness, and speaks only of south, east, and west erect dials. I want also those points which lie between. I want to set out also those dials which are not horizontal, but slightly inclined. In fact, I should like to understand the subject thoroughly. Any information will oblige.—Gnomon.

[75888.]—**Balloons.**—Your correspondent Mr. Southam gives the following formula for balloon diameters:—

$$D = \sqrt{25\cdot5\ W}$$

but does not state whether the diameter is in inches or metres, and the weight in kilos, grammes, lbs., or cwts. With none of these does the formula work out correctly for the common gas usually employed.—Aeronauticus.

[75889.]—**Formula Wanted.**—Will some reader give me the formula of such examples as the following, calculating this out. A hydrometer floats in a liquid, sp.gr. ·9, with 5in. more of its stem above the surface than it would have if placed in water. What point of the stem will be on the surface when it floats in a liquid whose sp.gr. is ·95?—W. M.

[75890.]—**Siphon—Defective.**—I have a double siphon, like the two short ends of a letter J joined together at their short ends, that I want to flush a glass containing vessel at regular intervals; but the contents do not come out altogether—some is always left in the bend. Why is this? Will some one please say how it can be altered? To state plainly, the siphon, filled by droppings from a tap, when full contains 2¼oz. of water. When the siphon discharges, ¼oz. is left behind. I should be glad of any help, and correspondents need not be afraid of referring me to back numbers, because I am a—Subscriber Since 1866.

[75891.]—**Indiarubber Cement.**—In Spon's "Workshop Receipts," second series, p. 87, there is a cement for joining indiarubber to metal—viz., "Some shellac is pulverised and then *softened* in ten times its weight of strong ammonia, whereby a *transparent mass* is obtained, which becomes fluid after some little time without the use of hot water. In three or four weeks the mixture is perfectly liquid," &c. (The italics are mine.) I made the mixture precisely as given above, but the shellac was not softened, nor was a transparent mass obtained. The shellac remains at the bottom of the bottle as a hard powder, on which the ammonia appears to have no action whatever, except to dissolve the colouring matter. The ammonia was s.p. ·890, and the shellac the best orange. The mixture was made three weeks ago.—W. Statham.

[75892.]—**Cleaning Sink-Pipes.**—What is the best thing to use to clear out the waste-pipes of sculleries, butlers' pantries, or housemaids' slop-rooms? I need not say that it ought to be something which will act powerfully upon the accumulation of grease and other non-mechanical dirt without affecting either the lead pipes or soldered joints.—Thermo.

[75893.]—**Leclanche.**—Can any of "ours" tell me (1) how to make a Leclanché battery with the zinc in the inner cell? (2) Whether the above battery has any advantage or disadvantage over the ordinary Leclanché? If so, what?—G. H. L.

[75894.]—**Wire for Magnet.**—Would Mr. Bottone or any other kind electrician tell me what quantity and size of wire to put on field magnets. The armature is 4in. dia. and 6in. long, of the Gramme type, wound with 2lb. of No. 16 B.W.G., and has 28 sections. I would like it to be a shunt machine.—Dynamo.

[75895.]—**Shrunken Woollen Goods.**—Can any of your readers inform me of any process for restoring woollen articles of clothing that have been shrunk in the washing to their original dimensions?—J. S. D.

[75896.]—**Hysteria.**—Some kind reader may have had similar to this in family, and could give experience as to cure. My oldest daughter, now over 21, always so cheerful, sensible, &c., was attacked with influenza last spring, which left her with a delusion that she has swallowed small tacks, pins, buttons, &c. We cannot convince her, and unless we can show her them if put away or used, it is useless arguing. She professes she can feel them in her. It causes her and us great trouble. Doctor stated she would change to some other delusion, but for seven months she has not. In all other things she is perfectly sensible, and oft cheerful, except some article is missed, then it's all fretting. She never does swallow them.—H. S.

[75897.]—**Stove.**—Wanted, a small stove for heating a bedroom, slow-combustion, to burn anthracite, absolutely without smell. Will any reader of the "E. M." help with suggestions?—A. M.

[75898.]—**Plane Mirror in Newtonian.**—How is the plane mirror in a Newtonian reflector fixed? I mean, by what means is it held in position, so as to be rigid and not obstruct the light?—F. J. G.

[75899.]—**Compressed Air.**—Will a vessel of very little buoyancy—say, for instance, ¾lb.—if filled with compressed air of two atmospheres to the square inch, gain or lose in buoyancy? In other words, compressed air has weight; will it sink a vessel if sufficiently compressed?—Air.

[75900.]—**Transformer.**—Will Mr. Bottone or any other competent reader kindly give me instructions, with sketch, how to make a transformer to transform a current of 110 volts to the strength of a battery of about 10 bichromate cells? I am also anxious to make a progress in drawing. Well, I should like to be fairly up in drawing generally. Would some competent reader tell me how to proceed? The name of a few books would be thankfully received.—Motor.

[75901.]—**Inside Gouges.**—I should be glad if some correspondent would tell me the best way to grind inside gouges. It seems to me that small emery wheels are suitable, rounded on the edges, and of proper thickness for the different widths of gouges. What should be speed of emery wheels? Would copper discs, turned up and used with emery and oil, be a good plan? At what speed should the discs run?—H. C.

[75902.]—**Adjustable Resistance.**—I am much obliged to "Mick," Mr. Bottone, T. C. Smith, and "C. I. Ohm" for their suggestions. I want, however, something that is accurate and (especially) constant; something, in fact, to replace the expensive box of coils used in testing. I am afraid, however, this is not to be had, and that I shall have to make the troublesome plugs and brasses?—Student.

[75903.]—**Incandescent Gas Lights.**—I shall be glad if anyone who is using these lamps will state their experience of them. Will they do for a village room? Are they difficult to manage? Is there any danger from fire if the "mantle" breaks? Also relative cost of 1 ordinary gas light, 2 oil lamps, and 3 incandescents, taking into consideration the light given by each. The Helios is the gas making machine sold by the Incandescent Gas-Light Company. Has any reader used one? If so, will he give his opinion of them?—Z. Y. X.

[75904.]—**Telephone.**—I have constructed a telephone which should work without battery, from instructions given in "E.M.," vol. 50, p. 402; but, after the most careful adjustment, I cannot get it to work. Would the introduction of a battery assist me? If so, how should I connect it, as I use the double-line wire?—Anxious.

[75905.]—**Engine Query.**—Which gives the most power—a condensing engine, or a compound engine? Also, what power should I receive of an engine working at 40H.P. high pressure, if I made it into a condensing engine worked with an air-pump? And how can I calculate such power?—One in a Fix.

[75906.]—**Spongy Gold.**—Having alloyed gold until it becomes the standard 18c., I use it in making various articles, and find it works well. Now, the scraps which remain will not always (in fact, rarely) work if melted again, but become spongy, or cracks, and is unworkable until reduced to 9c. Will any of your readers kindly inform me why this is the case, and give me a recipe for preventing the occurence?—Fred W. Pilditch.

[75907.]—**Damp Cellar.**—We are much troubled by the great quantity of water which is continually rising in our cellar. It comes in chiefly through the floor, but now also through the walls. The floor has been taken up, and red tiles placed down upon concrete, above which was placed a coating of the cement used for marine walls. The walls were treated in like manner for the height of 2ft. The water still oozes through. A pump has been fixed, but we find the water comes in too rapidly for the cellar to be kept dry by this means. Will some of "ours" kindly advise what is best to be done? We are thinking of raising the floor up by filling it in about another 2ft., so that it can be drained into the sewer. Are any ill effects likely to follow the adoption of this course, or would it be best to fill it right up?—Distressed.

[75908.]—**Punching Sheet-Brass Patterns.**—I have to get a large number of small sheet-brass articles, such as ornamental washers, &c. They will have to be made out of metal 1-20in. in thickness. Are the patterns (not embossed), screw-holes, &c., of such goods punched or cut out? If the former, what power is required to work a machine turning out about 1·500 pieces per hour—metal 1-20in. thick, 4in. by 1in.—simple patterns? If not asking too much, should also like to know probable cost of machine and dies? Are latter very expensive things when original patterns (simple) are required?—One Who Does Not Know.

[75909.]—**Dry Cell.**—Will some of our electrical contributors please tell me if a pocket battery that I made should light a 2½c.p. lamp? If not, what c.p. should I get from it? The size of plates is 4⅜in. by ⅞in. There are four cells, each containing one carbon plate, and a zinc plate, bent so as to be opposite both sides of the carbon, and so double the current. Between the plates is a paste of chloro-mercurate of ammonium and sodium chloride.—Falibu-l'-ilm.

[75910.]—**Taxidermy.**—I shot a heron some weeks ago, and after skinning its wings, put them away. The wings were folded when I put them away, and they have set stiff in that position. Can any of our readers tell me how I can open them out, so as to show their full size?—Ocsola.

[75911.]—**Resistance in Electro-Motors.**—What relation should the resistance of the armature of an electro-motor bear to the resistance of the fields?—1st, to be connected in shunt; 2nd, to be connected in series. Say a ring armature contains 1lb. of copper wire, 22s., what should the fields contain connected in both ways? Perhaps our worthy friend, Mr. Bottone, will oblige.—F. W. Bernard.

[75912.]—**Epileptic Fits.**—Is there any known remedy for epilepsy? My son, aged 15, has been afflicted for this past two years, and although he has had eminent medical treatment, the fits have not left him, and he appears now to be fast approaching imbecility. Is this last state the effect of the medicine, or the fits?—H. A.

[The effect of the medicine, we should say. We were interested this time last year in a similar case. A girl, aged 19, had had epileptic fits for three or four years, and was gradually growing worse. She was also paralysed in the left hand, and could walk with difficulty. She had had good medical advice, and had also been for some time in the Hospital for Paralysed and Epileptics in Queen-square, and in a hospital at Plymouth, without any improvement. We sent her in November last to the Hygienic Establishment of Dr. Allinson, the Medical Editor of the *Weekly Times*, at Harlesden, N.W. She remained there nearly three months, much against her will, for she objected strongly to the treatment, which is principally one of diet, and vegetarian. The result is she has never had a fit since, she can sew and knit with the hand that was useless, and can walk anywhere. If she will keep to the diet prescribed and observe the other conditions laid down, she is told she will recover entirely in time. No medicines of any kind.—Ed. "E.M."]

[75913.]—**Speed of Electro-Motor.**—I have an electro-motor which runs at a very quick speed—I should say about 1,000 revolutions per minute. I want to run the same at about 250 revolutions per minute in certain cases, and in others at the original speed; but I want to get as much power out of it as possible in both cases. How can I do this? The above is only a small motor, worked by four single-fluid bichromate batteries. This information will be thankfully received.—F. W. Bernard.

[75914.]—**Magneto-Machine.**—I wish to make a machine of about 15c.p. Will any reader say if such could be easily worked by hand; also probable cost of magnets (steel), and what pattern of armature would be best?—Boz.

[75915.]—**Wimshurst Machine.**—I have made a Wimshurst influence machine, and it works well without Leyden jars; but when I couple two pint jars on, it does not work at all. Could you tell me the cause? The machine is 12in. plates, the Leyden jars are made with two soda-water glasses nearly a pint each, tinfoil about one-third up; but inside, the tinfoil is on in three pieces, because I could not get it on in one piece. Would that make any difference? I connect the two knobs, one to each conductor, and connect the outside coatings together; but without any result.—Charles White.

[75916.]—**Cleansing Old Coins.**—I have a number of old silver and copper coins, some tarnished and clogged with dirt. How can I make them presentable and legible without risk of rubbing down the surfaces?—Numismatist.

[75917.]—**Pressure-Gauge and Thermometer for Hot Air.**—What sort of pressure-gauge must I use for heated air, up to about 40lb. or 50lb.? Also for showing temperature of same? Should it be thermometer or pyrometer to show 400° to 500° Centigrade?—Eager.

[75918.]—**Hot-Air Back-Pressure Valve.**—What is the best material and form for back-pressure valve for hot air? There is only a back-pressure of 5lb., and the tube about 1in. diameter.—Eager.

[75919.]—**Stoneware Pots.**—Is it possible to manufacture these from stoneware bottles, say, Stevens's ink-bottles, for they would be very useful for constructing electric batteries? I have tried chipping them round, but only succeeded in fracturing the bottle.—A. E. B.

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⁂ It must be borne in mind that no Displayed Advertisements can appear in the "Sixpenny Sale Column." All Advertisements must be prepaid; no reduction is made on repeated insertions, and in cases where the amount sent exceeds One Shilling the Publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O.'s.

The address is included as part of the Advertisement, and charged for.

Advertisements must reach the Office by 1 p.m. on Wednesday to insure insertion in the following Friday's number.

NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the Office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a Pink Wrapper, as an intimation that a fresh remittance is necessary if it is desired to continue the subscription.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above. which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, November 18, and unacknowledged elsewhere:—

GOLD.—A. Swallow.—J. A. Milne.—Basil.—Puzzled.—A.—Amateur.—Compound.—Bloemfontein.—L. W.—J. A. Furniel.—Apprentice.—A. George.—A Mechanic.—D.—N. D.—Sydney.—R. E. S. A.—Manchester.—R. F.—J. T. N.—A. B. T.—A. H. B.—J. Wimshurst.—A Fellow of the Royal Astronomical Society.—F. J. G.—Walter Strafford.

J. DUNBAR.—The respective secretaries of any of the institutes or societies will always give all particulars as to how to become a member. The rules are always printed, and can be had on application to the "secretary.")—NOVICE. (Sycamore, willow, poplar, in the order given. As to the special terms used, you must apply to those who use them for information, as we cannot undertake to explain what a tradesman means by the terms he employs to describe his goods.)—T. R. (Seventeen years is not too old to commence learning anything; but as to the other question, see "Hints" above. Perhaps you might find what is wanted at White's in Holywell-street, Strand. Much difference of opinion exists as to the best form of concert flute.)—W. C. R. (The query is too wide. Methods of staining ivory balls have been given frequently. They must be thoroughly cleaned in a solution of washing soda then "quicked" in a dilute solution of nitric acid, and stained black with nitrate of silver, or red with a solution of cochineal.)—JOHN D. NIDDRIC. (Celluloid is made by treating tissue paper with sulphuric and nitric acids, adding camphor. It cannot be made cheaply on a small scale. Better buy it as prepared by the manufacturers.)—DRAKEFELL. (It depends very much on the individual, and what is meant by the "continuous use of permanganate of potash." It is a useful "mouth wash," and very effective in cleansing the teeth.)—W. H. H. (If you mean the gelatine process, we gave that not long ago, and have often repeated it. If many copies are wanted, the best way is to use type, or the lithographic method.)—JOHN JOHNSON. (If there is ozena, better consult a surgeon, who can examine you; but as to the other matter, put the query to Dr. Allinson, through the *Weekly Times and Echo*.)—ALFRED LLOYD. (If it looks like silver, it is probably silver, the same as the cachous are covered with, and some pills. 2. A little benzoline will clean the type of a typewriter, and is better than ordinary lye, as it is without any tendency to rust anything. Apply with a brush.)—J. T. B. (There are many illustrations of medical coils in back volumes. Perhaps that given in the No. for Sept. 13, 1889, will suit.)—B. G., Penge. (Table-turning, when bonâ fide, is probably due to unconscious muscular movements on the part of the company.)—R. P. (Iron borings will not do for filtering. Spongy iron is a different thing altogether. A good filter can be made in the manner described by the late Dr. Guthrie: a large flowerpot, filled with bits of well-burned brick, over which the water is allowed to trickle, after soaking the filter for some hours in hot water, and allowing it to dry.)—T. W. (Answered recently. Either draw a magnet several times over it, or pass the bar through a coil of wire while a strong current is flowing.)—J. P. (Most of the publishers who issue technical works have such books in their lists, and you could see them at most of the free libraries.)—J. A. R. (If the patent is made out in your name, it must be properly assigned before anyone else can claim it. State the facts briefly, but clearly, to Mr. Wetherfield, the legal editor of the *Weekly Times and Echo.* 2. A little acetic or nitric acid in the paste will do for sticking labels on tin goods. 3. See Hints above.)—LOUIS STRIEGLER. (The subject has been frequently discussed in our pages. and just at present we cannot spare any more space for it. Very much information can be obtained from the publications of the Aëronautical Society of Great Britain, which you should join. Address, F. W. Brearey, Esq., Maidenstone Hill, Blackheath, S.E.)—J. F. BROWN. (Recipes for sealing-wax of various colours were given in the number for Oct. 16, 1885. Perhaps, however, you mean bottle-wax. That is mainly common rosin, coloured to suit. See Hints above.)—W. M. (We do not see how you can have your collection of specimens named unless you send it to an expert, or compare the specimens with those named in a museum. One exists in Glasgow, we think, which should answer the purpose.)—PHOTO. (Opinions differ. Some prefer a three-wick, some a four-wick lamp; but the best oil is probably good kerosene with a little camphor dissolved in it. 2. If it is really marble, it should be polished, not rubbed down with sand or any other abrading substance. If ordinary stone, it should be painted if it is liable to get so dirty.)—VIATOR. (You do not specify the page, and we do not remember the work. No doubt Simpkin, Marshall, and Co., Stationer's Hall-court, E.C., can supply it if it is in existence.)—H. E. K. (The construction of coils of different kinds and sizes has been described many times. See the indices, or look through recent numbers in this volume.)—A. Z. (The ball does occasionally fall, but it is kept up by the rotary movement imparted to it in both cases. See the back volumes. 2. Tables of squares, cubes, and roots are given in many of the pocketbooks.)—STAVE. (Ruled with a brass pen having the requisite number of nibs. Get a list from Mr. Jabez Francis, of Rochford, Essex.)—AINO. (Any hard wood—walnut, mahogany, and ebony are the most common.)—TILES. (We know of no such paper. The *Building News* gives occasional information on brick-making. Write Mr. M. Powis Bale, Appold-street, Finsbury, E.C. He may be able to indicate books. Other query next week.)—J. W. DEAR. (We know of no such library.)—BRADFORD. (Bad make, we expect; better ask the makers—if you think it worth while, that is.)—E. H. (Not Edison's; but you can make and use the modified form described in the articles referred to.)—A CONSTANT READER. (We cannot say. Better advertise in the Address Column.)—E. CHAPMAN. (You could probably find a suitable "Arithmetic" at a second-hand book-stall; but any bookseller can show such works.)

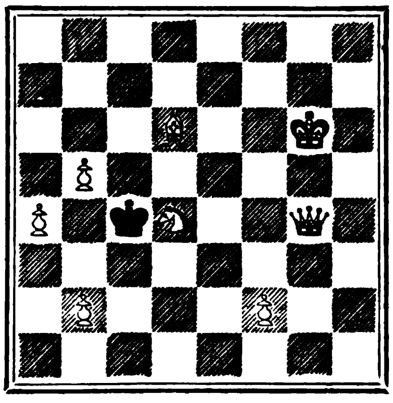
Health without Physic.—People frequently wonder how it is that by simply wearing one of Harness' Electropathic Belts disease may be effectually exterminated from the system. The marvellous curative powers of this genuine and convenient Electric appliance are fully explained in an interesting illustrated medical work, which may be had free of charge, together with book of testimonials, either personally or by letter, on application to the Medical Battery Company, Limited, 52, Oxford-street, London, W. All health-seekers should call or write at once.

CHESS.

All communications for this column to be sent to the CHESS EDITOR, at the office, 332, Strand.

PROBLEM MCCLXXXI.—By W. T. PIERCE.

Black.



White. [8 + 1

White to play and mate in three moves.

SOLUTION TO 1279.

White.	*Black.*
1. B to R 3.	1. B or R moves.
2. Q, Kt, B or P mates.	

NOTICES TO CORRESPONDENTS.

CORRECT solutions to 1279 by James Kistruck, T. Guest, and W. Jay; to 1278 by G. Collins, W. T. Bayne, W. L. Martin, Alex. Anderson, J. Johnston, T. Guest, and W. Jay; to 1277 by J. Johnston.

G. COLLINS.—1277 cannot be solved by B to B sq.

H. P. HOSKEN.—No. 1 is good, and shall appear. No. 2 is rather too easy.

T. A. WALLIS.—1277 cannot be solved by 1 B to K 6; Black's reply is R to K 4 ch.

GORGONZOLA.—Solutions may be sent on post-cards.

T. GUEST.—We are glad you admire 1279. The idea is not original, but it is well put together.

The Solution Tourney terminated with Problem No. 1277. The following is the score list in order of merit:—1, John Johnston (60); 2, T. H. Billington and W. Jay (both 58); 4, Biene, R. W. Houghton, T. Guest, and F. H. Guest (all 55); 8, W. T. Hurley (51); 9, W. L. Martin (50).

Too many marks were allotted to some solvers in respect of Probs. 1274 and 1275; the former has only one dual, and the latter only one dual and one triple. In the above score this has been rectified.

R. W. Houghton was credited wrongly with 4 duals to 1275, whereas there is only 1 dual.

*** Correspondents are requested to observe change of Chess Editor's address, as given at the head of this column.

ACCORDING to *La Nature*, volatilised petroleum is a convenient motive power for road vehicles. A four-wheel open carriage, somewhat like a Victoria, carrying three people, has made some long trial trips from Paris with very satisfactory results. The arrangements are described as very simple and easily under control. There is no coaling-up or filling a boiler as with a steam-engine, and no failure of electric storage; and the reserve supply of petroleum ready for volatilisation can be at any time readily known by means of a gauge.

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The remittance should be made by Post Office Order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 6d. each to cover extra postage.

Messrs. JAMES W. QUEEN and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 3d. each copy, to cover extra postage.

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All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post free from the office (except index numbers, which are 3d. each, or post free, 3½d.)

Indexes to Vol. XLIX., and to subsequent vols., 3d. each, or post free 3½d. Cases for binding, 1s. 6d. each.

Holloway's Pills increase the appetite, give tone to the stomach, assist digestion, and impart elasticity to the spirits, their essence enters the circulation and exerts its cleansing power over every organ. In the lungs they effect most striking changes, converting the impure venous into pure arterial blood, by which the whole frame is recruited.

OUR EXCHANGE COLUMN.

The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.

Wanted, to exchange small **Donkey Pump**, with ⅝in. ram, suitable for small boiler, for smallest size inspirator.—PAINE, Hampton Wick.

The Chenies-street Exchange offers best value in cash or instruments for scientific appliances and tools of all kinds.—CAPLATZI, Chenies-street.

New **Ediswan Lamps**, brass holders, switches, &c., bought, cash or exchange.—G. BOWRON, 93, Praed-street, London, W.

Telescope, Equatorial, 6in. aperture, by Sir Howard Grubb, finder, silver circles, driving clock, position circle, slow motions, six eyepieces, illumination, micrometer, photometer. Exchange offers.—Below.

Telescope, Equatorial, 5in. aperture, by Cooke of York, finder, prismatic, illumination, silver circles, slow motions, driving clock, five eyepieces, and accessories, complete. Exchange offers.—Below.

Telescope, Equatorial, 4¼in. aperture, by Alvan Clark, equatorially mounted by Cooke, finder, gunmetal circles, verniers, and microscopes, slow motions, four eyepieces. Exchange offers.—Below.

Telescope, Equatorial, 6½in. reflector, by Horne and Thornthwaite, London, hour and declination circles, slow motions, clamps, finder, six eyepieces, Barlows, solar, diagonal, &c.—Below.

Telescope, 3in., refractor, **Unifiler Micrometer,** by Grubb; Wedge Photometer, by Hilger, 840 g., Electric Hand Lamp, two Cameras, pair Telephones, Astronomical Diagrams.—Below.

Microscope, Binocular, large, by Crouch, magnificent instrument; also Monocular by Powell and Lealand. Exchange offers.—Apply Box 20, Post Office, Liversedge. List 3 stamps.

Self-acting hand **Bench Drilling Machine,** 7½in. lathe, 7ft. bed, value £30. Wanted, Photographic or Lantern exchange.—HENRY KILBURN, West House, Bishop Auckland.

Hot-water **Kitchen Boiler** for fixing in fireplace, 3s. 8d.; best Boiler Plate, equal new. Sketch. Particulars stamp. Exchange.—W. SMITH, Bilston-road, Wolverhampton.

Will exchange plated **Naval Telescope** for good Sextant, with cash if required.—LETCHER, Wind-street, Swansea.

200 **Organ Pipes,** powerful five-octave Harmonium, 3-stop portable ditto, for any Scientific Instruments, cheap.—A. CAPLATZI, Science Depot.

Wanted, **Tricycle** to pass 30in. doorway. Good exchange in Photo. Lenses, Lantern and Slides, Pictures, or superior Revolver.—LONSDALE, 45, Stroud Green-road, N.

Seven years' "**Amateur Work**" cost £2 6s 6d. All clean, one year bound. What offers?—DURRANT, Queen-street, Gt. Yarmouth.

Printing Press, prints 9in. by 15in., cost £12. No use to owner. Exchange to value of 40s.—W. GORNALL, Damside, Pilling, Garstang.

Good toned **Violin,** with bow and case complete. Will exchange for anything useful.—S. MILLS, 60, Wordsworth-street, Hove, Brighton.

8ft. **Steamer,** advertised in these columns at £5 10s. What exchange?—STUART, 39, Russell-square, W.C.

Wanted, Neat **Electric Light Outfit** for show case. 9ft. by 4ft. by 3ft. Good exchange. See notice tricycle wanted.—LONSDALE, 45, Stroud Green-road, N.

Wanted, 7-string **Banjo,** or **Air Gun** Walking Stick, part cash, for SAFETY BICYCLE.—A. SANDERS, Post Office, Wellington, Somerset.

50 good **Lantern Photographs.** Will exchange them for others, or for microscope slides; or offers.—E. B. FENNESSY, Pallasgreen, Limerick.

Splendid **Calendar Watch,** lever action, compensation balance, centre seconds, hall marked silver cases, perfect timist, shows day of week, date of month, &c., handsome appearance.—Below.

Give **Above and Cash** for good Lathe or Engine. Can be seen by appointment.—ADVERTISER, 3, Buckingham-street, Gt. Portland-street, London.

One volume "**Gazeteer of Scotland,**" with maps and illustrations, cost £1, and one powerful Shocking Coil, with regulator and bichromate battery, and one Gentleman's Watch, value 10s. Exchange for 50 or 52 Bicycle or Tricycle, or offers.—JAMES SHARP, Sanquhar, Dumfriesshire.

Eight vols. "**English Mechanic,**" unbound, odd Nos "Amateur Work" (old series). Exchange Roller Organ, Copying Press. Offers.—JEFFREY, 10, Grindlow-street, Stockport-road, Manchester.

Medical Induction Coil in first-class order, cost 15s. Will exchange for Air Gun or [illegible] [illegible].—[illegible], Lilly-bank Tottington, Bury.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, NOVEMBER 27, 1891.

LATHEWORK FOR AMATEURS.*
IX.

(*Continued from page* 189.)

Turning on the Dead-Centre Lathe.

SUPPOSE an amateur turner who has obtained a dead-centre lathe, with an assortment of all the accessories which have been indicated in the preceding papers, but who has not yet had any practice. He should first understand that it will be useless for him to undertake a piece of work of any kind until he has acquired—at least, to a certain extent—the rudimentary principles of the art. In all things it is only by overcoming, in some way, the first impediments that aptitude is gained to overcome those that succeed.

Thus we therefore consider the method of making a perfect cylinder to be the greatest difficulty to overcome in the art of turning, and also to be an indispensable thing to learn, and it is with this that we deem it expedient to commence.

Turning the Plain Cylinder.

To put a roughly shaped piece of wood on the lathe and make a cylinder of it, as shown at Fig. 117, first fix the left hand poppet in the slot of the bench by tightening the wedge or the screw which binds it. The piece is taken, and on each end of it is marked, either with compasses or by the eye, a point exactly in the centre. This point is hollowed to about ¼in. deep by the aid of a centre-punch made for the purpose, and ground sufficiently acute. A drop of olive-oil is put in each of these holes made by the punch. The right-hand poppet is brought up to a position suited to the length of the piece, and when this is found to be suspended between the cone points, marked P P, this poppet is fixed as firmly as the other one.

After having tightened up the cone screw, which passes through the right-hand poppet, till the piece does not shake at all, place the rest, marked R R, or crossbar (described on p. 417, Vol. LIII.) at about an inch from the exterior surface of the wood. The cord, from the pole or from the bow, which is attached to the treadle, is made to wrap twice round the work from left to right, so that on pressing the foot upon the treadle, the wood, in turning by the rotary motion given to it, comes towards the tool.

After being assured, by a few strokes of the left foot, placed near the middle of the treadle whilst the right foot remains steadily fixed on the ground, that the cord is neither too taut nor too slack—which may be known, in the first case, if too great an effort is required to bring the treadle down to the ground, and, in the second, if it comes down too easily—take a gouge (Fig. 106, p. 188), and work upon the piece thus mounted to round it, holding the gouge by its handle in the right hand, and using the fingers of the left hand to direct its action on the piece. It is convenient to make the first cut in the wood by slightly inclining the cutting edge of the tool, because it cuts much better in this position. It should not be applied directly towards the centre, as then the gouge would only scrape, but always slightly above that line. By this means the pressure communicated to the tool makes it cut properly, which may be shown by examining the shavings. These should be in the form of the hollow of the gouge, and of uniform thickness.

When it is understood how to place the tool and incline it suitably, it is brought near enough to touch the piece of wood to be operated upon. Then the treadle will be worked until at that point the piece is "true." This word is used amongst turners to signify that the tool touches at every point when the work revolves, which proves it to be round. When it is true, slightly withdraw the tool, and place it upon the side of the kind of groove just hollowed out. If it is on left side, marked A, Fig. 117, the gouge must be slighty revolved, so that the hollow part faces the groove already made.

Besides this movement, the attention of beginners is called to this demonstration, because it is of the first importance; and here is the ticklish point; besides this rotary movement, I say, the gouge must also have a manipulation peculiar to the case. By drawing the right hand, which holds the gouge-handle, slightly towards the left elbow, the shaving will be driven into the hollow C, Fig. 117, and the right side of the gouge does the cutting. This position must be maintained until at this new point equal truth is attained; the hollow will then be found to be enlarged by this new path of the tool. The same operations will be repeated as long as the truing process from right to left, as far as the left end of the piece.

When it is wished to work from left to right, the same process will be gone through in the inverse direction. That is to say that after the first stroke of the tool, and when the work is true at one point, the tool will be withdrawn slightly, as in the first case, and it will be applied upon the right side of the hollow B, Fig. 117, at fully one-twelfth of an inch from the point at which the slope commences. The gouge will be slightly revolved so that its hollow is towards the left of the turner, then drawing the right hand towards the workman's right, so that the tool cutting with its left side drives the shaving to the left. Continue working in this direction till the right hand end is reached, as was done on the left side. Only a full twelfth of an inch thickness of wood will be taken off at each fresh stroke of the tool, and care will be taken to withdraw it each time truth is attained.

The motive for acting in this way is easily understood. If, after making the first hollow in the middle of the cylinder, it is wished to cut towards the left, and that for this purpose the wood be worked upon in the thickness of the left slope; then, in withdrawing the handle towards the right, the grain of the wood would be raised up, and the tool would dig into it deeply, it would scrape and tear, but would not cut. Whereas, by following the method just indicated, the grain is laid instead of being raised, and the tool can not dig in deeper than is desired.

If the piece proposed to be turned had not been nicely prepared, and there was found to be much wood to be removed at certain parts, before getting it round, it might happen that the gouge, being compelled to enter too deeply, will bind against the sides of the groove. In this case the passage is widened by giving a few strokes of the tool to right and to left, at the same time, as stated above, turning the hollow side of the gouge towards the groove already turned, and always driving the shavings into the part already hollowed.

Many turners, in roughing out their wood on the lathe, content themselves by making plain grooves, one beside the others, without inclining the tool. This method is bad: the work is much less expeditious when it is followed; the grooves left in the wood are much deeper, and in following them there is a risk of diminishing the cylinder too much. A single groove deeper than the others necessitates reducing the wood its whole length in order to obliterate it. The gouge is the most commonly used tool; practice will teach beginners how to use this tool for smoothing the ends of a piece mounted on the lathe.

Position for Cutting Tools.

To properly understand the degree of inclination which the tool should have so that it may cut perfectly, the work on which it acts should be considered as a circle crossed by two lines formed by continuations of the bevels of the gouge. Thus considered, it will be easily understood that if the tool's edge A O B, Fig. 118, is presented straight at the centre, it tends to penetrate one bevel by the line A A, whilst the other tends in the direction B B, cutting off a portion of the circle, the greatest thickness of which should equal the thickness of the shaving. In fact, if the rotary motion ceased, and the impulse given to the tool were continued with sufficient force, the shaving cut off would present the form of an arc, of which the line B B would be the chord.

This principle fixed, the beginner may himself calculate what inclination he should give his tool. Examination of the bevel should decide it. Suppose this cutting-edge formed an angle of 30°, and, presented straight at the centre of the work—that is to say, so that the face of the tool, line A A, Fig. 118, passes through the centre of the work, and that the line B B, representing the bevel, divides the circle at one-fourth of its diameter. The tool cannot cut in this position—it will only scrape; because, supposing a force sufficiently strong to cause it to cut, it would take off three-quarters of the work at the first turn. Because it must not be thought that the cutting-edge would follow the line B B circularly, but the intermediate line C C, being impelled towards this direction by the equal force on each of its sides.

To take off shavings of only one-twelfth of an inch thick—a usual limit—the tool should be inclined so that the straight line A A, the face of the tool, passes through the line B B. In this manner the angle described by the bevel will make an angle of 60° with the primitive line A A; but the line D D, which forms the angle, being itself the chord of an arc too large for half its height to be but one-twelfth of an inch thick, a line, E E, is drawn parallel to the line B B, and separated from it by one-ninth of the quadrant of the circle marked in Roman figures. The blade of the tool inclined at 30°, as has just been said, is placed at the point F where the line E E cuts the circumference. Half the height of the arc, of which the line H H will be the chord, will be the thickness which the shaving should have. Now the tool, by the combined force of its bevels will follow, by a path which the rotary motion renders circular, the line K K intermediate in the height of the arc, H H VI., then the material will be cut properly. Thus the exterior angle E H, abutting at the point F, will indicate the bevel of the tool and the place where it should be placed.

Beginners, who do not wish to wait till some workman slowly teaches them what a long apprenticeship has taught him, will do well, to redraw Fig. 118. It will serve to determine the amount of inclination to be given to the tool, and the height it should be placed above the horizontal central line. It will be easy for them to see that elevating the tool above the ninth of the quadrant will produce the same effect as if the blade of the tool is brought towards the horizontal line. At the end of a day or two they will be accustomed to see at the first glance which is the point where the tool should be placed, and the ease or difficulty with which the wood is cut will indicate if the bevel differs from the angle of 60° at which it should be applied to the work. At an angle of 59° it will be harder work, and at 61° it will not cut off so much wood. They will see that the wood may be cut at all points on its

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* "Lathework for Amateurs" is mainly adapted from "L'Art du Tourneur," by Desormeaux; but deletions and additions are numerous and extensive. The illustrations are new, and the treatise entirely remodelled.

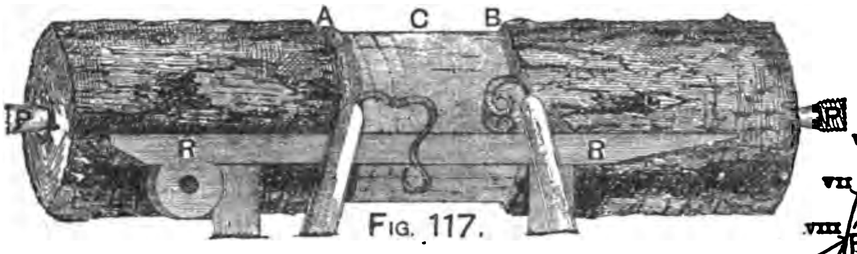


FIG. 117.

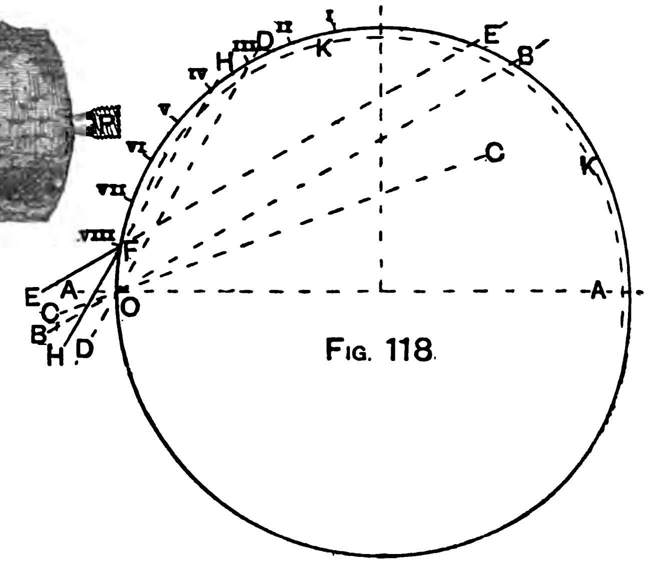


FIG. 118.

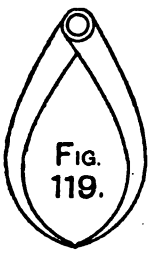


FIG. 119.

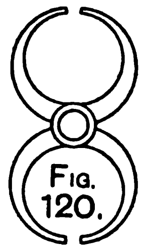


FIG. 120.

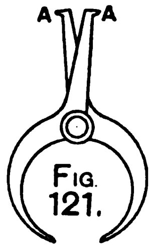


FIG. 121.

circumference, according to the way in which the tool is inclined, and that the point where the inclination is easiest for the hand is at F. Also that this depends upon the degree of proximity of the rest, for if the rest cannot be brought close to the work it must be operated upon much higher up, because, in this case, so much inclination cannot be given to the tool.

Turning the Ends of a Cylinder.

Workmen who are not very dexterous use the chisel for this operation, but it is not done so well, and the wood is not cut so cleanly as with the gouge. To assist beginners it should be stated that the manner of working is as nearly as possible the same as that previously indicated for cutting from the right and from the left. Very commonly the right end of the work is first smoothed. With this object it is cut squarely with the groove of the gouge turned towards the cone point. When a true ring cuts away the unevenness of the wood and shows what must be taken off, the right hand holding the handle is withdrawn towards the right, and it is elevated so as to direct the edge of the gouge towards the centre of the cylinder. This method of cutting presents some difficulties, as the gouge is then liable to run on the work and spoil it. The right side and the end of the cutting edge must alone operate, as will be further explained in the article on turning on the running mandrel.

If it were not for fear of tiring readers, a geometrical explanation would be given of the angle then formed by the bevel with the piece it cuts. But not wishing to enter upon long details which would be, in a great part, a repetition of the demonstration already made, they are invited to meditate upon this particular method of dividing material. This point will be returned to when speaking of the method of turning on the running mandrel lathe.

It will be explained shortly how this operation is done much more easily with the turner's chisel, so that beginners can at any time use this method whilst waiting for more practice and greater skill to allow them to use the gouge.

Smoothing the Cylinder.

When the cylinder is sufficiently prepared with the gouge, which is ascertained by means of the ordinary calipers, Fig. 119, or by the double-ended calipers, Fig. 120, or even by the eye. If it is found that no trace is left on the surface of the roughing-out cuts, made on the log with the plane or the draw-knife, the small ridges between the grooves will be cut away, always using the gouge and light strokes. Thus the surface will be made almost smooth, leaving only very small ridges which are inevitable owing to the shape of the gouge; then the turner's chisel will be brought into use—this tool (Fig. 107, page 188) is a most difficult one to manipulate.

Some people use chisels ground squarely on the end for smoothing. But, as in turning, the surface of the wood cannot be operated upon from the front—that is to say, parallel with its length, and the bevel must be presented obliquely to the axis of the piece being turned. We maintain that this method of grinding the chisel is as incorrect as it is inconvenient. Founding our opinion on this subject on the practice of the majority of turners and on our own experience, we say that the best way is to use chisels ground obliquely, because it is only necessary to present them perpendicularly to the wood for the bevel to be in an oblique position.

There are several reasons for cutting the wood obliquely to its grain, and not parallel; firstly, because wood cut in the first way offers less resistance, and the pores are found lying on the wood itself; secondly, for the reason that only the middle of the cutting edge should be employed for cutting wood. Supposing the piece to have been already properly roughed out cylindrical, the part of the bevel which does not cut bears upon a perfect arc, and does not allow the tool to cut otherwise than following the direction in which it is guided by that part of the cylinder on which it rests.

The chisel is held by the handle in the right hand, and its action is directed by the fingers of the left hand, taking care not to incline the tool too much. Because in this case, instead of smoothing the cylinder, only a series of grooves will be made which are apparent to the eye, and which it is very difficult to efface afterwards. Moreover, when smoothing a cylinder, the chisel must slide parallel lengthways of the work, and the movement should be as regular as possible, without either pause or jerk, so that each new application of the tool cannot be seen. This operation is very delicate, and beginners cannot be too strongly recommended to practise it as often as possible as the best method of acquiring precision of touch.

In this operation there is nothing to fear from the lower angle of the bevel, but not so with the upper angle. The beginner, unpractised in holding the tool, does not perceive the tendency which this has to descend. Thus, if the hand does not keep it up to its natural position, which is, as already stated, to cut with its middle, the upper angle, in descending below the centre of the work, will hook into the wood, penetrate deeply, and irrevocably spoil the surface of the cylinder. This accident is usually called a "master stroke."

When a cylinder has been turned passably true, the fingers should be passed round it and moved from end to end: hollows that escape the eye can thus be felt. However skilful one's hand may be, a hand-turned cylinder is never perfectly round; for, besides the unskilfulness of the turner, the unequal density of the wood, especially if it is quartered, is an insurmountable hindrance to making it perfectly round. To make sure, take a well-ground point tool, Fig. 111, p. 188, and hold it to the surface of the cylinder, barely touching; the point of the tool will be seen to touch the wood at all the high places, and not at the hollows. Unless the hand is well practised and steady, it is almost impossible to correct with the turner's chisel the imperfections noticed. The best way is to take the gouge and cut away only that wood which exceeds the perfect round, leaving the remainder untouched; then the chisel is again taken, and an effort is made to improve this time upon the preceding. In this way, in a short time, perfection will be attained.

It is easily seen that by this proceeding the diameter of the wood is continually diminished, and, if a definite measure had been given it would be already under size. For this reason work should never be undertaken in costly woods until certain control of the hand is attained.

The difficulty of turning a cylinder true is not the only one which may be met with. There is another not less important: it is that of keeping the same diameter from end to end, especially when it is a question of mathematical accuracy exacted in certain works, as in the necks of needle cases for example. It is possible to be mistaken in measuring, according as the callipers have more or less tightly pressed the part where they have been applied. Great care must consequently be exercised when measuring not to set the calipers too closely; but, on the contrary, to fix them in such a way that they slide over the work without any shake as well as without any tightness, which might allow an imperceptible widening in passing from a part that is rather scant to a part that is slightly large. If the happy medium is observed in the application of the calipers to the piece to be measured, and if the calipers pass from one end to the other without shaking or binding, it proves that the cylinder is uniform throughout.

Turning the Cylinder Ends.

The operation which remains to be done to the cylinder consists in cutting the two ends at right angles; but this cannot be done till a mastership has been acquired over the chisel. Some workmen use for this purpose the angle of the single bevelled chisel or of the point tool; but this method proves a want of skill on the part of the person who uses it. It has the disadvantage of leaving surfaces not naturally polished, as these tools, as has been said, scrape rather than cut.

It is, therefore, much better to cut the ends with the top angle of the chisel. First hollowing a shallow circle, next turning the tool on its side to form a chamfer, which, starting from the end of the cylinder, joins the circle which has been first hollowed. The circle and the chamfer are successively worked, and in this way, by properly directing the tool, the centre of the wood is reached perpendicularly, leaving a surface clean, flat, and almost polished.

Tools for Calipering.

As these have been mentioned in the preceding paragraphs, it is as well to describe them here, especially as their use is indispensable in the work next to be described. Fig. 119 shows the ordinary form of calipers, which are adapted for measuring both external and internal diameters. Fig. 120 shows the double-ended, or figure-of-8 calipers, now seldom used. Fig. 121 shows the in-and-out calipers, sometimes called the dancing-master. The two latter should not be bought without close examination. When these calipers are very true they are of great value, but as their adjustment is a long, difficult, and exacting operation, it often happens that those which are displayed in the tool-shops are defective, merely wasters, which never render satisfactory duty. Readers should, therefore, be made acquainted with the method of verifying their accuracy.

The figure-of-8 calipers is specially devoted to the measurement of thickness. When hollowing a globular vase it would be impossible to be assured that the interior positively conforms to the exterior without the help of these calipers. When accurate, they also serve to indicate how much material is left, and then there is no risk of breaking through the wall of the vase in continuing the hollowing; for this reason, by many people, they are called thickness calipers. In order that they may conveniently fulfil this purpose, the opening of the one O must be an exact repetition of the other. That is to say, when it is used to measure a thickness this must be faithfully shown by the opening of the other O.

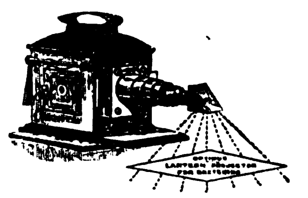
In testing the figure-of-8 calipers, when buying them, the first thing is to open them entirely so as to change ends; if the points meet equally after this test, it is good presumptive evidence. Next, with the ordinary calipers, measure the length of the O's from the centre washer; they should be of equal diameter. Finally, take a cylindrical piece and test it with each end of the calipers alternately; if it does not bind tighter at one end than at the other, it is a proof that these are true.

The in-and-out calipers, or dancing master, are even more useful for the running mandrel lathe than for the dead-centre lathe. In order to be accurate at every degree of opening, the separation between the curved limbs must be an exact repetition of the distance between the points of the small feet-like projections, A A, Fig. 121. To verify the accuracy of these calipers, select a small box which closes rather stiffly, measure the neck with the curved ends of the callipers, and, if exact, the feet will enter the cap and bind slightly. The dancing master is a very useful calipers for chucking on the running mandrel lathe, and generally in all cases where an exact fitting is required.

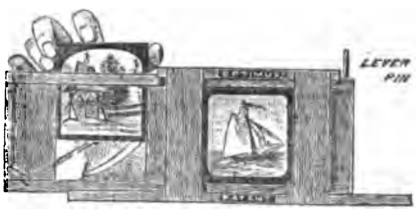
(To be continued.)

LANTERN ACCESSORIES.

ONE or two novelties are introduced by Messrs. Perken, Son, and Rayment, in connection with the lantern. The first, which is useful, and should prove instructive and entertaining, is the Optimus Projector for sketching. Any transparent photograph or sketch inserted in the stage is projected by means of a mirror on to a sheet of paper placed below, so that views or difficult architectural details, &c., may be accurately and easily sketched by tracing over the image shown thereon. This may be reduced, enlarged, or copied the same size as the original, and the projector is easily detachable, so that the instrument can be used as an ordinary magic lantern.



The next is an improved Carrier Block, which entirely prevents any dirtying of the surface of the slide by contact with the fingers, the removal of the slide being accomplished by pressing the lever pin, when the slide can be lifted out by its edges, as shown in the accompanying cut. Another useful contrivance is a lamp-wick trimmer, which, although primarily intended for trimming the wicks of lamps for photographic and optical work, will be found of much convenience to all who use oil lamps for illumination, its use insuring a clear flame and freedom from smoke.

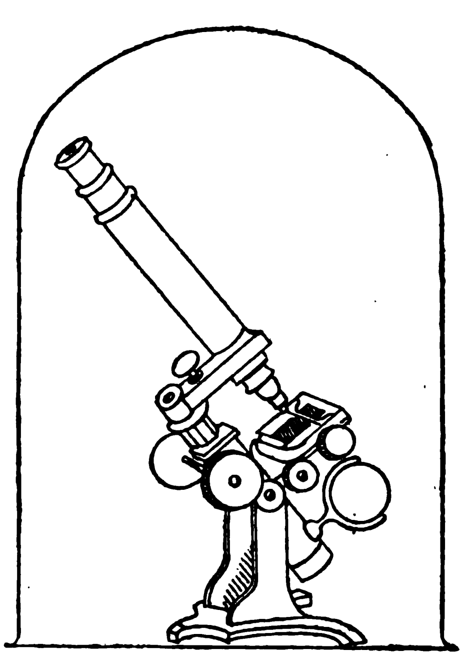


PRACTICAL MICROSCOPY FOR STUDENTS.—VIII.

By FREDERICK DAVIS, B.Sc.

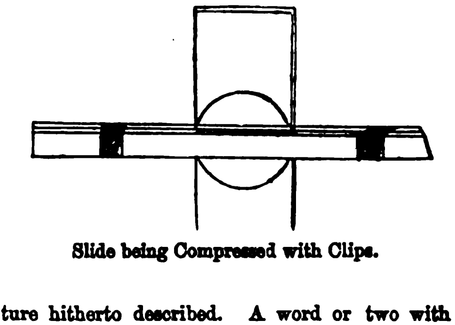
A FEW words descriptive of mounting specimens as permanent objects will now be acceptable to the student. Very little apparatus is necessary—merely a spirit-lamp, slips, cover-glasses, ether, spirit of turpentine, &c., and Canada balsam, the latter prepared in the manner described in a previous chapter. Having thoroughly cleaned the glass slip, first by washing and then polishing with a piece of chamois leather, drop, by means of a pipette, a little oil or spirit of turpentine on to the slide as near the centre as possible. Then place upon it the object to be mounted, and with a needle turn it carefully over several time that every part of it may become saturated with the spirit. This will render the object, if of vegetable origin and opaque, perfectly clear and transparent. We then hold the slide a little above the flame of the spirit-lamp and gently warm it, and again having recourse to a pipette, place upon the object a drop of the prepared Canada balsam; again turn the object over several times, and place upon it a cover-glass, and press firmly but gently down; this will cause a portion of the balsam to exude. Now if we take another slip and place it upon the cover-glass, and fix by means of clips firmly together, we shall find the object well compressed, the excess of balsam pressed out, and the cover-glass well down upon the object. After about two hours, remove the clips and the upper glass slip, which was merely employed to obtain even pressure. Gold-size the edges of the cover-glass to the slip, and then finish off nicely with the asphalte varnish as before described.

The turn-table will be found a very convenient instrument for insuring the regularity of the circle around the cover-glass, and if the varnish be put on smoothly and with care, gives the slide a well-favoured appearance. Some microscopists prefer the square cover-glasses; but to my mind the circular are better, not only because there are no corners for excess of balsam to adhere to, but also from the fact that air-bubbles are more easily excluded from beneath the circular cover-class. If the student so desires, in place of fixing his cover-glass with size and varnish, he may employ paper for the purpose by covering the whole slide, with the exception of the portion carrying the object. These papers may be purchased at the optician's, ready punched and gummed, very cheaply; but if the purse be studied, ordinary paper will answer the purpose, the holes being made with a gun-wad punch.

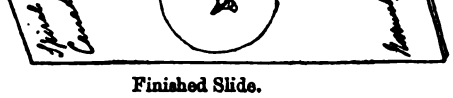


Microscope Under Bell Glass.

The student should in all cases name the object and affix the date and medium employed for mounting either at one or the other end of the slide. In a very short time he will find himself possessed of quite a nice collection if he prepares a typical slide of each cell, vessel, or structure hitherto described. A word or two with reference to mounting in media is now necessary. There are several methods in common use, one of which is that of a sunken cell, made by scooping out a portion of the slide itself. Another plan is that of the "built-up" cell: this is made by sticking firmly on the glass slip, evenly and well-cut pieces of glass in such a manner that, as it were, a little tank, impervious to the mounting medium is built upon the slide, but a better plan I think is to cut glass tubing to the required depth, and having ground the edges, stick it firmly to the slide by means of "marine glue," or, better still, a solution of isinglass in glacial acetic acid; this makes a cement so strong that if the tubing is evenly cut and ground, there is very little chance of the media siphing through, as we frequently find is the case with other cements.



Slide being Compressed with Clips.



Finished Slide.

Some microscopists prefer to build their cells with ordinary cement by merely drawing a circle, square, or oval upon the slide, permitting it to remain until quite dry, and repeating the process until a wall of sufficient depth is obtained. Many are the devices which will suggest themselves to the student, and in every case he should carry the idea out, as every microscopist has special practical methods of his own, and is generally more adept with these methods than those suggested by others. After having succeeded in making the cell, the method of filling is simple; it consists in pouring the mounting medium into the cell until quite full to overflowing, then cautiously place the object into this, turning it over several times with a needle, that any contained air may be relieved and rise to the surface. Then place on a cover-glass, and leave it in this position for a few hours, to permit any further air-bubbles to rise; then cement with gold size and asphalte as usual. It is imperative that air-bubbles be entirely excluded, or the beauty of the object will be spoiled.

If the student prefers to purchase his cells, he can obtain them reasonably from the optician; but to be able to rely upon oneself is important, and I would advise he make everything as far as possible for himself. The media generally employed for vegetable tissues are glygerine and water, dammar gum in spirit, distilled water, weak solution of perchloride of mercury (1 in 1,000). Canada balsam in benzole or isinglass may be used, and with practice forms a good medium. In this latter case the slide should be previously warmed. In every case it is necessary to carefully exclude dust or other foreign matter.

When not in use, all apparatus connected with the microscope should be kept rigorously excluded from dust; in fact, the instrument itself should be placed under a bell glass, more especially if kept in the vicinity of a chemical laboratory where acid and other fumes might act upon the metal of which the tube and stand are composed. The turntable mentioned above consists of a circular plate of metal revolving, generally speaking, by its own weight when once set in motion; this is applied horizontally to the slide, and guides the brush carrying the asphalte, varnish, or other substance; by its aid a good circle is produced. It may be well to mention the ring of varnish should be broad and smooth and well flattened.

These technicalities terminate the articles upon Vegetable Structures for the Student of Botany. The next articles will be allotted to animal tissues, &c., suitable for physiological students, to be followed by Pond Life and histology for the general student.

ASTRONOMICAL NOTES FOR DECEMBER, 1891.

The Sun.

Day of Month.	Souths.	At Greenwich Mean Noon. Right Ascension.	Declination South.	Sidereal Time.
	h. m. s.	h. m. s.	° ′ ″	h. m. s.
1	11 49 7·86 AM	16 29 22	21 49 13	16 40 13·55
6	11 51 8·58 ,,	16 51 5	22 30 34	16 59 56·34
11	11 53 21·89 ,,	17 13 1	23 0 55	17 19 39·13
16	11 55 44·31 ,,	17 35 6	23 19 52	17 39 21·92
21	11 58 12·33 ,,	17 57 17	23 27 11	17 59 4·71
26	0 0 42·04 PM	18 19 30	23 22 44	18 18 47·51
31	0 3 9·19 ,,	18 41 39	23 6 33	18 38 30·30

The method of finding the Sidereal Time at Local Mean Noon at any other station will be found on p. 367 of Vol. LII.

Spots and faculæ continue to increase in number and in interest, and should be looked for whenever the Sun is visible.

At 2h. 40m. a.m. on December 21 the Sun is said technically to enter Capricornus, and Winter is supposed to commence. He is, in reality, at this instant at the right angle of a right-angled triangle, which he forms with λ and μ Sagittarii. The 21st is the theoretical epoch of the shortest day; but in London no difference will be perceptible in this respect from the 20th to the 24th, on all four of which days the Sun will be above the horizon for 7 hours and 44 minutes; and, of course, for 16 hours and 16 minutes below it. Should the sun be visible on these four days, it will be an excellent time for determining the Meridian by the ancient method of equal altitudes.

Occultations of (and Near Approaches to) Fixed Stars by the Moon.

Day of Month.	Star's Name.	Magnitude.	Disappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.	Reappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.
			h. m.		°	°	h. m.		°	°
9	B A C 81	6½	10 46 p.m.	Dark	17	344	11 32 p.m.	Bright	280	245
13	B A C 1242	6	†10 29 ,,	S.E.	157	157				
14	56 Tauri	6	*6 47 a.m.	Dark	41	9	‡7 24 a.m.	Bright	300	272
14	99 Tauri	6	8 32 p.m.	Dark	27	66	9 22 p.m.	Bright	294	325
15	103 Tauri	6	1 40 a m.	Dark	98	63	2 47 a.m.	Bright	247	206
15	139 Tauri	5½	†8 20 p.m.	N. by W.	347	30				
16	39 Geminorum	6½	7 42 ,,	Bright	47	90	8 29 p.m.	Dark	301	345
16	40 Geminorum	6½	7 50 ,,	Bright	88	131	8 51 ,,	Dark	261	305
18	λ Cancri	6	†7 47 a.m.	N.N.E.	18	335				
24	46 Virginis	6	5 52 ,,	Bright	122	132	7 13 a.m.	Dark	313	307
25	*m* Virginis	6	†5 14 ,,	S.W.byS.	215	236				

† Near approaches. * Star setting. ‡ Star has set.
An illustrated description of the above table will be found on page 367 of Vol. LII.

Jupiter's Satellites.

Day of Month.	Satellite.	Phenomenon.	H.	M.	S.	Day of Month.	Satellite.	Phenomenon.	H.	M.	S.	Day of Month.	Satellite.	Phenomenon.	H.	M.	S.
1	I	Oc D	6	12	P.M.	11	II	Oc D	9	46	P.M.	21	IV	Ec R	6	41	48 P.M.
1	I	Ec R	9	49	21,,	12	III	Tr I	6	59	,,	22	II	Ec R	7	12	51,,
2	*I*	*Sh I*	4	42	,,	12	IV	Tr I	7	20	,,	23	*III*	*Oc R*	4	43	,,
2	I	Tr E	5	39	,,	12	*III*	*Tr E*	10	27	,,	23	III	Ec D	6	37	2,,
2	I	Sh E	7	0	,,	13	II	Tr I	4	57	,,	23	I	Tr I	9	13	,,
3	*I*	*Ec R*	4	18	17,,	13	II	Sh I	7	39	,,	23	*III*	*Ec R*	9	38	11,,
4	II	Oc D	7	7	,,	13	II	Tr E	7	50	,,	24	I	Oc D	6	34	,,
4	IV	Ec D	9	25	11,,	13	*II*	*Sh E*	10	28	,,	24	*I*	*Ec R*	10	4	56,,
5	III	Tr E	6	21	,,	15	*II*	*Ec R*	4	35	,,	25	I	Sh I	4	59	,,
5	III	Sh I	8	26	,,	15	*I*	*Oc D*	10	6	,,	25	I	Tr E	6	1	,,
6	II	Sh I	5	2	,,	16	III	Ec R	5	36	44,,	25	I	Sh E	7	16	,,
6	II	Tr E	5	10	,,	16	I	Tr I	7	14	,,	26	*I*	*Ec R*	4	33	46,,
6	II	Sh E	7	51	,,	16	I	Sh I	8	34	,,	29	*II*	*Oc D*	4	34	,,
7	*I*	*Tr I*	10	48	,,	16	I	Tr E	9	33	,,	29	IV	Tr E	6	42	,,
8	I	Oc D	8	9	,,	17	*I*	*Oc D*	4	35	,,	29	*II*	*Ec R*	9	50	49,,
9	I	Tr I	5	17	,,	17	I	Ec R	8	9	26,,	30	III	Oc D	5	31	,,
9	I	Sh I	6	38	,,	18	*I*	*Tr E*	4	3	,,	30	*III*	*Oc R*	8	57	,,
9	I	Tr E	7	36	,,	18	I	Sh E	5	20	,,	31	II	Sh E	5	10	,,
9	I	Sh E	8	55	,,	20	II	Tr I	7	38	,,	31	I	Oc D	8	33	,,
10	I	Ec R	6	13	53,,	20	*II*	*Sh I*	10	16	,,						

Ec, Eclipse; Oc, Occultation; Tr, Transit of Satellite; Sh, Transit of Shadow; D, Disappearance; R, Reappearance; I, Ingress; E, Egress. The printing of a phenomenon in *italics* indicates that its visibility is rendered doubtful, either by the brightness of the twilight, or by Jupiter's proximity to the horizon.

The Moon

is New at 15 minutes before noon on December 1st; enters her First Quarter at 5h. 13·3m. p.m. on the 8th, and is Full on the 15th 52·9 minutes after noon. She will enter her Last Quarter at 5h. 38·5m. a.m. on the 23rd, and be New for the second time this month at 3h. 19·9m. in the early morning of the last day of the year.

Day of Month.	Moon's Age at Noon.	Souths.
	Days.	h. m.
1	0·0	11 48·5 a.m.
6	5·0	4 27·9 p.m.
11	10·0	8 38·2 ,,
16	15·0	12 22·2 a.m.
21	20·0	4 43·9 ,,
26	25·0	8 6·7 ,,
31	0·4	0 25·5 p.m.

At 2h. a.m. on the 3rd the Moon will be simultaneously in conjunction with Mercury and Venus, Venus being 1° 54′ N. and Mercury 0° 30′ N. of her. She will be in conjunction on the 8th at 4h. a.m. with Jupiter (Jupiter 4° 12′ N.); at 1h. a.m. on the 23rd with Saturn (Saturn 2° 21′ S.); at 3h. p.m. on the 26th with Mars (Mars 0° 25′ S.); and, finally, for the second time in December, with Mercury at 6h. p.m. on the 31st (Mercury 6° 5′ N).

When our Notes commence, the moon has not long entered Ophiuchus, which constellation she quits for Sagittarius at 5h. 30m. p.m. on the 2nd. Her journey across Sagittarius terminates at 8h. a.m. on the 5th, at which hour she enters Capricornus. Here she remains until 2h. a.m. on the 7th, when she passes into Aquarius; as she does from Aquarius into Pisces at 4h. a.m. on the 9th. Travelling across Pisces she arrives at an outlier of Cetus, into which she passes at 6h. 30m. p.m. on the 9th, emerging from it into Pisces again at 4h. p.m. on the 10th. At 4.30 p.m. on the 11th she plunges into another outlying part of Cetus, and when she emerges from this 5 hours later, is into Aries. She quits Aries for Taurus 7h. 30m. a.m. on the 13th, and Taurus, in turn, for Gemini at 11h. p.m. on the 15th. She ha completed her journey through Gemini by 9h p.m. on the 17th, and entered Cancer, where sh remains until 10h. a.m. on the 19th, quitting Cancer then for Leo. She is in Leo until 9h. 30m a.m. on the 22nd, and then she enters Virgo. Her passage through this great constellation en at 3h. 30m. a.m. on the 26th, when she pass into Libra. Having traversed Libra, she arrives at 3h. 30m. a.m. on the 28th, on the wester boundary of the northern spike of Scorpio, and having crossed this, emerges from its wester edge at 3 o'clock the same afternoon in Ophiuchus. She leaves Ophiuchus for Sagittarius 1h. a.m. on the 30th. She is in the confines Sagittarius when the old year merges in 1892.

Mercury

is an evening star until within the last three four days of December, attaining his greate elongation east of the sun (20° 35′) at 3 p.m. the 11th, but he is about as badly placed as h well can be for the observer, rising too late an setting too soon in the mists of the winte horizon to be fairly seen. His angular diamete

Approximate Times of the Greatest Eastern Elongations of Saturn's Five Inner Satellites, visible at Greenwich.

Day of Month.	Satellite.	H.	Day of Month.	Satellite.	H.	Day of Month.	Satellite.	H.
5	Enceladus	3·4 a.m.	9	Tethys	4·9 a.m.	23	Mimas	4·8 a.m.
6	Tethys	5·0 ,,	9	Enceladus	6·1 ,,	24	Mimas	3·5 ,,
6	Mimas	5·7 ,,	10	Rhea	5·1 ,,	25	Tethys	2·0 ,,
7	Mimas	4·3 ,,	16	Enceladus	2·5 ,,	25	Mimas	2·1 ,,
8	Tethys	2·3 ,,	19	Enceladus	5·2 ,,	26	Mimas	12·7 ,,
8	Mimas	3·0 ,,	19	Rhea	6·3 ,,	27	Enceladus	1·6 ,,
9	Mimas	1 6 ,,	20	Dione	3·6 ,,	31	Dione	2·3 ,,
9	Enceladus	4·1 ,,	23	Tethys	4·7 ,,	31	Enceladus	4·2 ,,

A description of the above table will be found on p. 368 of our LIInd. volume. Titan is always at once recognisable. The greatest Eastern elongation of Hyperion will happen at 6·2h. a.m. on December 22nd. Iapetus will be in inferior conjunction with Saturn at 2·6h. a.m. on the 3rd.

increases from 5h. 6m. on the 1st to 10h. by the 28th, on which day, at 10 p.m., he comes into inferior conjunction with the sun.

Day of Month.	Right Ascension.		Declination South.		Souths.		
	h.	m.	°	′	h.	m.	
1	17	47·7	25	48·7	1	7·3	p.m.
6	18	17·8	25	42·0	1	17·6	,,
11	18	43·5	25	0·6	1	23·6	,,
16	19	0·3	23	51·6	1	20·7	,,
21	19	1·6	22	30·7	1	2·4	,,
26	18	43·3	21	16·8	0	24·4	,,
31	18	15·1	20	25·5	11	36·6	a.m.

The pendulum-like path indicated in the above Ephemeris is wholly in Sagittarius. Mercury will be in conjunction with Venus at noon on the 5th (Mercury 1° 16′ S.). He will also be in conjunction with the 3rd magnitude star, λ Sagittarii (of course, below our horizon) at 4h. a.m. on the 7th; the star will be only 10′ N. of the planet.

Venus

is an evening star, too; and is, in fact, so close to Mercury, that the remarks we have made above in connection with his position, *mutatis mutandis*, apply with equal force to hers. Her angular diameter increases imperceptibly from 10·4″ to 11·2″ during the month; she is now visibly gibbous.

Day of Month.	Right Ascension.		Declination South.		Souths.		
	h.	m.	°	′	h.	m.	
1	17	50·0	24	23·1	1	9·6	p.m.
6	18	17·5	24	31·0	1	17·4	,,
11	18	45·0	24	20·0	1	25·1	,,
16	19	12·3	23	50·2	1	32·7	,,
21	19	39·3	23	2·3	1	39·9	,,
26	20	5·9	21	57·1	1	46·8	,,
31	20	32·0	20	35·7	1	53·2	,,

Venus's path, like that of Neptune, begins in the western boundary of Sagittarius, but extends right across that constellation, and terminates in Capricornus. She travels through a region destitute of conspicuous stars. We have referred to her conjunction with Mercury on the 5th under the heading of that planet.

Mars

is for the purpose of the observer still invisible, a remark which also applies to Uranus.

Saturn

is a morning star, and as he does not rise until shortly after 1h. a.m. at the beginning of December, nor until 11h. 9m. p.m. on the last night of the year, we should, under ordinary circumstances, defer our ephemeris of him until next month. Inasmuch, though, as we have begun to look upon the north side of his ring, and as valuable observations may be made during the period when, as now, we are viewing it, comparatively speaking, nearly edgeways, we give his place in the sky for every fifth day at Transit at Greenwich in the hope that the student may be induced to watch the planet at an otherwise inconvenient hour in the morning. His angular equatorial diameter increases imperceptibly from 16·7″ on the 1st, to 17·6″ by the 31st of December. He is in "quadrature" with the Sun at 11h. p.m. on the 21st.

Day of month.	Right Ascension.		Declination North.		Souths.		
	h.	m.	°	′	h.	m.	
1	11	58·9	2	24·7	7	19·4	a.m.
6	12	0·1	2	18·3	7	1·0	,,
11	12	1·1	2	12·9	6	42·4	,,
16	12	2·0	2	8·5	6	23·6	,,
21	12	2·8	2	5·1	6	4·7	,,
26	12	3·4	2	2·7	5	45·6	,,
31	12	3·8	2	1·4	5	26·4	,,

Hence it will be seen that Saturn will be almost on a line joining β and η Virginis, and travelling in the direction of the last-named star.

Jupiter,

now that the nights are so long, is fairly placed for the observer, but should be looked at as near to the meridian as possible. He comes into (so-called) "quadrature" with the sun at 10h. p.m. on the 1st. His angular equatorial diameter shrinks from 40·3″ on the 1st, to 36·8″ by the end of the year.

Day of Month.	Right Ascension.		Declination South.		Souths.		
	h.	m.	°	′	h.	m.	
1	22	46·1	9	12·0	6	4·9	p.m.
6	22	47·9	8	59·9	5	47·0	,,
11	22	50·0	8	46·1	5	29·5	,,
16	22	52·3	8	30·8	5	12·1	,,
21	22	54·9	8	14·0	4	55·0	,,
26	22	57·7	7	55·9	4	38·2	,,
31	23	0·7	7	36·6	4	21·5	,,

Hence it will be seen that Jupiter starts from a point a very little to the south of λ Aquarii, and describes a short arc in a north-easterly direction from such starting-point. He will be nearly due east of λ Aquarii on the night of the 22nd, and a little more than 2° from that star.

Neptune

is now visible all night long, and is in every respect excellently placed for the observer possessed of sufficient optical power.

Day of Month.	Right Ascension.		Declination North.		Souths.		
	h.	m.	°	′	h.	m.	
1	4	24·4	19	58·5	11	42·2	p.m.
6	4	23·8	19	57·1	11	21·9	,,
11	4	23·2	19	55·9	11	1·7	,,
16	4	22·6	19	54·6	10	41·5	,,
21	4	22·1	19	53·5	10	21·3	,,
26	4	21·5	19	52·4	10	1·1	,,
31	4	21·0	19	51·4	9	40·9	,,

The short retrograde arc indicated in the above ephemeris is described about 1° north of the 4-3 mag. star ε Tauri, the northernmost one in the Hyades.

Minima of the Variable Star Algol

will occur on December 10th at 6h. 4m. a.m.; on the 13th at 2h. 53m. a.m.; on the 15th at 11h. 42m. p.m.; on the 18th at 8h. 31m. p.m.; and on the 21st at 5h. 20m. p.m., as well as on other occasions when the phenomenon will be invisible here.

Shooting Stars

may chiefly be expected on the night of the 10th; but less conspicuous showers may be watched for from the 4th to the 8th inclusive, and again from the 18th to the 22nd.

Greenwich Mean Time of Southing of Fifteen of the Principal Fixed Stars on the Night of December 1st, 1891.

Star.	Souths. h.	m.	s.	
α Aquarii	5	19	6·79	p.m.
Fomalhaut	6	10	25·48	,,
Markab	6	18	6·05	,,
ι Piscium	6	53	1·39	,,
α Andromedæ	7	21	20·97	,,
α Cassiopeiæ	7	52	50·77	,,
Polaris	8	37	54·17	,,
α Arietis	9	19	19·32	,,
α Ceti	10	14	43·40	,,
α Persei	10	34	38·94	,,
γ¹ Eridani	11	10	55·94	,,
Aldebaran	11	40	34·77	,,
Capella	*12	26	26·59	a.m.
Rigel	*12	27	4·80	,,
α Leporis	*12	47	38·68	,,

* Early morning of 2nd.

The method of finding the Greenwich Mean Time of Southing of either of the stars in the above list on any other night in December, as also that of determining the Local Instant of its Transit at any other station, will be found on p. 368 of Vol. LII. It must, however, be noted that the rules there given are not rigidly accurate as applied to Polaris, nor, in fact, to any close circumpolar star, though they will probably be found quite sufficiently so for practical purposes.

A SHAPING ATTACHMENT.

OUR illustration shows a modified form of shaping attachment similar in some respects to that described in our issue of October 31, 1890, which has been designed by Mr. F. M. Rogers, of No. 21, Finsbury-pavement, London, to meet the demand for a tool of this class capable of working on slight-built single-geared treadle lathes, such as are used by amateurs and other light-metal workers. The stroke is fixed and is determined by the throw of the eccentric sheave shown in Fig. 2, which is screwed direct to the nose of the mandrel, and travels in the grooved path upon the back of the sliding face-plate, thereby imparting a noiseless reciprocating motion to it. The stroke in the size shown, which is that adapted to a 4in. centre lathe, is about 2in., which enables as many as 120 strokes per minute to be taken with ease in soft metal,

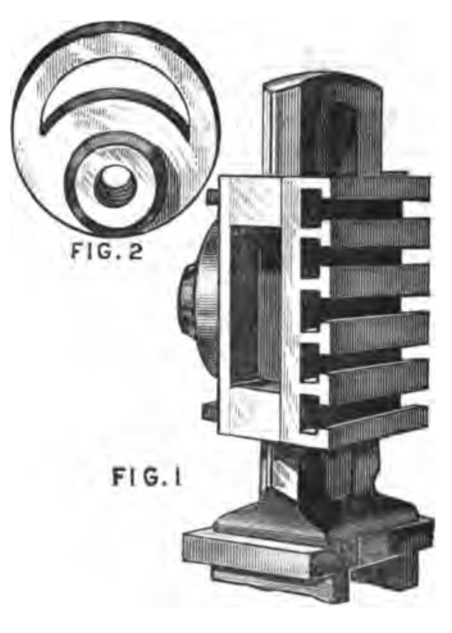
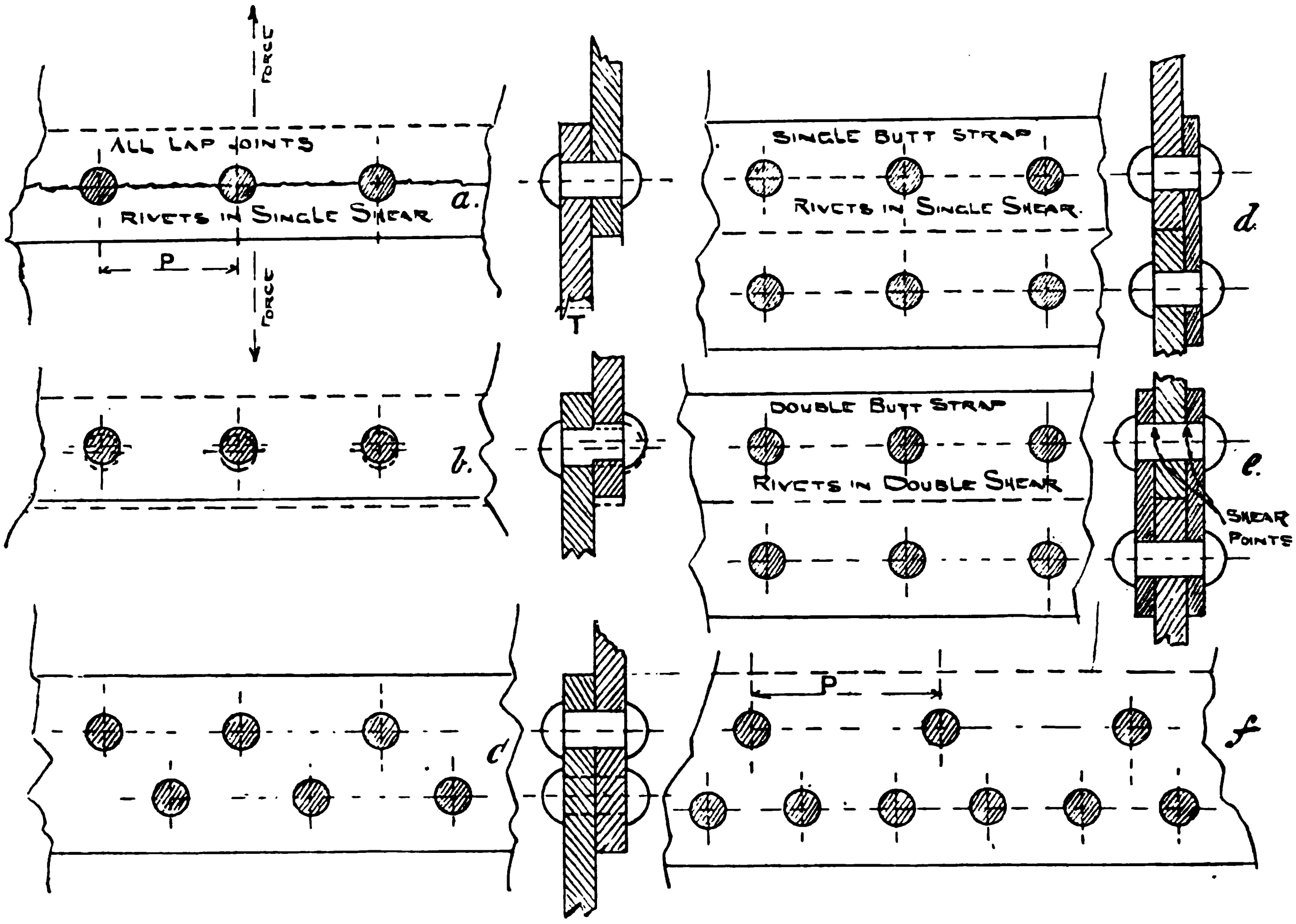


FIG. 2

FIG. 1



such as brass or gun-metal. The V-shaped packing block are of gun-metal, and an adjustment is provided for taking up wear. When fitted with a parallel vice this little tool will rapidly shape odd pieces of metal which would otherwise have to be filed up. Larger work is bolted to the grooved face-plate. The slide-rest is operated by hand or by a self-acting motion.

PRACTICAL HINTS IN BOILER DESIGN.—V.

By W. C. Carter.

Riveted Joints Exposed to Tension.

We now come to one of the most important points in connection with the design of riveted work, and one that ought to be thoroughly mastered. The question was briefly introduced at the conclusion of Art. I., and we will now consider it more closely.

When plates are joined together by rivets, and and subjected to forces tending to rend the joints asunder longitudinally (see Fig. 7), one of two things must occur before fracture of the joint takes place—either the plate will tear along between the rivets as at *a*, or the rivets will be sheared by the plates sliding upon each other, as at *b*. It would be possible for the joint to fail in other ways; but we shall give such proportions to the parts as shall render it unnecessary to consider any but the two ways of failure here stated.

We have seen, in Art. I., that it is usual to consider the strength of the solid plate to be represented by 100, while the strength of the joint, either in the plate or the rivet, is represented by the corresponding number expressed as a percentage of the solid plate strength. As it is the holes for the rivets which reduce the plate strength at the joint, by placing the rivets too close together we get *too many rivets*—i.e., too high a rivet strength, and *too many holes*—i.e., too low a plate strength, while, of course, if the rivets are too far apart, the converse is true. The question to be solved is, therefore, to find such a pitch of rivets as shall give equal percentages of strength for both plate and rivet.

In the case of land and locomotive boilers which do not have to pass a survey, the judgment of the designers has free play, and the strength calculations of the steel joints are based upon actual experiments with riveted joints, and these consequently vary with different makers and institutions. Naturally, where, as in the case of marine boilers, workmanship of varying degrees of excellence has to be brought together under a comprehensive system of rules, such as those of the Board of Trade or of Lloyd's, it is not safe to reason from one set of experiments to the work of other makers, and for this reason the gains of strength, due to friction between the plates, &c., have to be ignored, and the strength is calculated as follows: It will be observed that the plate fails in tension, and the rivet in shear, and so long as the tensile and shearing strengths of the material may be considered as approximately equal, as in wrought iron, what we have to aim at is simply to get such a pitch as will give equal sectional areas of plate and rivet. Where the joint is lapped or has a single butt strap, as in *a* and *d* (Fig. 7), each rivet presents a single section only to resist shear; but in the case of double butt-straps, the rivets must each shear at two points, as at *e*, before fracture can occur. Theoretically, therefore, the rivets in a double-shear joint are twice as valuable as those in a single-shear joint; but in practice it is usual to consider them as only 1¾ times as strong.

Inasmuch as the whole joint contains a certain number of pitches which were all similar, what is true of the whole joint is true of one pitch, and the arguments may therefore be based upon a strip of plate equal to the distance P (*a*, Fig. 7).

As seen above, we make our standard of reference the solid plate, and the sectional area of solid plate in this instance is P × T, and we have agreed to represent this by 100. The weakest section of the plate will be in the line of holes, and here we have to subtract half a hole on each side, and the plate we have left is only (P – D) × T. Comparing this with the solid plate, i.e., multiplying by 100, we get the percentage of plate section thus—

$$\frac{(\text{Pitch} - \text{Diam.}) \times \text{Thickness} \times 100}{\text{Pitch} \times \text{Thickness}} = \text{Percentage of Plate at Joint} \ldots (\text{xviii.})$$

In the joint shown at *b*, we have for each strip of plate P, one rivet, which has to be sheared through before the unfractured plates could be drawn apart. In a double-riveted joint, as at *c*, two rivets must be sheared for each strip, P; similarly we can see at once how many rivets occur for each pitch for any joint, the number corresponding to the number of rows in regular riveting; while in the case shown at *f* there are three rivets to each pitch, although there are only two rows. This arrangement will be considered afterwards. Meantime we see that the rivet strength is expressed thus—

$$\frac{\text{No. of rivets per pitch} \times \text{Area of sec. of rivet} \times 100}{\text{Pitch} \times \text{Thickness}} = \text{Strength of Rivet} \ldots (\text{xix.})$$

As before, P × T is the section of plate which we use for comparison, and the formulæ xviii. and xix., therefore, give us the relative strengths of plate and rivet for the joint in question, and it is expressed as a percentage of the solid plate.

If the rivets are in double shear, the result of xix. must be multiplied by $\frac{7}{4}$.

If we combine these two formulæ in such a manner as to give us P on the unknown side of the equation, we shall be able to find the correct pitch for any given thickness of plate and size of rivet—i.e., such a pitch as shall leave the plate and rivet strengths equal. If we can effect this, we have obtained the greatest possible strength for the joint in question, as any change in the pitch would unduly increase one of the strengths at the expense of the other.

The formula for the simple case *a*, found by combining xviii. and xix., is—

$$\frac{A \times N}{T} + D = \text{Pitch} \ldots\ldots\ldots\ldots (\text{xx.})$$

If the rivets are in double shear at *e*, xix. becomes—

$$\frac{N \times A \times 7 \times 100}{P \times T \times 4} = \text{Strength of Rivet} \ldots (\text{xxi.})$$

and xx. becomes—

$$\frac{A \times N \times 7}{T \times 4} + D = P \ldots\ldots\ldots\ldots (\text{xxii.})$$

When steel rivets are used in steel plates, these rules must be so modified as to give an excess of rivet section over that of the plate, because the tensile strength of steel is so much greater than its shearing strength. The Board of Trade assumes them to be as 28 to 23. To obtain this proportion, xx. becomes for single shear joints—

$$\frac{A \times N \times 23}{T \times 28} + D = P \ldots\ldots\ldots\ldots (\text{xxiii.})$$

and for double shear—

$$\frac{A \times N \times 23}{T \times 16} + D = P \ldots\ldots\ldots\ldots (\text{xxiv.})$$

while the result of xix. must be multiplied by $\frac{28}{23}$ to find the actual value of the rivet section. Should any other relative values be desired, they may be substituted for those here given.

The writer uses, for solving all the above rivet-joint formulæ, a specially designed slide-rule which obviates all calculation. The case shown at *f* deserves special attention. At the first glance it would appear that the plate is weakest along the inner row of rivet-holes, where the pitch is only half that of the outer row; but when we remember that before the plate could come apart on this line, the outer row of rivets would have to shear at the same time, we see that the true strength of the joint along the inner row of holes is that of the plate strength, plus the strength of the outer row of rivets. We shall find that the weakest part of the plate would be at the outer row of rivets, and P must be taken on this line as shown, while the rivet strength is that due to all the rivets contained in the strap P—i.e., in this case N = 5.

SOME NEW EXPERIMENTS ILLUSTRATING THE NATURE OF FLAME.

THE following entirely novel experiments have recently been devised by N. Teclu, a German scientist.

Take a common "Woulffe's" bottle (vide Fig. 1), fitted with a bent tube passing through a cork at *a*; *b* is a stopper that can easily be removed; and *c* is a straight tube fitting through a cork in the middle neck of the bottle.

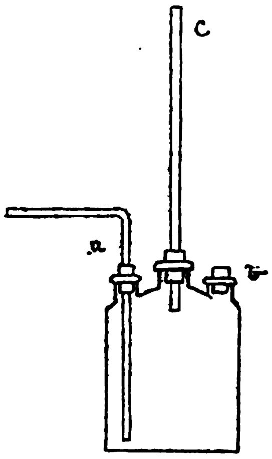


fig I

Now pass illuminating gas through the bent tube, and ignite it at A. On shutting off the gas, and removing the stopper at *b*, air enters, and the flame gradually loses its luminosity, going through a succession of changes; finally, a greenish-coloured cone is formed inside the flame, which diminishes rapidly in size, divides from the outer portion, and passes down the tube *as a separate flame* until it reaches the bottle, when the mixture of air and gas in it explodes.

The "Woulffe's" bottle is chosen because it is nearly always procurable without any trouble. If, however, it is desired to perform the experiment in a more striking manner, the arrangement shown in Fig. 2 should be adopted. Here A has a capacity of 1 litre, and is furnished with a tube, B, 350mm. long, and 10mm. in diameter, the tube C serving to pass in the gas;—these tubes pass through perforated corks.

On lighting the gas at *f*, and then shutting off the supply, the same phenomena are observed as in the first experiment, and if air is passed through C at the moment when the flame divides, the separated portion of the latter passes downwards with increased rapidity. When, however, the tube C is pushed up, so that *a* is as near as possible to *g*, and gas is passed through it, the flame is again driven upwards; whence it appears that the downward motion of the flame is dependent on the velocity of combustion, and, since the motion of the gaseous mixture is upward, and, therefore, in the opposite direction to that of the flame, the latter will take up a position corresponding with the resultant of these two motions.

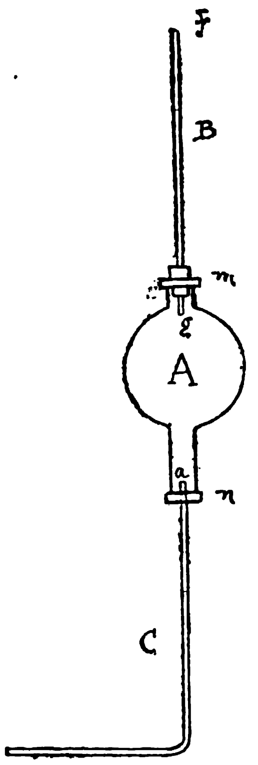


fig II

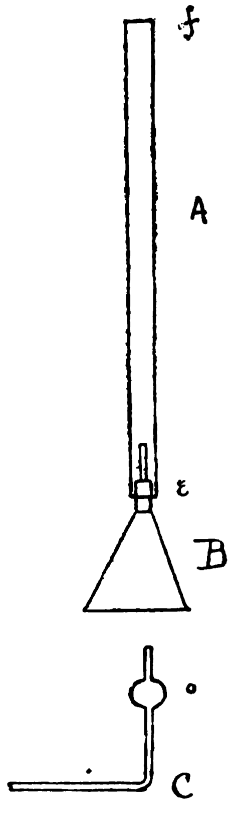


fig III

By employing the apparatus shown in Fig. 3, the lower flame may be brought to a fixed position. Here A is a tube 600mm. long, and 20mm. in diameter, and has a funnel 80mm. in diameter attached to it by means of a stopper; C is a tube 3mm. in diameter, having a bulb, *o*, sufficiently large to close the funnel when placed in the apex.

If *o* is inserted into the funnel, a stream of gas passed up, and, after lighting it at *f*, the tube C lowered, air will enter with the gas, the flame loses its luminosity, and soon becomes bluish, and on further lowering C, the flame, as in the experiment first described, divides.

When the pressure of the gas is constant and the air quite still, the flame which has descended into the tube A can be kept in the same position for any length of time. It is then seen that the cooler upper flame at *f*, which obtains its oxygen from the surrounding air, has its surface turned upwards, whilst that of the lower greenish-coloured and very hot flame is turned downwards. A portion of the gas is therefore burnt in the tube by means of the air mixed with it: whilst the other portion passes upwards and is burnt in the upper flame.

By raising C, both flames can be made to approach one another, and, when in contact, a flame resembling that of a bunsen-burner results. The bunsen-burner flame therefore appears to consist of two conical flames of different heights; in the outer one that part of the gas which escapes burning in the inner flame is burnt at a relatively low temperature by the outside air, whilst in the inner flame, the height of which is conditioned by the velocity of the combustion (see above) the gas is burnt by the air entering from below.

When the amount of gas passing into a Bunsen burner is diminished so that the relative quantity of air is increased to such an extent that the flame divides, it burns below.

The structure of the Bunsen flame can be shown by holding within it strips of wood 200mm. long, 100mm. wide, and 5mm. thick, charred figures being produced. These figures represent horizontal or longitudinal sections of of the flame according to the position in which the strips of wood are held; and they show that in the inner flame the heating surface inclines towards the centre, whilst in the outer flame it inclines outwards. This, we need hardly point out, is a very important consideration to be acquainted with in practice.

J. T. N.

CHEMISTRY FOR STUDENTS.—III.

By JOHN MILLS.

Author of "Alternative Elementary Chemistry," &c.

The Air we Breathe.

THE air in which we live, and constituting what is commonly called the *atmosphere*, is an invisible, tasteless, inodorous, and elastic envelope entirely surrounding the earth, and extending to a height (variously estimated by different philosophers) of from fifty to two hundred miles. No. doubt the effects of this air would be inappreciable at the former height; but there is no positive evidence to show why it should not reach to, or even beyond, the latter

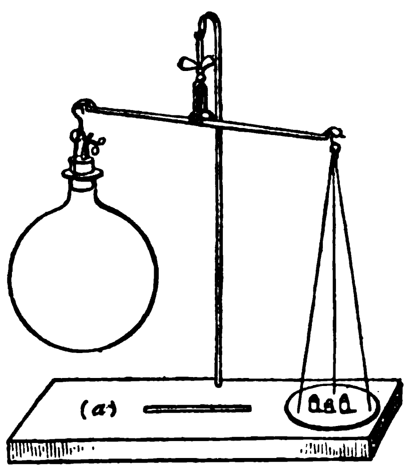


FIG. 17.

distance. It has been inferred from observations made upon luminous meteors that the gaseous envelope is at least one hundred miles high. In the days of the alchemists air was considered to be one of the elements, that is to say, that it consisted of one kind of matter only; but we shall presently indicate to the reader how he may readily satisfy himself, by simple chemical means, that such an idea is erroneous.

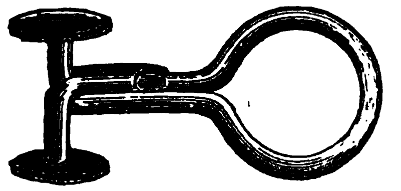


FIG. 18.

We all know, from every-day experience, that the atmosphere is of the highest importance to the maintenance of animal and vegetable life; to it the disintegration of rocks and consequent formation of soils is in great measure due; we owe to its influence the gradual transition of day into night, and through its modifying power the withering effects of solar heat are avoided. We are reminded of the existence of the atmosphere every time the wind blows, the sensation of pressure which we then feel being due to the motion of the air; or, if the open hand be moved quickly, a draught is felt, which results from the resistance of the atmosphere.

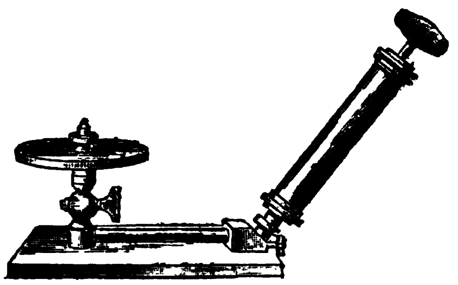


FIG. 19.

Ponderability of Air.

The ancient Greeks conjectured that air was a material substance possessing weight and elasticity, and devised means for exhibiting its properties; thus, by compressing the invisible fluid by the aid of a sort of syringe, they were enabled to impart motion to small bodies. They also knew something of the vacuum, and had crude notions of the reasons for its existence. The minute particles of air are so easily movable upon each other that the hand cannot grasp them, and the interference of the atmosphere with the freedom of our motions is so small that we do not, in the ordinary course of events, suspect its ponderability.

We can, however, readily prove conclusively that air has an appreciable weight. To do this, counterpoise a globular flask, Fig. 17, on one arm of an ordinary apothecaries' balance. Now detach it from the balance, attach a glass tube (a) to the caoutchouc tube, open the clip, and suck as much air out of the flask as possible, and whilst the exhaustion is being continued, close the clip. On again weighing, it will be found that the flask weighs less than before. Instead of sucking the air out, the flask might be heated over a spirit flame, and the clip closed while the flask is still hot. The heat rarefies the air, a portion being thus driven out of the flask, and the same result obtained as in the first experiment. In Fig. 18 is shown a suitable form of clip.

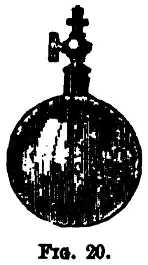


FIG. 20.

Although not indispensable, it is advisable to take advantage of the air-pump, Fig. 19, when such is available, in demonstrating that air has weight, and to use in conjunction therewith a flask provided with a stop-cock, as indicated in Fig. 20. Having satisfied ourselves as to the corporeal nature of the transparent mantle which envelops our globe, we will proceed to describe the means in general use for estimating its entire weight or pressure.

The Barometer.

Long before the year 1643 it was well known that water could be raised by a suction-pump only to a limited height—viz., about 34ft., and this fact was commonly expressed by saying that "Nature abhors a vacuum." But Torricelli, who lived contemporaneously with Galileo, found during the year referred to that nature's abhorrence of a vacuum varied for different fluids. Thus if a straight tube about 34in. in length, and sealed at one end (Fig. 21), be completely filled with mercury, then closed at the open end with the thumb and inverted in a basin of mercury, the liquid sinks slightly in the tube till a column of about 30in. remains. Now, if water were substituted for mercury, a tube not less than 34ft. in length would be required to accommodate the column of liquid.

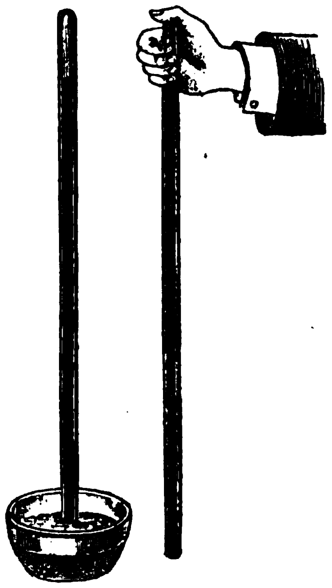


FIG. 21.

Torricelli soon perceived that it was the pressure of the atmosphere upon the surface of the liquid in the basin which sustained the mercury or water in the tube, and that the lengths of these columns varied in the ratio of the specific gravities of the liquids employed. For example, in the case under consideration, a column of water 34ft. in length = 408in., and this, divided by 30, the length in inches of the column of mercury, gives 13·6, which is the specific gravity of mercury. It follows, therefore, that the weight of a column of air 1sq.in. in section, and reaching to the utmost limit of the atmospheric envelope, is equal to the weight of a column of mercury 1sq.in. in section and 30in. in length. Such a column of mercury weighs 14·73lb.; hence it is commonly stated that the atmosphere exerts a pressure of about 15lb. on every square inch of surface.

The density of the atmosphere, and hence its pressure, is constantly varying according to the temperature, hygrometric condition, prevailing storms, hurricanes, and so on, and the fluctuating height of the column of mercury in the barometer tube serves to indicate the varying pressure of the air. Fig. 22 shows a simple form of barometer, the siphon tube being open at the end of the shorter limb, and the changes in height of the column of mercury are read off by means of graduated scales attached as indicated. The pressure of the air also decreases the higher we ascend above the sea-level, and the mercury is depressed more and more as the ascent is made, so that it is possible to register the heights of mountains, and other elevated objects, by the use of a barometer.

Effect of Heat and Pressure on Air.

A bladder partly filled with air and tightly closed at the neck, when placed before a fire, distends and becomes hard and smooth. In other words, the air expands and so entirely fills the bladder. We may effectually demonstrate this expansion of air on the application of heat by a very simple apparatus. Fit tightly into the neck of a flask a cork, provided with a bent delivery tube (Fig. 23). Fill a test-tube with water, and invert it over the end of the delivery. Place the flask in a saucer, and pour in water so as to surround the flask. The air in the latter, as it increases in volume, is expelled, and collects in the test-tube. It will be seen that the air left in the flask occupies the same volume as before, but the main body has obviously suffered expansion to the extent of that contained in the test-tube.

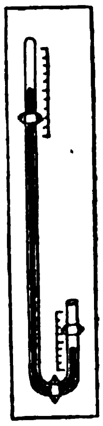


FIG. 22.

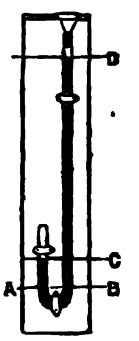


FIG. 24.

We may do the experiment in a simpler way still. Thus: Hold a test-tube in the flame of a spirit-lamp for a short time, then close the open end with the thumb, and open it beneath the surface of water. The air having expanded while heating, will now contract on coming in contact with the water, and some of the latter will enter the tube and occupy the place of the expelled air.

If air, or any other gas, be subjected to pressure, its volume decreases; that is to say, it occupies less space than is the case under ordinary circumstances. Hold a small beaker-mouth downwards, and press it upon the surface of water contained in a basin. The confined air will resist the downward motion, and when the hand is removed the beaker will spring upwards, because the air at once returns to its original volume. We shall not enter into full details here as to the laws which have been enunciated from a knowledge of the effects of temperature and pressure upon air and other gases, because these will be considered subsequently in a separate chapter, our aim at present being merely to obtain a knowledge of general principles. Let mercury be poured into a siphon tube, Fig. 24, until it stands at the same height in each limb A B; now pour more mercury into the longer limb B, when it will be observed that the confined air in the shorter limb A will gradually diminish in volume as the mercury is added. When the difference in level between mercury and the two limbs is about 30in., the air will occupy only half of it

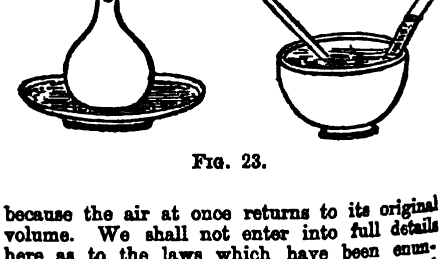


FIG. 23.

original volume. The pressure on the air in the shorter limb has thus been doubled, or another and more common way of expressing this fact is to say that the air is subjected to a pressure of *two atmospheres*. Generally, *the volume of air, or any other gas, varies inversely as the pressure upon it.*

(*To be continued.*)

LUMINOUS PAINTS IN ALL COLOURS.

THE following recipes for luminous paints in colours are given by a German contemporary: All the paints can be used in the manufacture of coloured papers, &c., if the varnish is altogether omitted, and the dry mixtures are ground to a paste with water. The lumineus paints can also be used as wax colours for painting on glass and similar objects by adding, instead of the varnish, 10 per cent. more of Japanese wax and one-fourth of the quantity of the latter of olive-oil. The wax colours prepared in this way may also be used for painting upon porcelain, and are then carefully burned without access of air. Paintings of this kind can be treated with water-glass.

Orange: 46 parts of varnish are mixed with 17·5 parts prepared barium sulphate, 1 part prepared Indian yellow, 1·5 parts prepared madder lake, and 38 parts luminous calcium sulphide.

Yellow: 48 parts of varnish are mixed with 10 parts barium sulphate, 8 parts barium chromate, and 34 parts luminous calcium sulphide.

Green: 48 parts of varnish are mixed with 10 parts prepared barium sulphate, 8 parts chromium oxide green, and 34 parts luminous calcium sulphide.

Blue: 42 parts varnish, 10·2 parts prepared barium sulphate, 6·4 parts ultramarine blue, 5·4 parts cobalt blue, and 46 parts luminous calcium sulphide.

Violet: 42 parts varnish, 10·2 parts prepared barium sulphate, 2·8 parts ultramarine violet, 9 parts cobaltous arsenate, and 36 parts luminous calcium sulphide.

Grey: 45 parts of the varnish are mixed with 6 parts prepared barium sulphate, 6 parts prepared calcium carbonate, 0·5 part ultramarine blue, 6·5 parts grey zinc sulphide.

Yellowish-brown: 48 parts varnish, 10 parts precipitated barium sulphate, 8 parts auripigment, and 34 parts luminous calcium sulphide.

Luminous colours for artists' use are prepared by using pure East India poppy-oil, in the same quantity, instead of the varnish, and taking particular pains to grind the materials as fine as possible. For luminous oil-colour paints, equal quantities of pure linseed-oil are used in place of the varnish. The linseed-oil must be cold-pressed, and thickened by heat.

SETTLING A QUARREL BY FLUORESCEINE.*

A REMARKABLE addition to the vast and continually increasing number of applications which chemistry has found in practical life is reported from Germany. The event is the more striking by giving evidence of the incredible sensibility sometimes observed in chemical reactions. In a mountainous part of the above-mentioned country, located at the water-shed of two large streams, the population from ancient times enjoyed on abundance of delicious trout frequenting the environing brooks. Modern industry, however, did not hesitate to place several manufactories on the shores of these creeks, and their refuse waters soon were noticed to pollute the downward courses. The raisers and consumers of fish, however, were soon to protest; they sued one of these establishments for damages, claiming that the refuse fluids had killed all the fish in their brooks. To this the manufacturer objected, declaring there was no communication between the water passing his works and the plaintiffs' brooks. The latter, however, though no visible connection of both waters could be ascertained, maintained that the communication was a subterranean one.

This being the state of affairs, a chemist happened to visit the scene of the quarrel, and, having been informed about the trouble, at once declared that the question might very easily be settled by a simple optical test. Both parties agreeing to submit to his decision as an expert, he undertook to perform the task.

The class of organic compounds comprised by the name of benzene derivatives, and abounding with brightly and richly coloured bodies, as well as with important medicines, also includes a substance called "fluoresceine," from the peculiar intense fluorescent properties of itself and some of its compounds. The substance represents a dark-red powder, dissolving in alcohol with a reddish colour having a green fluorescence. Its compound with sodium offers this green fluorescence to an almost incredible degree of intensity; it is perceivable in water containing one part of the compound to ten millions of water. In its effect upon man and animals of any kind, however, fluoresceine is a perfectly harmless substance.

It was to the optical property of fluoresceine that our expert resorted when one fine day, provided with a tin box containing two pounds of sodium compound, he proceeded to dissolve it in a barrel of water, the contents then being poured into the brook above the factory buildings. No sooner had the admixture taken place than the brook, formerly clear and transparent, became opaque, but of a shining green colour, which spread rapidly downwards with the flowing water. All the water in the lower course of the brook, and even in some ditches and creeks which had not been known to communicate with the brook subjected to the test, became green, and kept this colour unto its inflow into the broad stream about five miles away.

The population were astonished and became excited, fancying that the water had been poisoned —a fear which they did not abandon before having been convinced that the water was still drinkable and unchanged in taste, and even in colour when held against the sun. The green hue was only perceived in the water covering the dark background of the river bed. People also became easily persuaded that only the water in communication with the stream passing the factory was subject to the change, all the others having remained in their former condition, including the one belonging to the suing fishermen, who thereupon gave up the complaint and resorted to efficient expedients to provide fresh trout for their waters.

The question whether there are communications existing between several natural currents of water may happen to be both of scientific and practical interest. The recent formation of a lake near the Colorado River gave rise to various conjectures as to its origin. In such cases the fluoresceine test would answer with unsurpassed certainty. It would also reveal the source of pollutions in drinking-water in the researches that are at present being performed in the Croton district, supplying the city of New York.

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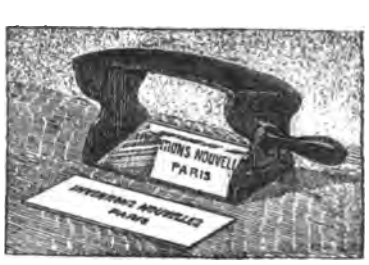
* By WILLIAM BERNHARDT, in the *Popular Science News* (Boston, U.S.)

MIRROR LENS.

THIS little instrument has been devised especially for the reading of certain English and American journals that are printed in very small type, and the continued reading of which soon fatigues the eyesight. But it may be employed just as well for the reading of manuscript, and in this case it is much easier to use than is the hand lens usually employed.



It consists of a concave lens designed to give an enlarged image of the characters, which reflects the latter upon a small plane mirror which lies upon the sheet of paper just above the line that it is desired to be read. As soon as the reading of the line is finished, the apparatus is slid over it, and one immediately perceives the following line in the mirror.—*Les Inventions Nouvelles.*

ACCORDING to the *Electrical Review* of New York, ozone is being tried in America for oxidising suspected water. Nothing could be more perfect than the killing of organisms by the very process that obtains in Nature. In a very short time we will doubtless use ozone as a cheap disinfectant. It will be made wholesale by electrical discharge, and will be used for disinfecting, bleaching, oxidising oil for linoleum and such work, and perhaps vulcanising rubber, and a thousand and one other uses will spring up as soon as the reagent is really in the market.

A New Electrical Machine.—At a recent lecture M. Henri Becquerel exhibited an ingenious frictional electrical machine, devised by his demonstrator, M. Peignot. Mercury is forced by means of a pump through the pores of a piece of chamois leather, and electricity in cynsiderable quantities is generated by the friction. Ducretet, the well-known Paris instrument maker, has just finished a machine of this kind for the Conservatoire. The column of mercury is 1 mètre high and 30 centimètres in diameter.

SCIENTIFIC SOCIETIES.

ROYAL ASTRONOMICAL SOCIETY.

THE first meeting after the vacation was held on Friday the 13th inst. General Tennant, president, in the chair. Prof. Oliver Lodge was elected a fellow of the society.

Mr. Knobel read a paper by Mr. E. E. Barnard on observations of the planet Jupiter made at the Lick Observatory with a 12in. refractor. Mr. Barnard stated that a number of new white spots had become visible on the planet during the last few months, and in the northern hemisphere of the planet a number of dark spots had appeared. These dark spots moved more rapidly than the white spots, or than the great red spot. In fact, Mr. Barnard finds that the great red spot gives nearly the slowest rotation period of any feature on the planet. The great red spot has recently regained much of its former colour and distinctness of form. A new oblong red spot has appeared in the southern hemisphere, which gives a still slower rotation period than the great red spot. Evidently rapid colour changes are going on on the surface of the planet. Mr. Barnard was inclined to think that most of the permanent markings seen could not be clouds, but were parts of the actual surface of the planet, which must be in a plastic condition, and capable of undergoing great change from year to year.

Mr. Knobel then read a paper by Mr. Stanley Williams on the supposed duplicity of the first satellite of Jupiter. Mr. Williams had been observing Jupiter on the night on which Mr. Barnard and Mr. Burnham observed the double appearance of the satellite, and had noted a small dark spot on the belt transited by the satellite. It was not at the time near to the satellite; but Mr. Williams suggested that at a later period during the transit it may have given rise to the double appearance, for neither Mr. Barnard nor Mr. Burnham appear (owing to the presence of visitors at the Lick Observatory) to have been able to watch the double satellite for more than a minute or two.

Dr. E. J. Spitta said: Several years ago I made a number of experiments on the transits of Jupiter's satellites, and I feel convinced that the observation of the double satellite may be accounted for by the brightness of the background on which the satellite was observed. With a bright background there would be irradiation, which would appear to eat into the disc of the satellite, and might appear to divide it into two if there were a dark belt; and with a background darker than the satellite, you might have irradiation from the satellite, making it appear to have a disc elongated in the polar direction.

Mr. Knobel said: There was a transit of this first satellite on Saturday last, which I observed. When it entered on the disc it appeared quite bright in comparison with the background; but when it had passed about a quarter of a radius on to the disc I could see it as a dusky spot on a bright background. There will be some more transits across this southern dark equatorial belt, and there will, therefore, be an opportunity of verifying Mr. Barnard's observation if it is due to contrast.

Capt. Noble said: I was struck with the remark in Mr. Barnard's paper, that the markings on Jupiter are many of them permanent, and, therefore, we must actually be looking at the plastic surface of the planet. How would he account for Mr. Stanley Williams's observation of the spot which last year drifted up to the red spot and then went under it and was lost? It has always seemed to me possible that the great red spot might be something like a solar protuberance, a region were we saw matter issuing from the substance of Jupiter himself. There can be no doubt about its permanance on the planet.

Mr. Ranyard said: It seems to me that the different periods of rotation of the different spots and markings upon Jupiter are sufficient evidence that we have in Jupiter a body with a very deep gaseous envelope, probably something like our sun. It is only a gaseous body which could rotate with different velocities in different latitudes. There is also other evidence that we are looking at a gaseous body: when a star is occulted at the limb of Jupiter it does not disappear suddenly. Some seven or eight years ago I put together in the *Monthly Notices* several observations of such gradual disappearances of stars and satellites at the limb of Jupiter. In one case Prof. E. C. Pickering observed a star of the 7th magnitude, which took two or three minutes before its light was entirely lost. The light died down, and then became brighter again two or three times over before it was finally lost: it must have been seen through a depth of nearly a thousand miles within the limb. There seems to be strong concurrent evidence that there is a great development of red spots and red markings on the surface of Jupiter. At the present time change is evidently going on there more rapidly than usual, and it is interesting to note that it is at a time when sunspots are beginning to be more numerous and larger. In 1870 I compared, in a paper in the *Monthly Notices*, the records of such activity on the surface of Jupiter with the sunspot period, and came to the conclusion that there was a good deal of evidence showing a connection between the two classes of phenomena. The activity on Jupiter was very marked in 1869 and the following year, and there was a similar development of red spots and rapid change in 1880 to 1883, and now again, with the commencement of a new period of solar activity, we hear of these changes on Jupiter.

Mr. Howlett asked whether it would be possible for a double satellite to revolve in such close proximity without being drawn together, so that the two bodies would merge into one another.

Mr. Ranyard: I think that we may be sure that, if two iron balls 1,000 miles in diameter rested on one another, they would crush together; even steel would flow out like water under the pressure of their mutual gravity.

Mr. H. H. Turner read a paper on some new forms of levels. He said: I should like to make this a joint paper with Mr. Common, and to discuss some possible modifications of the old form of level. The great difficulty has always been that it has been impossible to get a level with a uniform scale. This is partly due to the inequalities in the tube of the level, and to the changes in the shape of the bubble caused by the expansion of the glass or the liquid. My proposal is, that the bubble should always be brought to the same part of the tube by means of a micrometer screw. The bubble will then always be brought to one part of the scale, and the reading will really be made by reading the screw, about the errors of which we know a great deal more than about the errors of levels. Mr. Common has suggested to me that we should get rid of a spirit-level altogether by having a horizontal telescope with a prism at the end, which enables you to look down into a trough of mercury, and compare the place of the wires in the telescope with the wires as seen reflected from the mercury. The level of the telescope would then be changed, and the wires brought into coincidence with their images by means of a micrometer screw.

Mr. Brett: In your instrument, how do you know that the inside of your level is a true cylinder, and that the bubble has not changed its shape from one part to another?

Mr. Turner: That is just the difficulty that I propose to avoid. I always bring the bubble to the same part of the tube before I make the reading.

The President said: I think that the subject dealt with by Mr. Turner deals with a very old difficulty about which a great deal has been written. It has been said that spirit is too light a fluid. No doubt that mercury, by reason of its weight, would be very sensitive.

Dr. Spitta read a paper on "Some Photometric Experiments connected with the Application of the Law of Limiting Apertures and small Object-Glasses." He showed by diagrams the very great variety of the size of the image of star made by different parts of object-glasses by different makers, and the dangers of relying on the constancy of such images for photometric work.

QUEKETT MICROSCOPICAL CLUB.

THE 297th ordinary meeting of this club was held on Friday, Nov. 20th, at 20, Hanover-square, W., Dr. W. H. Dallinger, F.R.S., President, in the chair.

The Secretary said that something beyond the ordinary form of acknowledgment was due in the case of the new edition of Dr. Carpenter's "Revelations of the Microscope," presented by the editor, their esteemed president, Dr. Dallinger. It was, perhaps, an excess of modesty on Dr. Dallinger's part to entitle what must have required immense labour and original research, a mere new edition: it was practically a new book. The first seven chapters, relating to microscopic optics, the instrument and its accessories, and their use as true scientific tools, were entirely new, and included a concise, yet accurate summary of Prof. Abbe's important theories now for the first time brought together in a single work. This particular subject, though of the highest possible importance to microscopists, was hardly touched upon by the late Dr. Carpenter, was, in fact, brought forward in the latter period of his life, when he seemed to shrink from dealing with it, and since the last edition in 1881 very considerable advances had been made, both in the theory and practice of microscopic optics, which would be found fully discussed in the one now before them. The question of the absolute requirements of a microscope intended for the best class of work was dealt with without favour, and with such discernment that it must, and did, recommend itself to whosoever had endeavoured to work with the instrument in a truly scientific spirit. Chief, perhaps, among Dr. Carpenter's many merits, and one which cannot be too highly commended, was a great capacity for lucid exposition of any subject he wrote or spoke upon, and he wished to convey a high compliment by saying that, in his opinion, the present edition was in this respect not one whit behind its predecessors; and, as far as extended knowledge, acute criticism, and research could make it, immensely their superior. The Secretary further said he was sure every member present would hear with great regret that their esteemed treasurer, Mr. Gay, who had held this office since 1875, felt himself compelled, by reason of continued ill-health, to resign his post. He was, however, in a position to state that their well-known friend, Mr. J. J. Vezey, had accepted the treasurership, and would be proposed in due course at the next annual general meeting. He would also, in order to relieve Mr. Gay as far as possible until then, receive current subscriptions and transact the financial business of the club.

Mr. C. L. Curties exhibited a new microscope by Reichart. Mr. C. H. Gill exhibited and described a "life slide" and slide carrier, for use with oil-immersion condensers.

Mr. Hardy made some remarks on a simple form of monochromatic light illuminator, consisting of a dense flint prism attached to the mirror fitting. Mr. Nelson pointed out that although this simple arrangement gave a coloured light, it could hardly be said to be strictly monochromatic, and it was essential that the prism should be used in the position of minimum deviation.

Mr. Rousselet read a short reply to the criticisms made at the last meeting on his paper "On Vision in Rotifers." Mr. Parsons read a paper on two new rotifers, Pterodina cæca and Callidina magna-calcarata, found at Epping Forest. Mr. Western corroborated and supplemented Mr. Parson's discovery by some further remarks on these organisms.

Mr. E. M. Nelson read an abstract of a paper "On the Diffraction Theory and Fraunhofer's Theorem." This went to prove that the Abbe theory in part and Fraunhofer's theorem were incompatible; that diffraction phenomena did not begin with a given small interval; and that Eichorn's calculation was incorrect. Mr. Nelson also showed a photo-micrograph of the ultimate structure of muscle fibre.

Votes of thanks were passed for these communications, and the proceedings terminated.

Mr. T. Powell exhibited a resolution of Navicula rhomboides with a new apochromatic $\frac{1}{15}$ homogeneous immersion.

The next meeting will be held on Friday, Dec. 18.

USEFUL AND SCIENTIFIC NOTES.

THE Butter Committee of the French Chamber has framed a Bill by which all adulteration of butter is prohibited. Makers and retailers of margarine are to notify the authorities, to pay 2f. per 100 kilogrammes, and to affix a label. Violation of the law is to be punishable with from six months' to two years' imprisonment. Exception, however, is made with regard to omission to affix the label, which is punishable with imprisonment for a period ranging from a fortnight to three months.

Coal Burnt on the Atlantic Steamers.—The steamship *Majestic*, on her first record passage, is said to have maintained a speed of 20·1 knots, and burning 220 tons of coal each day; her engines indicated 19,500H.P. The *City of Paris* is accredited with 260 tons of coal during the voyages she is at present making, and her average speed is said to be about 19½ knots; but her indicated horse-power is less than that of the *Majestic*. Reckoning 2,240lb. per ton, the coal consumption of the *Majestic*, according to the foregoing figures, is 1·05lb. per indicated horse-power, which shows a remarkable economy of fuel; in fact, these figures would seem to indicate that there is a mistake somewhere. It is asserted that during a recent voyage the coal consumption of the *City of Paris* was only 240 tons per day for both main engines and all auxiliary power. But her total horse-power and the necessary deduction for the auxiliary power is not given.

Thomson's Sounder.—Sir W. Thomson, writing to correct some misconception of his sounding machine, says:—It is true that the chemically-prepared tube was the only appliance for measuring the depth which I had in my apparatus when it was first brought into use 14 years ago, but about six years ago I introduced a depth-recorder in which the depth is indicated by a marker pushed along a scale of depths by a piston working in a tube forming the neck of a bottle. The piston is held back by a spring, and the distance to which it is pushed inwards by the increasing water pressure as the sinker descends to the bottom is proportional to the depth. The marker is left at the position on the scale corresponding to the depth, until the sinker is hauled up and brought on board, when the depth is read off and the marker is reset in its zero position, to be ready for use again. Both the chemical tubes and this depth-recorder are regularly supplied along with my sounding machine. Some navigators prefer the chemical tubes, because they give a permanent record of the depth. Others prefer the depth-recorder, and do not use the chemical tubes at all. Many use sometimes the chemical tubes and sometimes the depth-recorder, according to circumstances. The depth-recorder has great advantage over the chemical tubes in avoiding the expense of relining the tubes with the chemical preparation.

SCIENTIFIC NEWS.

THE position of Wolf's comet on Dec. 9, Berlin midnight, is, according to Dr. Berberich's ephemeris, R.A. 4h. 19m. 37s., S. Dec. 14° 26·6′, brightness 6·35 as compared with unity at time of rediscovery. Those who possess instruments of even moderate aperture may probably be able to follow the comet until about Christmas; but on that day the brightness will be only 4·35, and the S. Dec. 1° 39·7′.

The death is announced, in his 63rd year, of Prof. Joseph Wolstenholme, who will be affectionately remembered by many Cambridge men, and also by many students at Cooper's Hill, where, after resigning his Fellowship at Cambridge, he became the first professor of mathematics. The deceased was looked upon as one of the most accomplished mathematicians of his time, and, amongst other works, published a collection of original mathematical problems devised by himself.

The "master" of the Birmingham Mint, Mr. Ralph Heaton, is dead. He was born in 1827, and early in life was associated with his father in the business of brassfounding, stamping, and tube-making. When Boulton's mint at Soho was dismantled, Mr. Heaton's father purchased the coining apparatus, and made great improvements in the production of "blanks" and completed coins. When the present bronze coinage was introduced, the firm received large orders from the Government for blanks, and subsequently for completed coins. Mr. Heaton was chairman of the Birmingham Mint Company, and at one time or another had made coins for nearly every country in Europe, as well as for India, China, Canada, and several of the South American Republics.

The Vice-Chancellor of Cambridge University has received a petition from 2,689 persons resident in New Zealand, praying the senate to grant degrees to women.

The Spanish Government intend to open two exhibitions in September, 1892, in celebration of the fourth centenary of the discovery of America. One of these will be at Madrid, and will be called the Exposition Historique Américaine de Madrid. The other, at Huelva, will be called the Exposition Historique Européene de Madrid.

The Council of the Royal Scottish Geographical Society have appointed a committee to co-operate with the Director-General of the Ordnance Survey of the United Kingdom in the revision of the place names of Scotland. Dr. J. Burgess, C.I.E., is the convener.

At the meeting of the Royal Geographical Society on Monday last, a paper descriptive of a journey across the Pamirs made by Mr. St. George Littledale and his wife was read by the secretary. It appears that the stories of summer pastures refer, so far as they are true at all, only to isolated cases. The country in question cannot feed the caravans that cross it; far less can it sustain the baggage animals of an army on the march.

Under the auspices of the German East Africa Company Dr. Oscar Baumann is to make a series of explorations in the Masai territory, in which he says there are many regions about which little is known.

The Committee appointed at the Cardiff meeting of the British Association to obtain information as to the climate of Tropical Africa, and to endeavour to establish a network of observing stations, ask for the assistance of all who can help them. They are tabulating all the data known to them, and will supply blank forms to any residents in that portion of Africa who will undertake to make regular observations and return the forms duly filled up. The committee consists of Mr. E. G. Ravenstein (chairman), Mr. Baldwin Latham, and Mr. G. J. Symons (secretary). Communications should be sent to Mr. Symons, at 62, Camden-square, N.W.

Writing about the remarkable barometric depression of Nov. 11, Mr. G. J. Symons says that it has been exceeded only five times in the thirty-five years during which he has been making meteorological observations. Anticipating a great depression, he started the Richard brontometer at 6.30 a.m. and kept it running for ten hours, thus obtaining on a roll of paper about 60ft. long such a record of the movement of the barometer as has never before been obtained—every little pulsation being shown in detail, even if it lasted only two seconds.

It is well known that Mr. Edison has been studying a scheme for working all railways by electricity, and it is understood that he will endeavour to show an example at the Chicago Exhibition of 1893, and probably run trains from that place to Milwaukee, which is situated on the shore of Lake Michigan, about 100 miles above Chicago. Mr. Edison is reported to have said that "Electricity will displace steam, if economy, as well as speed and safety, is a factor of locomotion, not because it will make a speed of 100 miles an hour easily, while steam strains itself to make 60, but because it will get one-horse power out of 1lb. or 2lb. of cheap coal, while a locomotive only gets that power out of 6lb. of dear coal. He also thinks that "full speed on this system is—or I see no reason why it should not be—200 miles an hour. But for practical purposes I feel sure that a 10lb. rail on a ballasted track would stand a speed of 100 miles an hour."

The American Institute of Electrical Engineers have appointed a committee to suggest plans for the International Electrical Congress to be held at Chicago in 1893. Prof. Gray is president of a local committee formed for the purpose of making preparations for the Congress.

The Blackpool Electrical Tramway continues to pay a good dividend and to work without a hitch, so that it is evident electric traction can be worked with success.

Notices of several underground-railway projects have been lodged in the Parliamentary Office, and it is safe to assume that all these will ask for power to work by electricity as well as by other means.

It is stated that the result to the State of working the Indian railways was a considerable financial loss during 1889-90.

It is reported that a fluid extract of Eucalyptus leaves has been tried on some of the Indian railways to prevent and remove scale from boilers, and the results, according to the Director-General's report, are satisfactory; at present the experiments are not complete.

Arrangements are now completed for issuing certificates to those watch and clock repairers who satisfy the examiners of their proficiency. The ordinary certificate will be granted to watch repairers who satisfy the council that they have a fair knowledge of depths, the verge, horizontal, and lever escapements, and keyless work; for first-class certificates, evidence will be required in addition of the applicant's ability to time and adjust, and of his familiarity with chronographs, repeaters, and other complicated pieces. The practical work and question papers will be examined at the Horological Institute. This scheme should attract the attention of all young watch and clock repairers, who can obtain all particulars from the secretary of the Horological Institute, Northampton-square, London, E.C.

The fumes of burning naphthalin are stated to be a cure for whooping cough by Dr. Chevernac, of Aix, who discovered its powers accidentally. He places about three-quarters of an ounce in a metal dish and applies heat. The naphthalin soon melts and fills the room with white fumes that are not unpleasant.

Next Sunday, Nov. 29, Sir R. S. Ball, F.R.S., lectures at St. George's Hall, Langham-place, at 4 p.m., on "How came the Great Ice Age," with lantern illustrations. This lecture concludes the first series of seven lectures of the Sunday Lecture Society. Twenty-one lectures in three series are given during the season.

"Copernic et la Découverte du Système du Monde," by Camille Flammarion (Paris: Marpon and Flammarion), is a little work which will interest those of our readers who read French, and wish to learn something of astronomy and its founders.

Electrolytic Galvanising.—Herr Schaag, of Berlin, and a Baden firm have patented the following method of obtaining, by way of electrolysis, an adherent deposit of zinc:—Salts of magnesium and mercury are added to the ordinary bath. The addition of magnesium increases the conductivity without increasing the acidity of the solution. The deposited zinc contains a minute trace of magnesium, which renders it hard and adherent. The mercury is said to insure a regular white deposit.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

PROJECTILES, AND THE ROTATION OF THE EARTH—HELIOMETER—ANGULAR SUBTENSE OF FIELD OF TELESCOPE—ASTRONOMICAL TELESCOPE—MU CEPHEI—UNPUBLISHED OBSERVATIONS—LENGTHS OF A DEGREE OF LATITUDE AND LONGITUDE—THE SUN'S LIGHT.

[32925.]—EVERYONE who has ever opened a book on gunnery must be familiar with the allegation that the rotation of the earth from west to east causes a very perceptible deviation in the flight of a projectile fired from north to south or from south to north, such deviation being in our northern hemisphere always to the right of the line of fire. For example, in General Boxer's "Treatise on Artillery," he states that a ball fired due south in latitude 52° from a 56lb. gun with a charge of 17lb. and an elevation of 35° (giving a range of 5,600 yards) would have a right-hand or westward deflection of 10·914 yards. I was, then, a good deal struck by the following letter, which appeared in the *Standard* last week:—

"SIR,—With reference to the statement that a rifle bullet has a tendency to the right in the northern hemisphere and the contrary south of the Equator, I may say, after two-and-a-half years' experience of match shooting and practice with the regulation Martini rifle in New South Wales, that this assertion is incorrect, and that the bullet tends to the right there as here.

"I am, Sir, your obedient servant,
"Nov. 2. "N.S.W. RESERVE RIFLEMAN."

Now, of course, I have not the faintest notion who "N.S.W. Reserve Rifleman" is, or with what authority he claims to speak; but he makes a very definite assertion, and as the ENGLISH MECHANIC circulates wherever the English language is spoken, I write in hope that this may catch the eye of some Artilleryman in the southern hemisphere who will give us the benefit of his personal experience in this matter. The theory of the thing is sufficiently simple: it would be odd should it be shown that that theory is diametrically contradicted in practice.

I am sorry that I misinterpreted the original communication (letter 32815) of "Zed" (letter 32896, p. 263), and will make what amends I can by telling him that as far back as 1794 Triesnecker measured the distances between stars, the diameter of Jupiter, &c., with a divided object-glass; that Bessel's classical measures of 61 Cygni were made with it, and that Dr. Gill, Her Majesty's astronomer at the Cape, used the heliometer in his determination of the Solar Parallax by observation of Mars' at Ascension in 1877. As "Zed" is probably aware, the observations consisted in the measurement of the distance of the planet from certain selected stars, and I know that Dr. Gill had the utmost confidence in his results. Let me thank your correspondent for his corroboration of my own experience in the observation of ϵ^2 Lyræ.

If the middle of "Inquisitive's" fence (query 75813, p. 272) is 4,700ft. from his telescope, its ends will be 4,700·55ft. Of course your correspondent knows that the chord of an arc = 2 sin. of half the arc, and hence we may at once obtain the sin. of the semi-angle by dividing 72 by 4,700·55. Thus—

72 log. 1·8573325
4,700·55 log. 3·6721488

52′ 39·554″ log. sin. 8·1851837

and, doubling this, will give 1° 45′ 19·1″ as the angular subtense of the whole 144ft. of fencing, and, consequently, of the diaphragm defining his field of view. His fencing wire would subtend an angle of between 9″ and 10″. There is nothing wonderful in his seeing this. Theoretically, a telescope of 1·625in. aperture ought to divide a double star whose components are only 2·8″ apart. His ½in. bullet-mark would obviously be visible 2·273 times as far off as a ·22in. one—i.e., at 10,683ft. distance.

Mr. Jay (query 75829, p. 272) should have more than one diaphragm in his telescope, the aperture of each being so regulated by its distance from his object-glass that it shall subtend the same angle at its focus as does the objective itself. For example: Suppose that the diaphragm is 22in. from the object-glass, it must be of half the diameter of the latter, or 2¼in. in aperture. If it is two-thirds of the focal length from the objective—i.e., 29·33in., its aperture must be 1·5in., and so on. The Huyghenian eyepiece, described almost hundreds of times in these pages, is the one which must be employed for astronomical purposes. Any of the opticians who advertise in these columns would supply these eyepieces very much better and cheaper than your querist could make them.

That well-known authority on variable stars, Mr. J. E. Gore, F.R.A.S., has just reproduced his observations of the variable star μ Cephei from January 1, 1888, to December 31, 1890, from the *Proceedings* of the Royal Irish Academy. They are of a very puzzling character, inasmuch as the variation of the star's light seems to follow no discoverable law, little or no change being perceptible during months at a time, and such variations as were observed being strangely irregular, and never exceeding 0·5 magnitude. In short, Mr. Gore's results seem to set the hypotheses of cosmical clouds, revolving dark companions, and the like at defiance.

I have just been reading a letter by that well-known astronomer, Mr. John Tebbutt, of Windsor, New South Wales, which appeared in the *Australian* newspaper for September 26, and which deals with a matter of much more than local interest. It discusses the condition of the Sydney Observatory, and points out that whatever may have been effected in that establishment since it has been properly equipped with instruments, has been lost to the public through the non-publication of results. Mr. Tebbutt is, not unnaturally, indignant that while Mr. Stone has produced his superb catalogue of more than 12,000 accurately determined southern stars, Sydney, with its fine transit circle, has only turned out "two small catalogues for 1877 and 1878 of 167 and 254 stars respectively. These embrace the usual clock stars of the *Nautical Almanac*, and a few others observed specially for the trigonometrical survey, and in connection with the opposition of Mars." I wonder whether we need travel as far as Sydney to find a Government-supported institution in which a huge mass of observations are lying which have never been given to the public, which has paid for their being made—though some of them have been used in books published privately?

Mr. Collins (query 75879, p. 294) can find the angle of the vertical for any latitude in any ellipsoid by the following formula: Call A and B the major and minor semi-axes of the ellipse ϕ the geographical latitude, and ϕ' the geocentric latitude. Then $\tan.\ \phi' = \frac{B^2}{A^2} \tan \phi$. In his first example $\frac{B^2}{A^2} = \frac{1}{4}$; in his second $\frac{1}{16}$. But, as Mr. C. says, this only gives the angular distance between the geographical and geocentric latitudes. If he wants to find the length of a degree of latitude or longitude at any part of the earth's surface (using Clarke's spheroid), he can do so by the use of the following formula. Call δ the length of a degree of latitude; and δ' that of a degree of longitude.

Then—

$$\delta = 364609\cdot12\text{ft.} - 1866\cdot72 \cos.\ 2\phi + 3\cdot98 \cos.\ 4\phi;$$

and—

$$\delta' = 365542\cdot52\text{ft.} \cos.\ \phi - 311\cdot80 \cos.\ 3\phi + 0\cdot40 \cos.\ 5\phi.$$

Should this meet the eye of Mr. Holden (letter 32852, p. 220), I should like to say that, since writing paragraph three of letter 32890 (p. 262), I have been re-reading the most masterly address delivered before the British Association at Cardiff, by its president, Dr. Huggins, and there find a reference, which I had temporarily forgotten, to Mr. Stas's paper. It is as follows:—

"In a recent paper Stas maintains that electric spectra are to be regarded as distinct from flame spectra, and, from researches of his own, that the pairs of lines of the sodium spectrum other than D are produced only by disruptive electric discharges. As these pairs of lines are found reversed in the solar spectrum, he concludes that the sun's radiation is due mainly to electric discharges. But Wolf and Diacon, and, later, Watts, observed the other pairs of lines of the sodium spectrum when the vapour was raised above the ordinary temperature of the Bunsen flame. Recently, Liveing and Dewar saw easily, besides D, the citron and green pairs, and sometimes the blue pair and the orange pair, when hydrogen charged with sodium vapour was burning at different pressures in oxygen. In the case of sodium vapour, therefore, and presumably in all other vapours and gases, it is a matter of indifference whether the necessary vibratory motion of the molecules is produced by electric discharges or by flames. The presence of lines in the solar spectrum, which we can only produce electrically, is an indication, however, as Stas points out, of the high temperature of the sun."

A Fellow of the Royal Astronomical Society.

BRILLIANT METEOR, NOV. 19, 1891.

[32926.]—This evening (Nov. 19, 1891), at 7.10 Greenwich (6.45 Irish) time, I observed a very large and brilliant meteor in the north-eastern sky. I should say it was in view for fully five seconds, and in spite of the great light given by the rising moon in a cloudless sky, was a most vivid and striking object.

The meteor travelled from near Capella to the centre of the constellation of the Great Bear, and was of a bluish-green colour, moved very slowly, apparently emitting sparks, and left a tail or track behind it. I can only compare the latter to the sparks and luminosity apparent in a dark room, when you make two or three unsuccessful attempts to strike a Tandstickor match on the friction surface of the box. **Edward J. Travers.**

Ashtown, Phœnix Park, co. Dublin.

THE RECENT ECLIPSE OF THE MOON.

[32927.]—I had a very fair view of the eclipse on the 15th inst. here, though at times heavy banks of clouds obscured the moon. When the moon was about half-eclipsed (10.55), no lunar detail was visible through the telescope (8in. spec.) with a power of 60, on the dark part, which was of a very dark-grey colour. This was different to the eclipse of 28th January, 1888, when detail was plainly seen, and might be due to the hazy atmosphere, although there was good definition on the uneclipsed part. At 11.30, just before totality, the haze seemed to clear, and part of the moon appeared a bright red, with detail showing, but not distinctly.

11.40. The moon was of an orange tint, darker in the centre, with yellow and steel blue at parts of the limb.

11.55. Occultation of a small star, which was quite bright up to the time of disappearing.

12.35. The moon appeared a red hue, with a band of light yellow at one side.

12.45. Detail much plainer, and the rays from Copernicus were very clear. Plato looked like a white spot with one or two rays from it.

12.50. More clouds about, and I noticed that, when they were passing over the moon, the red colour gave place to a dull grey, through which some detail was visible.

12.55. Moon getting brighter. Where the light was coming on it was a pale blue, shading off to pale orange, and on the opposite side a darker orange.

1.0. End of totality, during which I do not think the moon was nearly as bright as during the 1888 eclipse.

1.18. The retreating shadow at Copernicus; colour of dark portion: dark blue at edge (nearest the light), going off into an orange-grey.

As the shadow was passing off, I noticed the edge of it slightly serrated, though not so much as in the 1888 eclipse. After that eclipse, if I remember rightly, it was suggested the serration was caused by the shape of some of the mountains on the earth being thrown, as it were, in profile on the moon. Is it not possible these irregularities in the shadow may be caused by the shadow passing over the irregularities of the moon's surface? The serrations certainly seemed to change in shape as the shadow passed over the different lunar seas and mountains. I do not suppose this is a new theory, and I only mention it as I noticed the change in the shape of the edge of the shadow in the course of my observations. **Neville Holden, F.R.A.S.**

Lancaster, Nov. 20.

[32928.]—Although the eclipse of the 15th inst. does not appear to have been observed much in England on account of bad weather, some fairly good views were obtained of the phenomenon here. Observations were, however, much hindered, and at times entirely stopped, by the rapidly-drifting clouds or scud, of a misty nature, the wind being from the north. I observed with naked eye, binocular magnifying about five times; and 2¾in. refractor, power 37.

At 9h. 20m., Dublin Mean Time, low scud drifting rapidly over the moon, very much obscuring it. Impossible to say if there is any diminution of brightness (the moon not having as yet entered the umbra).

9.44. Moon quite obscured with clouds.

10.14. Apparently a "hopeless" state of things.

10.32. Clearing again; shadow well seen; limb seen through it, to naked eye and binocular.

10.39. Shadow brownish or ashen-grey, except in northern corner of the cusp, where it is ruddy.

11.0. A cloudy interval seems clearing away; rather a thin, flat crescent left; a very marked ruddiness seen at the upper part of darkened section.

11.7. A small flat crescent (if that term is not outrageous) still visible through thick haze. Altogether a weird, dark look about everything terrestrial.

11.11. A momentary glimpse showed the dark part illuminated most exquisitely with a pink, coppery light.

11.14. Clouds prevent anything but a very faint, feeble view of moon.

11.27. The W. limb evidently brightly illuminated, but view not clear. Curiously enough, the sky above the N. horizon up to zenith keeps brilliantly clear, but the drifting clouds seem to focus themselves just over the moon's place.

11.31. Up to now not a sign of a star in the telescope.

11.36. An exquisite spectacle. The greater part of the disc golden yellow, a patch to the N.E. limb being blood red.

11.40. In binocular very fine. A crescent to S.W. limb is pale, ashy green, the remainder rich, coppery red, with dark shading towards centre, all the tints melting imperceptibly into each other.

11.55 A singularly bright patch of light on limb a little S. of E. point.

12 0. The moon is now just between two stars of about 7·5 or 8 mag., beautifully seen in binocular. Later on it was noticed she had crossed the line joining these two stars. The latter are doubtless in the "D.M.," but not having that catalogue, I have not been able to identify them.

12.6. There is a crescent of yellowish light along S.E. limb, the rest coppery red. Beautiful in binocular; but the colours were lost in the telescope.

12.10. Moon quite hidden by clouds again. Noticed previously, the moon advancing towards certain telescopic stars.

12.21. A 9m. star about 4′45″ of arc due S. of moon's limb.

12.23. Singularly lovely in binocular.

12.31. A very bright patch at E. point of limb, then a crescent of golden yellow, extending to N. and S. points; the rest a coppery red. At times the idea of red-hot iron was suggested by the moon's appearance.

12.34. Light now beginning to creep on near the bright patch previously mentioned, which may possibly have been the harbinger.

12.40. A small, flat crescent appears weirdly through clouds.

12.52. Contour of shadow apparently perfectly regular; effect of radiation noted by naked eye—i.e., the illuminated portion of the disc seemed to belong to a larger circle than that in shadow. This, however, was not seen in binocular. A clear view, but the small stars near are now blotted out by the moon's increasing light.

12.58. The principal *maria* distinctly seen through the red, coppery light; moonlight getting bright again now; low-driving clouds passing over the moon, but intervals pretty clear.

13.3. Shadow's edge apparently still quite regular—curious effect, as driving clouds obliterated the red portion of the moon from time to time, leaving the bright crescent alone visible. Good-night.

On the whole, the eclipse appears to have been a very bright one. At no time was the limb obscured, and it was perfectly sharp and clear, especially in the telescope. I don't quite know the meaning of the dusky patch seen towards the centre of the disc. If this duskiness was due to some irregularity in the refraction of the sun's light into the shadow-cone by the rim or section of our atmosphere as presented to the moon, then it ought to have kept its position, and so to have first appeared on the moon's limb, as it cut its way through the shadow, successively occupying different positions on the disc. But this was not the case, it always appearing near the centre. I therefore take it, this appearance was an optical effect.

The neighbourhood of the moon's place was observed some fortnight previously with the telescope for small stars, and positions of certain of them were noted; but no occultation and no reappearance was observed—probably due to bad weather.

In the morning of the 15th, at 10.45 a.m., the sun was observed; there was one moderately-sized round solitary spot in the *n.f.* quadrant, and one small spot close to limb in the *s.f.* quadrant.

A number of water-colour sketches were made next day, giving the general appearance of the moon. It is, of course, impossible to reproduce them here.

I fancy I had better luck than many others in England; but I shall never forget (or forgive myself) once quietly going to bed about an hour or so before a lunar eclipse commenced, in sheer ignorance of such an important astronomical event being about to occur. The remembrance was all the more provoking as the evening in question was beautifully clear, and I had been sitting in the verandah of a house in Maritzburg, Natal, that very evening, enjoying the moonlight. This was in the autumn of 1884, and I believe the eclipse was a black one. I had an unusual opportunity of making observations under very favourable conditions, but it was lost I should say, however, that a pressure of official business just at that time had prevented me giving any attention to astronomy, and I had not kept my eye on the almanac. As in cards, they never forgive mistakes, so here I lost a black eclipse, and shall never perhaps recover it.

E. E. Markwick, Lieut. Col.

Haulbowline, Queensland, Ireland, Nov. 23.

STAR TESTS.

[32929.]—In reply to the request of Mr. Whittle, letter 32893, I wish to state that I saw the double-double in Lyræ similar to his sketch, with an instrument of 2¼in. diameter, of 36in. focus, and a power of 100 (one hundred).

Last night, on looking at the Trapezium, I could distinctly see three stars with a power of 50, and on applying a power of 100 I imagined I could see four when not looking directly at the object, and in the position shown in Proctor's "Half-hours with the Telescope." Will any reader say whether he has seen the four with a similar instrument—as Proctor says only three are visible with a smaller aperture than 3in.?

I also plainly divided α Piscium last night with 100. What is the highest power a 2¼in. will bear?

Jimmy.

AURORA—SUNSPOTS VISIBLE TO NAKED EYE.

[32930.]—Last evening, Nov. 20, at 6 p.m. I noticed what I believed to be an auroral "arch," but as there were no "streamers" during the time I observed it, I thought I might be in error as to its nature.

This morning, in arranging some apparatus, I came on a set of coloured glasses, and as the day was bright, I thought I would look at the sun to see if there were any "big spots" on him as companions to the aurora. At a glance I saw what looked like a fly with circular black body and lighter upraised wing in the S.W. quadrant with a duller spot towards the east. Two others saw the spots, each finding it best to keep the coloured glasses 2in. to 3in. from eyes, and a field-glass confirmed the observations; while a 36in. o.g. gave an image on a carte-mount (held behind eyepiece) which showed the spots distinctly.

On 25th August, '88 or '89, a very large "spot" was visible to eye, and could be observed without coloured glasses for about an hour before sunset. In your "Scientific News" soon after you reported the fact of the spot having been seen with the naked eye, as news from Denmark, so I thought it might interest your readers to know that home eyes were equal to those of Danes!

As I write the auroral display is brilliant; long streamers this evening leave no doubt of its nature.

The great meteor of October 11 was "seen" here by many, but none could give details, as it was a dull, clouded evening.

Newcastle West, Nov. 21. **J. D. M.**

COMMUNICATION BETWEEN SHIP AND SHORE.

[32931.]—The recent shipwreck off Sandgate, where all attempts to establish a communication between the shore and a stranded vessel by means of a rocket fired from the beach failed, suggests the question: Why should not ships be furnished with a rocket apparatus, carried (if possible) in one of the tops? It would be much easier and more certain for a ship, fitted with such an arrangement, to effect communication herself than for people on the beach to do so. The rocket ought to carry with it the two ends of a line, the bight of which is passed through a block secured to the mast. On its reaching the shore all the coast guards, or other relief party, have to do is to attach to one end of the line the block of the cradle tackle, and then, by hauling on the other end to transport that block to the ship, where it would be at once made fast to the mast or some part of the rigging. The cradle tackle is then ready for action, the cradle being attached to a rope either on shore or on board. Probably the latter plan would be best. The scheme I propose may have been tried for aught I know; but supposing that not to be the case, I venture to think it worth investigation. It may, of course, be a question whether a rocket or a harpoon-shaped projectile fired from a gun is best in certain cases. On that point I am not able to offer an opinion.

Charing, Kent. **J. R. C.**

INCUBATORS.

[32932.]—I could not help smiling rather wide on reading Mr. Fraser's (Cottoun) letter on p. 286 this week's "E. M." on Incubators, "After laying all joking aside, it is useless to make an incubator to hold less than 50 eggs," is the advice of Mr. F. This is contrary to my experience. I have one that only holds 35 eggs, and it works well; in fact, this old box is rubbing off a lot of prejudice, as I lend it to those in doubt, or those in need of a hen to set; and I see no reason why we may not have a machine to work just as well whether it holds five or 50 eggs. Mr. F. finishes his letter by saying, those filled with boiling water morning and evening "wont do." Well, Sir, if they wont do, I beg to assure your readers that they will hatch chickens very well—boiling water needed to work it, now the sawdust is dry; in summer from one to three pints every 12 hours, in winter from three to six quarts. Anyone failing with these machines, I should say the construction must be of the shoddiest kind, and the attention very indifferent. I described this machine about three years ago in the *Weekly Times and Echo*, over the pen-name of

A Country Chip.

[32933.]—I APOLOGISE to readers of the "E. M." and all concerned. I shall be unable to write anything more about the incubator that I constructed, and which you published. Although I have never seen Hearson's, or any other maker's, incubators, I have had a letter from the above firm declaring that the incubator I made is a patented article of theirs, so I regret if I have interfered with the interests of that firm. I received the specifications of their incubator, and although the details of mine are different, the principle is the same. I received also an intimation that I shall be required (besides sending this letter to the "E. M.") to send my incubator to that firm. **J. Fraser.**

Cottoun, Glencarse-by-Perth, N.B.

DIALLING: TO MAKE A SUNDIAL, GNOMON INCLUDED, OUT OF A SINGLE PIECE OF PAPER.

[32934.]—ANY instructions that I have hitherto seen for making a sundial, though doubtless giving correct results, are yet quite empirical, and give no explanation of the *rationale* of the subject. In some the first direction is to purchase a dialling scale; but this costs money, which, if the purchaser cannot use the scale intelligently, might better be expended in buying a sundial. I trust the following will be found free from such objections.

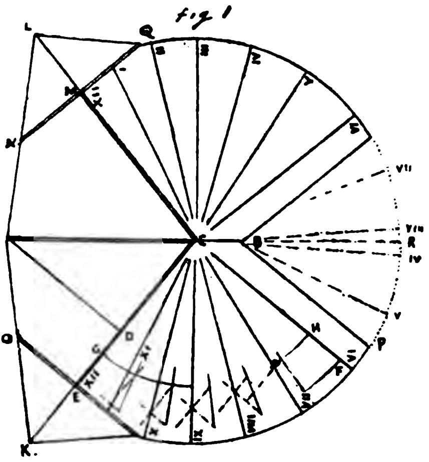
Of course, by "sundial" is generally understood the ordinary horizontal one. There are, however, several other forms, in some the dial-plate being vertical. The simplest, though perhaps not the most easily constructed form, would be one in which the gnomon is a straight rod, and the dial a hollow half-cylinder, the rod forming the axis of the cylinder, and casting its shadow on the concave cylindrical surface, upon which the hour lines are drawn from end to end, parallel with each other and the gnomon, and at equal distances apart. Such a dial would suit all latitudes, from the equator to the pole, all that is required in placing it being to arrange that the gnomon's shadow shall fall upon the central hour line at 12 o'clock. It is from the idea of this cylindrical dial that the structure of the plane horizontal dial may be deduced as follows:—

Suppose, then, this cylinder, with its central gnomon-rod, to be erected upon our horizontal dial-plate, so that they make, with that plate, the correct angle corresponding to the latitude for which the dial is intended. The line of intersection of the cylindrical and plane surface will have the form of an ellipse, and the hour-line of the cylinder will mark out upon the edge of that ellipse the points towards which the hour-lines on the horizontal plate must be drawn from the point of contact of the gnomon-rod with the plate. The problem, then, is to determine the relative positions of these points.

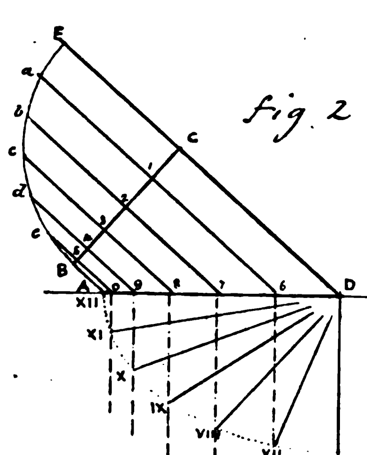
In the accompanying diagram (Fig. 1), the portion above the line A D shows a vertical section of the above supposed arrangement, A D representing the horizontal dial-plate, A B C D the half-cylinder, and C D the gnomon. C D A is the angle of latitude. With C for centre and C B radius, describe the quadrant B E, and produce D C to E. This quadrant represents the curve of one-half of the half-cylinder as viewed from above or endwise. Divide the quadrant into six equal parts, and from the dividing points draw five lines parallel to E D, meeting A D in the points 6, 7, 8, 9, 0. These lines represent the hour-lines on the cylinder, and the points D, 6, 7, &c., indicate the positions of the points on the ellipse (viewed edgewise), which are to be the terminals of the hour-lines of the horizontal dial. Now imagine the dial-plate rotated upon the line A D until its plane coincides with that of the paper. Then, upon it, from the points D, 6, 7, &c., draw lines at right angles to A D (D-vi, 6-vii, &c.) It will now be evident that the points upon the edge of the ellipse, which we are in search of, must be located upon these lines; their distances from A D being just those at which the cylinder hour-lines meet the dial-plate—measured from the same points on the line A D. The longest of these distances is, of course, that measured from D, and is exactly the semi-diameter of the cylinder, equal to C E. The others are just the lengths of the lines (1-*a*, 2-*b*, &c.) between B C and the dividing points of the quadrant. Therefore, make D-vi, 6-vii, 7-viii, &c., respectively, equal to C E, 1-*a*, 2-*b*, &c. Having thus determined the points vi, vii, &c., upon the edge of the ellipse, draw the hour-lines to them from the point D, and one-half of the dial is complete. The other half, of course, is exactly the same, but reversed—on the other side of A D. C D A is the angle of latitude, and of the gnomon.

The following method of laying out the hour lines of a sundial occurred to me many years ago, and "A. S. L.'s" Fig. 2 (page 223), has reminded me of it. No doubt it was not original; but the fancy of using a single piece of paper for the complete article is, I think, new.

Fig. 2.—On a piece of stiff paper draw the line A B. From the point C draw C K, making the angle A C K equal to the angle of latitude. From C, and from A draw C F and A D, both at right angles to C K. With centre C and radius equal to C A draw quadrant E F, and, with radius equal to A D, concentric quadrant G H. Divide E F into six equal parts, and from the dividing points draw radii dividing G H into six corresponding parts. From the dividing points on G H draw, across the space between the two quadrants, lines parallel to C K, and from the corresponding points on E F draw lines parallel to C F. Through the intersections of these two sets of parallels draw the hour-lines VII., VIII., &c., converging to C. C F and C E are the VI. and XII. hour-lines. Through E draw O X at right angles to C K, making E O and E X equal. Join A O, and produce it to K. Join K X; and from X, with centre C, draw arc X P. Lastly, draw P B parallel to C F.



Now carefully fold the paper (back to back) along the line A B, and then cut out the figure through both thicknesses along the outline A K X P B. With a fine needle prick holes through both plies at the point E, and the intersections of the hour-lines with the quadrant E F. Unfold the paper, and through the pricked points M, &c., draw the hour-lines L C, i., ii., iii., &c.; also N Q at right angles to L C. Slit the lines K E, L M, and B C, taking care not to cut beyond the points E, M, and C. Now fold the paper (*face to face* this time) along the lines C E and C M, O E and N M, and then lightly gum or paste the back of the paper within the outline N M C E O, but avoid spreading the gum or paste beyond these limits. Then fold as at first, along the line A C, so as to make the pasted backs adhere. This brings the two XII. hour-lines together, and sets up the gnomon, of which A C now forms the sloping ridge. Unfold the dial and lay it flat, and then the two VI. hour-lines will be found to lie in the same straight line, and the others in their proper relative positions. Now, to retain the gnomon stiffly, erect at right angles to the dial plane, paste the backs of the triangles L N M and K O E, and the faces of L M Q and K E X, and fold them inwards, making them adhere, so that the point L of L N M falls upon Q, and the point K of K O E upon X.



If desired, the morning hour lines IV. and V., and the evening ones VII. and VIII., can be added, by measuring off their arcs equal to those between VIII., VII., VI., as indicated by the dotted lines. But in that case, of course, the paper within the angle at B must not be cut away, but only slit from from R to C.

Edinburgh. **Walter M. Hardie.**

MAGIC SQUARES.

[32935.]—"G. H. S." suggests that a pattern might be obtained which, if impressed on the memory, would enable one to write down the numbers consecutively in any square. Such a pattern is well known to exist for odd squares, as in the Indian and other methods. For evenly-even squares, also, exceeding 4, an analogous pattern is obtainable, only, as might be supposed, it is double.

The example given below of a 6-square is not a pattern where consecutive numbers follow in a straight line, but one which is symmetrical, and shows a principle applicable to all evenly-even and oddly-even squares exceeding 4. This principle is more easily applied to evenly-even than to oddly-even squares:—

5	36	3	34	1	32
35	6	33	4	31	2
21	20	19	15	23	13
16	17	18	22	14	24
26	7	28	9	30	11
8	25	10	27	12	29

Without interference with the numbers in its central diagonal lines, transpositions may take place in the rest of the square, owing to the disposition of the complementary pairs, which would produce upwards of 100,000 different varieties.

The following are some of the properties of the above square:—1. The sum of any four numbers symmetrically placed in the square = 74. 2. Excepting the numbers in the central two rows, the difference is constant between any two numbers equidistant from the centre in a straight line drawn through it. 3. The *difference* is constant along the first two rows, between the two numbers vertically adjacent, and also along the last two rows; while the *sum* is constant of the two numbers vertically adjacent along the two middle rows.

In my letter 32886, for "Sept. 10" read Oct. 9.

J. C.

[32936.]—IF you have not yet closed the discussion in your columns on magic squares, the following may be of interest to some of your readers:—

1	30	47	52	5	28	43	54
48	51	2	29	44	53	6	27
31	46	49	4	25	8	55	42
50	3	32	45	56	41	26	7
33	62	15	20	9	24	39	58
16	19	34	61	40	57	10	23
63	14	17	36	21	12	59	38
18	35	64	13	60	37	22	11

The numbers are alternately even and odd, both lengthways and downwards. The sum of each pair of numbers connected by a | is 49 (or 7^2). The sum of each pair of numbers connected by a + is 81 (or 9^2). The sum of each set of four as marked by the dark lines is 130, or half of 260. Also each quarter of the whole square makes a magic square of 130. The numbers taken consecutively form a "knight's tour" on the chess board. **H. B. R.**

LANTERN MICROSCOPY.

[32937.]—PERMIT me to say a few words in correction of Mr. Chadwick's paper on Leach's Lantern Microscope, reported in the issue of Nov. 13.

In the first place, Mr. C. is dead against every authority regarding magnification. Extreme magnification, such as Mr. C. suggests, is condemned by every authority of note, both for the microscope and the lantern microscope. That the magnification which enables the observer to see *all* the details of an object is the largest to which it should be subjected, anything beyond this defeating the purpose.

Mr. C. says that, with his arrangement, high powers can be used for class and other demonstrations, although he has previously stated that the arrangement of condensers is only adapted for objectives of $\frac{1}{10}$in., which is by no means a high power. Mr. C. cannot surely be ignorant of the fact that lantern microscopes, of whatever make, have long been discarded by college authorities where *high* powers are required. I see, too, that he has come round to my views, and does not recommend the use of special objectives.

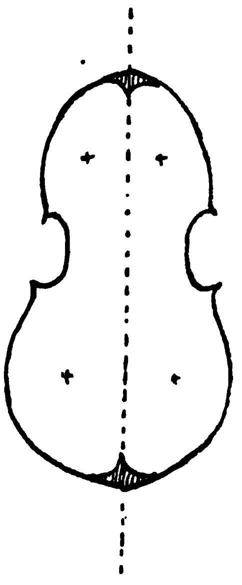
His last paragraph but two is a contradiction of the previous portion of his paper, where he leads us to suppose that he can use high powers—that is, of course, $\frac{1}{16}$in. or $\frac{1}{20}$in. objective with his arrangement, simply because he uses an alum trough. What he says is simply this: in order to use a high power requiring a large amount of light, interpose an alum trough which stops 50 per cent of the light. Mr. Chadwick does not seem to be aware of the fact that it is possible to focus the heat rays at a point beyond the luminous rays, and thus avoid all heating of the slide. I should just like to inform Mr. Chadwick that the substage condenser of which he speaks, and the novel way of interchanging the objectives was used by me more than 16 years ago, and shown to Mr. Leach in 1876.

In conclusion, Mr. Chadwick says that lantern microscopes which have no alum trough are self-condemned. This I deny, as I do not use an alum trough and never will, and I may say that I have never melted a slide. **J. A. Furnivel.**

5, Kay-street, Ardwick-green, Manchester.

A NOVELTY IN VIOLIN CONSTRUCTION.

[32938.]—In view of the recent articles on violin construction which have appeared in the "E.M.," I think that the following remarks regarding a new and so-called improved method of constructing stringed instruments, brought forward by Dr. Stelzner, and explained at a meeting in the rooms at No. 40, Wigmore-street, may prove of interest.



Dr. Stelzner's improvements are briefly as follows:—

1. The instrument is constructed solely upon parabolic and elliptical curves, the effect of which it is claimed is to focus the molecular vibrations of the instrument and of the air inside, to four points (marked + in the sketch), which points being those least supported, are put into more ample vibration than in other instruments, thus producing greater tone, and of a finer quality.
2. The blocks at each end of the instrument are also constructed upon parabolic curves, as shown in the sketch, thereby tending to focus the vibrations towards the points indicated.
3. The shape of the *f* holes is slightly altered, a sort of tongue being left at the lower extremity, which is supposed to allow of free vibration.

After the explanation on the principles of the construction of the instruments, a practical trial of their capabilities by competent artists took place, which, in my opinion, however, did not tend to show that the instruments possessed either the fine quality of tone or the great power claimed for them.

It would appear that there is something more in the making of stringed instruments than Dr. Stelzner has considered; something altogether apart from the mere form of the instrument. In the first place nothing was said about the kind, quality, and thickness of the wood to be used, which, as everybody knows, is extremely important. The influence of the varnish on the wood, and consequently upon the tone produced, was likewise omitted, as well as sundry other important points.

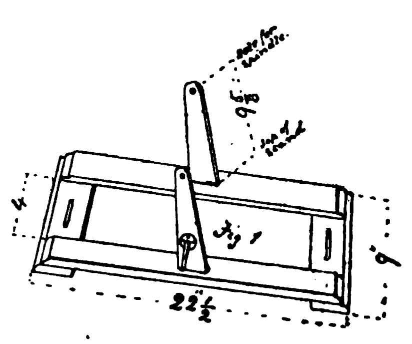
At the close of the meeting a trial took place between the Stelzner violin (a good new violin), and a Guadagnini violin, the same pieces being played upon each in turn, which showed that, although both of the first two instruments had undoubtedly more power than the last named, the difference between them was small, and their tone could not be compared to that of the Guadagnini violin as regards beauty and smoothness, and that marvellous "ring" which is peculiar to Italian instruments, which, after all, are the qualities required.

Fine old instruments, therefore, are still likely to hold their own, in spite of the "improvements" which Dr. Stelzner claims to have discovered.

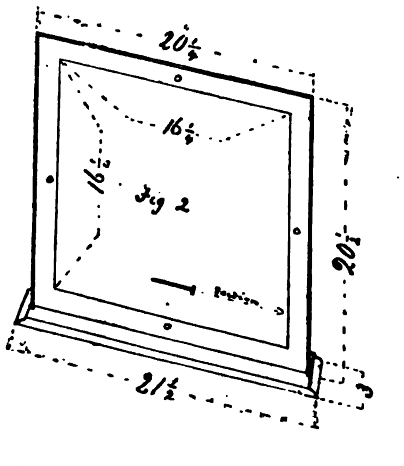
J. A. Milne.

WIMSHURST'S ALTERNATING INFLUENCE MACHINE.

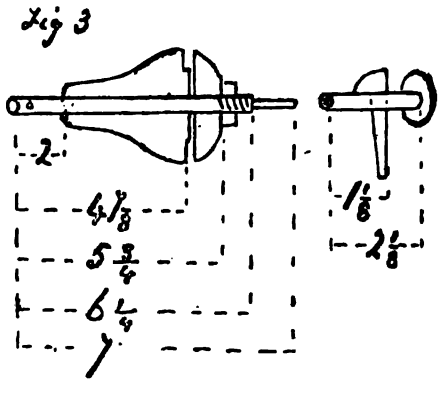
[32939.]—For the information of those who desire to build up these instructive machines, I have made and furnish sketches from the one which was exhibited at the Physical Society, and elsewhere. The figured dimensions are given thereon; but I very earnestly ask of those about to build such machines that they follow the specification given, or that they really improve upon it—for it is most prejudicial, both to the reputation of the machine, and to the advance in knowledge, for persons to build, to use, or to sell machines under the above name which are neither useful nor ornamental.



The Stand.—The stand should be made of mahogany, to the form and dimensions shown in Fig. 1; its bounding edges should be finished with a bold quarter-round and quirk. This is, perhaps, the easiest form of moulding, and looks well when finished—at the corners of the stand the sides are glued, and screwed to cross pieces 9in. long, and 1in. thickness. The edges of the stanchions, and also their tops, should be finished with a half-round, they are to be fixed into the sides of the stand by tennons and glue; the clear distance between the stanchions is 6⅜in., the length of the stanchion measured between the top of the stand and the centre of the hole for the spindle is 9⅝in.



The Vertical Frame.—The vertical frame is made of mahogany, and is rectangular in form; the dimensions are given in Fig. 2. It should not be more than ¼in. in thickness, or just sufficient to make the space between the glass inductor plates, and to admit of the disc rotating freely without touch. The corners of the vertical frame may be halved together and then glued. A flat marginal piece of sufficient size to project beyond both surfaces of the frame is then fitted; the projecting edges not only stiffen the frame, but they also make a guard or stop to hold the glass inductor plates. The frame itself is then pierced with a number of centre-bit holes ⅜in. in diameter, equally spaced, and into four of these holes pins have to be fitted which carry the inductor plates. The frame is attached to a stout base, or sole-piece, the latter being held in its place upon the stand by two screws at each end; it is therefore capable of side adjustment to suit the position of the rotating disc.



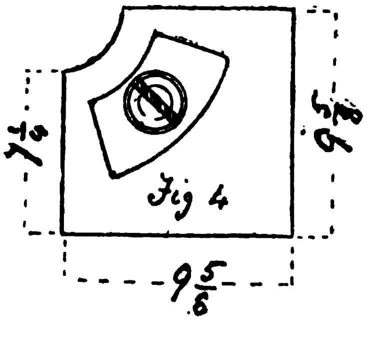
The Spindle and Boss.—The spindle and the boss are shown in Fig. 3; the length outside all is 7in.; it is ⅝in. diameter at its largest part. At the one end is a hole by means of which the driving pulley is secured; the other end is turned down to ⅜in. diameter, to fit into a tube which makes a continuation of the spindle between stanchion and stanchion. A length of the spindle next the reduced end is to be turned down to ¼in. diameter, then screwed and a nut fitted.

The boss is made of well-seasoned wood, driven tightly upon the spindle, and then turned to the form and dimensions shown in Fig. 3; the cap, or loose end is of sufficient length to fill the space between the glass disc and the nut upon the spindle; the nut should be finger-tight only, so as to be readily removed.

Tube Continuation of Spindle is made by a piece of brass tube ⅜ internal diameter and 2⅛ in length, having on the one end a ring, and at a distance from the ring, equal to the thickness of a stanchion, a key-way hole is cut, and a key fitted, so that when the tube is in its place it is firmly held to the end of the stanchion. It will be seen (Fig. 3) that this arrangement is necessary to obtain, when the tube is removed, a gap between the end of the spindle and the inner surface of the stanchion sufficient for the nut, the loose end of the boss and the disc, so that the change of the discs may be freely and quickly made.

Driving Pulleys.—The one upon the spindle is 1¾in. in diameter, and has a large size V-groove in it; it is held in place by a pin, which passes through it, and also the hole in the end of the spindle. The larger pulley is 6in. in diameter, and has a corresponding V-groove cut; but in mounting this it is desirable that it should have a long boss and spindle, for without this such pulleys always wear, and run untrue. In the machine under notice the boss extends out beyond the surface of the wheel quite as far as does the handle; its end is rounded, and although it looks to be in the way of the hand, yet when working it is with difficulty that the hand can be made to touch it.

Glass Discs.—The discs are of window-glass cut 16in. in diameter, and with a hole in the centre of a size to just fit on the boss. It is always well to test the electrical quality of the glass before adding labour. A simple test is to warm a fragment of the glass, then place a penny on its surface, and give the penny a charge of electricity, a small pith ball suspended by a thread of silk makes all the electroscope which is necessary. The penny ought to retain its charge for a minute or more, if it does not do so, then reject the particular quality of glass, and try some other brand.



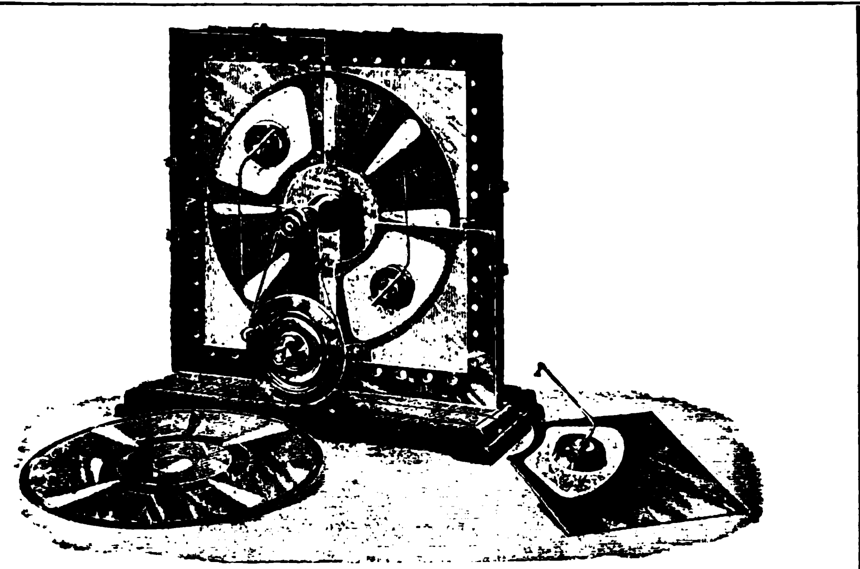


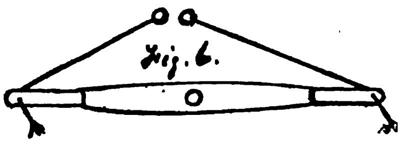
Fig. 5.

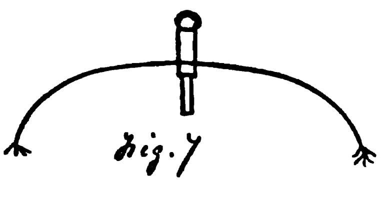
Glass Inductor-plates.—The inductor-plates are rectangular in form, having one corner cut away (Fig. 4) to make space for the boss. The tinfoil patch is stuck upon one of the surfaces, and upon the tinfoil comes the wood disc, which again, in its turn, carries the brush-holder. Upon the face of the wood disc is a metal plate, to which is attached a spring to hold the brush-holder; a piece of flat crinoline-spring extending right across the metal plate is perhaps the best form of spring for the purpose. Let its ends be bent round, so as to have them covered by the metal plate in order to prevent leakage from any angles; there must be, however, a metallic contact between the brass plate, the spring, and the tinfoil patches.

Brush-holders.—The brush-holders are made of 7¼in. lengths of $\frac{3}{16}$th brass wire, the one end of each wire is to be bent through an angle of 90°, holes being drilled in the extreme ends to receive the brushes; the other ends are flattened out and soldered to brass discs of about 2in. diemeter (see Fig. 5).

Brushes.—The brushes are made of about twenty very fine wires, such as may be bought at any gilt-lace makers. It is about the thickness of a human hair; it is known as 22-gauge wire; it costs about 1s. per ounce. Two or three pennyworth will be sufficient quantity to make up, perhaps, 200 brushes.

Exploring Rods.—The one is made as shown in Fig. 6. The centre part of the length is made of wood. It has a hole in the middle which fits tightly upon the inner end of the tube, which makes the continuation of spindle. The ends of the rod are made of short lengths of vulcanite, through which pass wires carrying brushes at the ends nearest the disc, and terminal balls at the other ends. A second exploring rod is made of a short length of tube having in one end wooden plug of a size to fit tightly into the hole at the outer end of the tube, which continues the spindle. A bent wire carrying brushes at its end makes this complete (see Fig. 7).





Additional Plates.—The first of these may be cut of the full size to fill the vertical frame, and the inductors and brushes fitted so as to build up the Voss machine. The first of the exploring rods will serve in the place of the collecting combs and the terminals.

A second variation may be made by substituting a Holtz plate, with its holes and its paper armatures. The first form of exploring-rod makes the collecting combs and terminals.

A third variation may be made by cutting rectangular slips of glass the length of the vertical frame horizontally, and, of course, little less than half-size in height. Inductor patches may be stuck upon the middle of the glass slips, and a very good Bertsch machine is formed. If wires and brushes then be carried from the inductor patches, so that the brushes touch the rotating glass disc, then the machine becomes a powerful generator. The exploring-rod again makes the collecting combs and the terminals.

Other rectangular glass slips may be cut of the size next above, and the paper armatures added, when a still more powerful generator is made; in fact, the variations are numerous. Inductor plates of all sorts and of all sizes—with large tinfoil patches or small tinfoil patches—discs without sectors or with sectors, may all be used, and, strange as it may seem, it will be found that almost all of the combinations are self-exciting; this being so, it seems the more extraordinary that self-exciting influence machines were not much earlier known and made. All the glass used must be coated with varnish, and I find the following the best way to make and to keep it:—

First get a wide-mouthed bottle, into the mouth fit a quickly-tapered plug, and into the plug fit a large-sized brush; let the hair of the brush be about 3in. from the bottom of the bottle. This makes the containing vessel, with its brush, complete. Then fill the bottle about three-quarters full of light orange shellac, to which add the methylated spirit in sufficient quantity to just cover the shellac; shake the bottle pretty frequently for the first day, and then the varnish is ready for use. Avoid using the brush upon dusty surfaces, and never rest the brush anywhere but in its place in the bottle.

I shall be glad to answer the questions of anyone making, or about to make, these machines, if they ask the question in your columns. J. W.

TECHNICAL EDUCATION.

[32940.]—As I see you mention in the Scientific News (p. 261) the opinion of the Speaker of the House of Commons on the very subject referred to by "A. M. B.," hailing from Blackburn Technical Schools, in his reply to me on p. 288, I will, with your permission, say a few words on the question of technical education. "A. M. B." seems to find fault with me for expressing the opinion that "It is practically useless to teach boys a trade they may never follow," and proceeds to imply that to "teach a boy to use a hammer, knife, or chisel is to teach him something he will be thankful for." In my experience a good-sized healthy boy does not require much teaching how to use hammers, knives, planes, saws, or chisels, but sometimes he uses them in a manner which does not altogether suit the views of *mater*. That, however, is not the point at all; but that such an argument should emanate from a "technical school" emphasises the remark of the Speaker of the House of Commons that there is a "danger of the sums granted for technical education being frittered away." The subject selected by "A. M. B." will answer as well as any other, and possibly some of your intelligent readers will express their opinions. The point is that it is useless to teach a boy a trade he may never follow—teaching him (presumably a schoolboy) by keeping him at work with saw, and plane, and chisel, when he should be at his books, and his teacher should be endeavouring to lead out (*educo*) whatever there may be in him. Actual manual labour with the tools of any craft is not what is meant by technical education; but the teaching of the "why and wherefore" is the important part. In the case taken, the boy can't do much with a hand-saw (that is, when his mother wants him to cut up some wood for the fire), but he can be taught why saws are of different shapes, and have their teeth set differently; he can also be taught the difference between a jack, a smoothing, and a jointer plane, and why the angle of the edge of the cutting-iron should be different according to the purpose for which the plane is used. He can also be taught the difference between a gimlet and a bradawl, and why the one borer is used in preference to the other; and he may be taught why hammers and nails are of different shapes. The reason why a gouge is so different compared to a firmer chisel, and the latter to a mortising chisel, may also be explained—and that is technical education in the proper sense of the term. To teach him the best way to use the tools is the business of the employer who wishes his apprentice to do as much work as possible; but it is no part of the business of the public to provide employers with apprentices already accustomed to the "use" of tools from actual experience. I have used the carpentering branch, because "A. M. B.'s" remark suggested it; but what I have said applies to all trades. My experience may be limited; but such as it is, it teaches me that the average schoolboy—even if he has passed the sixth standard—has not much solid groundwork on which to build. A printer's reader (a corrector of the press, I should say) with whom I am acquainted, tells me he finds a difficulty in obtaining boys who can read print in a decent manner. He does not expect to get a boy who can read offhand such manuscript as I suspect you, Mr. Editor, often receive; but he does expect to find a sixth-standard boy able to read print rapidly and correctly—emphasis and punctuation he cares little about. And yet Reading is perhaps the most important of the three R's. A few months ago I paid a visit to an institution in London where I saw boys with their noses scarcely higher than the tool-rest working at lathes; they were being "technically educated" according to the views of some people; but in my view they were wasting their energies in work (doubtless agreeable to them) which they might never be called upon to do in after-life. Teach the elementary principles of science as much as possible in the time available, but do not expend time in teaching a boy how to "use" a chisel: he will learn that fast enough if he becomes a carpenter, especially if he is well grounded in the principles. The same applies to any trade or handicraft. I need not say I do not admit "our backsliding," which "A. M. B." mentions: that is a fiction. T. L.

REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75501.]—**Hydraulic Pump or Ram.**—I have been trying hard to find you a suitable hydraulic ram; but all that I have come across are too cumbrous, and I could not get satisfactory sketches of them, and even if I could have, I could only have produced them on a small scale, and the chances are they would not have been understood, because I should have to draw them so compact. It would be impossible for the editor to allow a large sketch of my own to be published; besides the complicated parts of a hydraulic ram would take up no end of room, and of course there are others to be thought of. I advise you to get sketches from a maker, or buy a book on hydraulics. C. G. M. Bennett.

[75524.]—**American Organ.**—The "Practical Organ Builder" (p. 289) "firmly believes" that I know well the "improvements" which he mentioned. Indeed I do not; and I again ask him if he cannot give the numbers and dates of the patents to give some idea of the nature of those "improvements" to which he referred. He surely would not have said that "many great and important improvements had been made" without knowing something about them, and I ask him to tell us at least as much as he knows. Never mind about the minor improvements—it is the important ones I want, with the view of writing a fresh series of instructions less "vague" than those which seem to have upset our friend. Organon.

[75529.]—**Artificial Foot.**—This querist will find an illustration of the sort of thing he wants on p. 532, Aug. 7, last. I know nothing as to best make, but probable cost could be easily ascertained from the makers. D. L.

[75534.]—**Printer's Roller Composition.**—The ordinary compo. made with treacle and glue will do if the components are of good quality; but it is advisable to add a little bichromate of potash in solution, stirring well before casting. If the querist makes his own rollers, he should experiment, especially as he prefers to make, and apparently objects to pay for the patented rollers. As his query reads, it looks as if he wanted someone to tell him how to make a composition which would be worth patenting. Possibly he might find a beneficial remedy in not having those "very hot rooms." There is such a thing as ventilation.

R. S.

[75535.]—**Detached Retina.**—Such a query as this, coming all the way from Baltimore (U.S.), and from a pharmaceutist and chemist too, says a great deal for the far-reaching and apparently ubiquitous English Mechanic; but I am afraid the answer to the question must be that the eye having the detached retina will have to be examined by an ophthalmologist before any useful advice can be given. In our eye hospitals, and also in Germany, they do many wonderful things; but the only advice that can be given here is to study the general health (get into good condition), and possibly the blood-clot will be absorbed.

Nun. Dor.

[75536.]—**Condensing Steam-Engine.**—This query as it stands is incomprehensible. A condensing steam-engine is not what is understood by an "atmospheric engine." Does "Vulcan" mean a hot-air engine, or an engine the exhaust steam from which is condensed by passing through tubes exposed to the air? M. T.

[75538.]—**Fire Lighters.**—I suppose that some of the waste oils—dead oils as they are termed—might do mixed with pitch; but I don't know of anything to improve the quality of rosin for such a purpose as making fire-lighters. Should have thought it best and cheapest in its crude state. But the querist should experiment. Rosin will not dissolve in mineral oils. S. R.

[75539.]—**Switch Board.**—I think if the querist looks through his back numbers he will find something that will suit him, either in Replies or in Mr. Allsop's articles. Q.

[75547.] — **Theopathy.**—Probably this word applies to the method of cure adopted by the Peculiar People, or, in the American way of putting it, letting things slide; but it may mean something very much different; that is, suffering one's self in order to relieve others—e.g., "Sisters of Mercy." Where does "Istriel" find the term?

Nun. Dor.

[75550.]—**Planing-up Thin Stuff.**—I suspect that most cabinet-makers in the trade get their 1-16in. stuff planed by machine; but if a bit of waste at the "stop" end can be afforded, there should be no difficulty in doing it. If the piece is long, perhaps the tail-end can be held down by a cramp, thus dispensing with a "stop," and reversing the ends when part is done. C. L.

[75562.]—**Sounds at Sea.**—Without actual experience of the phenomena described by the querist, it is not easy to answer such a qustion; but it is not impossible that the sounds were caused by waves breaking on rocks or against cliffs. X.

[75564.]—**Safety Bicycles.**—A light steel rod can easily be fitted to a bicycle to hold it up; but see p. 266. X.

[75570.]—**Enamelled Iron Plates.**—Old plates of this kind are of very little use, but they might be employed for making such things as roofs of fowl-houses, &c. R. M.

[75579.]—**Buzzing Water Tap.**—If this tap is one of the screw-down pattern, probably the buzzing is caused by the vibration of the leather or rubber cushion. If possible, take the tap to pieces and see how the washer fits. L. T. C.

[75583.]—**Softening Rubber Washers.**—The rubber washers which have gone "hard" may possibly be softened a bit by gentle warming; but the chances are they are what is known as "perished."

F. E.

[75588.]—**Heating by Steam.**—The "hammering" noise is probably caused by water accumulating in the pipes. See indices for notes on the subject. T. L.

[75599.]—**Enamelling Bricks.**—There is some information on this subject in back volumes, I know. Davis's book, "Practical Treatise on Manufacturing Bricks, Tiles, Terra-cotta, &c.," published by Spon at 25s., might suit; but the querist should procure catalogues from the different publishers. L. M.

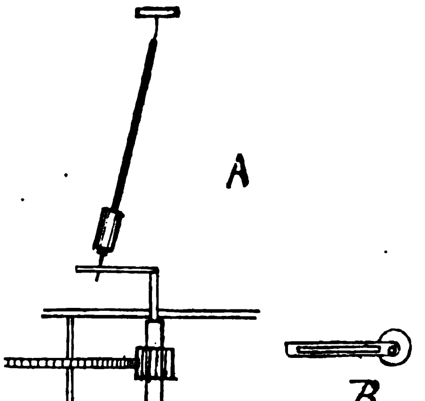
[75612.]—**Interest.**—I am sorry I cannot give "Discere Cupio" a better method of solving the equation I formulated than by "trial and error." I will, however, put it in better form for the purpose, thus—

$$\frac{y^n - 1}{y^n (y - 1)} = \frac{A}{b}$$

"S. M. C." is wrong in saying that this is a question of compound interest by my method. I worked out the question on the supposition that the interest was always paid when it was due, which I stipulated to be *quarterly*. If the interest were payable *yearly*, the rate per cent. per annum would be about 50·9. For loans of this kind bankers usually deduct the interest at the time of lending.

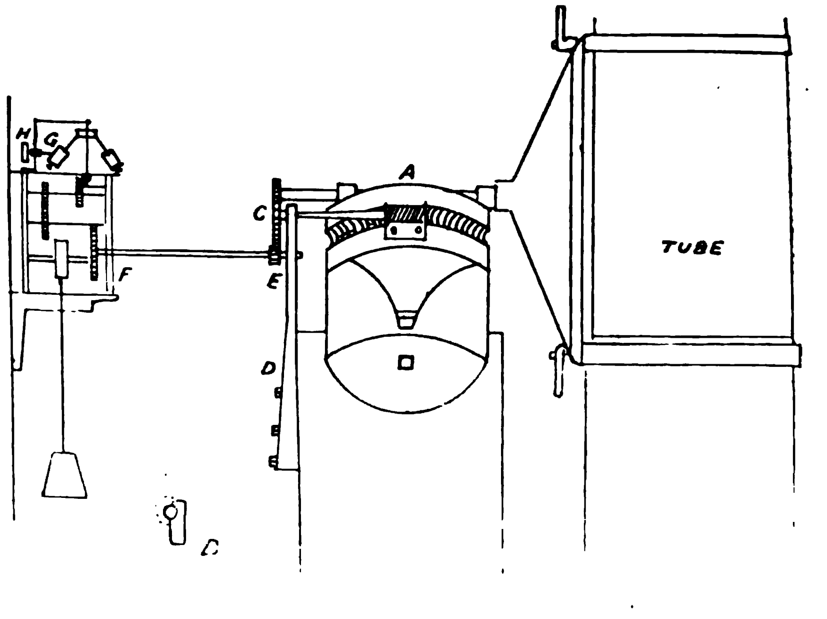
Too Much for the Whistle.

[75683.]—**Astronomical Driving Clock.**—I note the reply of "F.R.A.S." in "E. M." for Nov. 13, and think I am right in saying that these clocks are not made by clockmakers, but by the manufacturers of the instruments to be driven. As no one has come forward to help "Regulus," I will describe an ordinary conical pendulum and escapement as applied to a clock of fanciful design. A is a general view, B is a plan of fly without pendulum. The power is applied by means of a weight or spring, and transmitted through a train of wheels to the "fly" wheel, which in this takes the place of a 'scape-wheel. The "fly" wheel axis is provided with a radial arm which has a slot in it. Through this slot the free end of the pendulum passes, thus permitting large or small arcs. The pendulum is suspended centrally over the "fly" wheel axis in such a manner as to be free to swing in a circular direction without friction. A piece of fine spring steel wire (music-wire) will effect this. The bob is raised or lowered in the usual way. There is thus a slight but continuous pressure of the fly-arm on the pendulum, leading the latter round, as it were, in a circle. The time kept by such a clock will obviously depend in a great measure on the power applied to drive it. Why would not a dead beat escapement do with a quarter-seconds pendulum weighing, say, ½lb.? The motion of the 'scape wheel would be practically continuous. At every quarter second it would pause, say, ⅛th sec. What would be the apparent movement of, say, a star in ⅛th sec.? I make it ·0005°, and should certainly think (I am no astronomer) that the superior timekeeping of this form would far outweigh the slight deviation. I have never seen an astronomical driving clock, but imagine I could soon design something to suit if I had particulars. F. J. G.



[75731.] — **Motion for Equatoreal.**—The accompanying sketch will show "A. S. F." the manner in which I utilised an old English clock as a motive power and regulator for my 6½in. reflector. The instrument was mounted on an ordinary equatoreal block, shown at A. The first thing to be done was to remove the bearings of the tangent screw from the upper revolving disc, and to attach it to the base. A side view of bearings is shown at B. There a squared tube was fitted over the end of tangent screw in place of the Hooke's joint. At the other end of this tube is soldered the toothed wheel C, the tube passing through bearing in D, a support fixed to pillar of stand. E is small toothed wheel working into C, and fixed on the prolonged spindle of the first wheel of the driving clock, F. This spindle, which should be of brass-covered tube, is determined in length by the distance of the clock (which should be on brackets on observatory W wall) from the stand. The reason of not connecting F directly to the tangent screw is to allow of the passage of the counter-weight when the telescope is revolved in R.A., besides reducing the speed. The 'scape wheel of the clock must be removed, and a bevel gear substituted, which works the upright governor-shaft. The size of the balls depends on the driving weight and power required to drive the telescope. They are governed by a fine spring, G, which may be adjusted by screw H until the right speed is attained. The clock will run nearly an hour, or the cord may be led over pulleys near the roof to get more drop. I should say that in my case it required 300 revolutions of the tangent screw to complete the 24 hours in R.A. (In the sketch the clock is drawn on much smaller scale than the stand, &c.) I do not know if this arrangement will be possible with Cooke's mounting; but in my case it worked well.

A. Southgate.



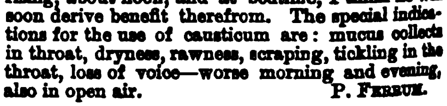
[75761.]—**Throat.**—If "Troubled Throat" will obtain from a homœopathic chemist a 6d. or 1s. bottle of causticum pilules No. 3, and allow two to dissolve in his mouth three times a day—viz., on rising, about noon, and at bedtime, I think he will soon derive benefit therefrom. The special indications for the use of causticum are: mucus collects in throat, dryness, rawness, scraping, tickling in the throat, loss of voice—worse morning and evening, also in open air. P. Ferrum.

[75761.]—**Throat.**—I would recommend you to try what I use myself with benefit—viz., pure terebene (not the drier). You will get it at any chemist's—10 drops on sifted sugar three times a day, before meals. I would also recommend you to use Pfarrer Kneipp's water cure as a general strengthener. I use the complete affusion every morning with great benefit. A translation of his book is newly out, price 5s., published by Blackwood and Son.

Plymouth. B.Sc.

[75805.] — **Centring of Short Lengths of Pipe.**—I send two diagrams, which "Mechanic" may find useful. Fig. 1 consists of two cones, fitted to the mandrel-nose and to the poppet. The pipe is fitted between them, and the necessary grip is given by thrusting the poppet forward. Fig. 2 consists of the cone C, connected with the rod A, on

Fig 1.



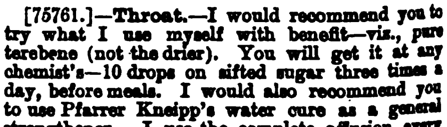


Fig 2.

which slides the cone D. A screw is cut on A, and D is pressed forward by means of the nut B. These are practically self-centring.

H. Shackleton.

[75800.]—**Cleaning Copper Utensils.**—After you have burnt the grease off, you might scour well with the scales from a smithy; but it will take longer and more "elbow grease" than if you used the acid. If you have the use of a smith's hearth you could use the acid under the chimney, so as to allow the fumes to ascend, when I think you would feel no ill effects. I generally do such work in the open air, taking advantage of the wind to blow the fumes away. I am afraid the method given by "Eos" would hardly suit an English workman. I, for one, would like to see my tinning last a little more than a fortnight; nor should I like to do them for 2s. 6d. per score (especially if there were several copper stock-pots amongst the score), as I am afraid at that rate, like the Indian workman, I should never earn a pair of trousers. H. Robinson.

[75806.]—**Hydraulics.**—Hawksley's rule for the amount in gallons per hour of water at any pressure through any pipe :—

$$G = \sqrt{\frac{(15\,D)^5\,H}{L}}$$

Where H = height of fall in feet; L = length of pipe in yards; and D = diameter of pipe in inches. Another rule for the cubic feet per minute:—

$$W = 4{\cdot}71\sqrt{\frac{D^5\,H}{L}}$$

Where D = diameter of pipe in inches; H = head of water in feet; and L = length of pipe in feet. Also, for head from pressure, or pressure from head:— $P = H \times {\cdot}4335$; and $H = P \times 2{\cdot}307$. Where H = head of water in feet, and P = pressure in lb. square inches. Walter Strafford.

[75810.]—**Screw-Cutting.**— Let the lathe be ready to commence, then mark the position of the rest; also put chalk-mark on face-plate to correspond to mark on bed, and do. on screw, corresponding with same on screw-bracket. Then start the lathe, and let every cut be started with all the marks in the same position as at first cut. For return of tool to starting place, screw out with one turn of handle, previously placing chalk-mark to denote the commencement of turn, so that the cut may be adjusted. All these relations of the parts may be secured by little mechanical contrivances which a little thought will discover.

Walter Strafford.

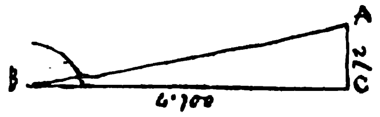
[75813.]—**Telescope: Angle of View.**—Construct a triangle thus: With distance 4,700ft. as base B C, and half the length of fence 144ft. ÷ 2 = 72ft. as perpendicular A C. Make A C radius, then A C : B : : radius : tan A.

By logs. B C 4·700 log. + 10 + 13·672098
A C 72 log. 1·857332

A = 89° 7′ log. tan. 11·814766

Then— 90° 0
− A = 89 7

= B 0 53 and 0° 53′ × 2 = 1° 46′ angle of view. As ·22in. at above distance subtends an



angle of about 0′ 8″, I should consider performance good for size of o.g. given. As ·22in is, roughly speaking, equal to ¼in., the distance at which ¼in. disc would be visible under same conditions should be about double the above distance, or, say, 1½ mile.

J. Adams.

[75822.]—**Damaged Boiler.**—If the leak is not large, try a cement composed of 1lb. quicklime, 1lb. finest sand you can get, and 2lb. powdered litharge, mixed to a paste with boiled linseed oil.

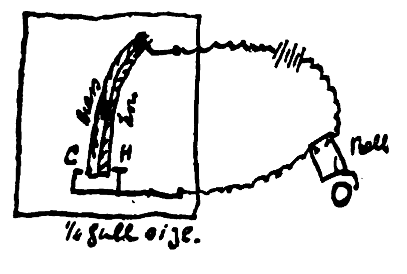
H. Robinson.

[75822.]—**Damaged Boiler.**—It is a common thing to run cement into boilers for the purpose described, but it is a most inadvisable practice. A "Boiler Smith" should know that the best plan is to renew the parts affected, and protect from contact with ashes by sheet-iron screen.

Walter Strafford.

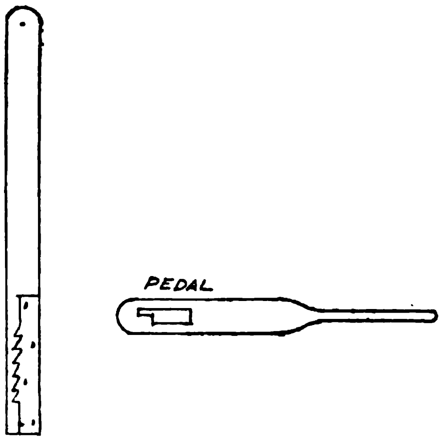
[75827.]—**Rusty Kettle.**—The quickest way of cleansing any rusty iron vessel is to treat it with a weakly-diluted liquor of hydrochloric acid and water (8 parts water to 2 of acid). Fill the kettle to the brim, and when the contents become muddy and red in colour, throw them away. Rinse with water, then fill up again with fresh water, in which dissolve ¼oz. washing soda. Boil it. Eos.

[75823.]—**Electrical Temperature Indicator.**—Fix a compound bar, i.e., a bar made of iron and brass welded together, which can be bought at



Dale's, Ludgate-hill, so that when the temperature exceeds a certain value contact is made at H, and if the temp. falls below a certain limit (45° F.), contact is made at C. A. D. Southam.

[75836.]—**Balanced Swell Pedal.**—In reply to "Discere Cupio," I do not see how an ordinary "recovering" pedal can be converted into a "balanced" one; but it may be made to set open at five or six different points, or grades of power, by the method schemed by myself, and described some time since in *Musical Opinion*. The method is as follows:—Mark on the swinging-rod the point at which the swell is closed, and also when it is fully open. Take the swinging-rod out; prepare a piece of wood ½in. narrower than the swinging-rod, and a little longer than the distance between the two marked points, and notch one edge (notches about an inch apart and ⅜in. deep) like the teeth of a saw. Now screw this piece so prepared on the face of the swinging-rod between the two marked points, and take care to keep the points of the teeth or notches a ¼in. clear from the edge of the swinging-rod, or they will catch the sole of the boot when the pedal rises. Now take out the pedal, and make the mortise sufficiently wide to allow the double thickness of the swinging-rod to work freely; and at the bass, or left-hand end of the mortise, lengthen the mortise about ½in. half-way across its width from the back; this will allow the plain or original portion of the swinging-rod to slide freely sideways and let the notches catch on the front portion of the pedal not mortised away. This pedal can be set open at any notch, and can likewise be pumped up and down with impunity. I have had it in use at St. Gregory's, Sudbury, for two and a half years; it is also applied to St. Peter's organ, Sudbury. It is easy to use, never fails, and there is nothing to get out of order.



Thomas Elliston.

Organist of St. Gregory's, Sudbury, Suffolk.

[75841.]—**G.N. Loco.**—The method of stopping priming in the G.N. boilers is by a steam-pipe in the boiler full of small holes, inside this another similar pipe, the perforations of one pipe not opposite the other. The steam in entering dashes against the inside pipe and the spray falls out. With this method the water has to be kept much lower in the boiler than those fitted with a dome. The sketch you require is in *Engineering* for November 1st.

Compound.

[75841.]—**G.N. Loco.**—If "J. H." will refer to Vol. L. p. 61, he will there see one of the G.N.R. locos., No. 776; these are called high-flyers in the loco. shops. There is another class, No. 230, with inside cylinders and a pair of leading wheels instead of the bogie. "J. H." is also mistaken about the priming. All loco.'s prime more or less; but the dome prevents this to a great extent. The G.N.R. locos. have a tube running through the top of the boiler (inside) into the smoke-box, which is perforated on the top, and, of course, the steam, being damp, must condense somewhat before it gets to the cylinders, and so cause priming. A dirty boiler also causes priming. Basil.

[75845.] — **Natural Drinks — Fermented Milk for Delicate People.**—Half fill a lemonade or sodawater bottle with new milk, cork and wire it, shake well, and turn it every day for twelve days; it is then ready for use. N. D.

[75848.]—**Jam.**—For the effectual preservation of jams and marmalades there are two points requiring special care: (1) The total evaporation of aqueous particles in the fruit juices; (2) the perfect exclusion of the atmosphere, teeming with the germs of ferment. The jars (4oz. to 8oz. capacity being most convenient) should have been scalded with a boiling solution of soda in water, then rinsed thoroughly, dried bottom upwards. The flat cork stoppers must be new and very sound, each jar having one fitted to it ready for filling. I suppose your jam to have been properly boiled and poured into the receptacles while hot till the preserve will touch the stopper when corked. Into a saucer pour pure French brandy (about 4oz.); procure some thick bibulous paper (white is best), Cut out a number of circular pieces a trifle larger than the interior of your jars. Soak them in a saucer of brandy, remove one at a time carefully, and press the same down on the top of your preserve until quite smooth and adherent. When you have got through a good stock of jars, dip a goose-feather in the brandy, and sprinkle each paper lining liberally till saturated. Moisten the edges of your corks with the spirits, and press them down with some force till quite tight. Get some ox-bladders from a butcher, cut off the fleshy necks and soak the bladders in a pan of tepid water till quite soft and pliable, remove them, and with large scissors cut to paper pattern discs sufficiently large to cover the cork and neck of a jar. Having made a quantity of these envelopes, apply one while soft to the top of each jar; it will stretch, and you will secure it round the neck with two turns of twine. Put the whole lot on a high shelf in a warm room, and in 24 hours you wil find each top as tight as a drum. Tear off any projecting scraps of bladder, and then tie on additional covers of stout packing paper, writing description and date on the the same. I do not like parchment paper: it is not air-tight, and is very inferior to the membrane cover. Mice are greatly addicted to gnawing all jar covers, and traps are needful to set on the shelves, for preserves perish directly the covers are punctured. Hermetically sealed tin cases are vastly preferable to corked jars, but no amateur could accomplish "canning" on a small scale.

Eos.

[75859.]—**Coppersmithing.**—You could braze with gas providing you have a suitable blast which could be got by a pair of foot bellows. Ordinary brass wire makes a good solder for copper; eight parts brass and one part zinc is what is generally used, or one brass and two of tin does not take so much heat. I have never used rivets so small as 1/16, but should think you could get them. Why not use small lengths of copper wire that size? You do not say what size taper you wish to work the copper into; if it is large you could roll it between a pair of tinman's rolls; but if small you could hammer it round an iron stake fixed to the bench or held in a vice, using a mallet to prevent bruising the copper.

H. Robinson.

[75860.] — **Boiler Covering.** — Take 1 part Parian cement, 1 part cheap flour, 4 parts cinders; grind in a mortar-mill with water, but only sufficient to mix; then add cowhair enough to stick it together. Do not mix more than you intend to use the same day, and have the boiler hot when using the above. We have at our works scores of yards of steam-pipes covered with the above mixture.

F. W. Bernard.

[75862.] — **60c.p. Manchester Dynamo.** — To Mr. Bottone.—Armature 4½in. diam., 2in. deep; field-magnet cores, 2in. diam. 5in. long. Armature wound with 2½lb. No. 20 d.c.c. Field-magnets, 8lb. No. 22, connected in shunt with the brushes. S. Bottone.

[75863.]—**Electric Shop Bell.**—You can obtain an alarm contact to close the circuit on opening the door, and to break when door is closed. A switch under counter will do to turn off the current when not required. F. Askew.

[75863.]—**Electric Shop Bell.**—In working continuous-ringing bells, the stopping and resetting of the bell are done by means of a cord and lever attached to the bell itself. Your arrangement for stopping and resetting from downstairs will have to be something like a trigger on the door, with a cord instead of a push. Mick.

[75863.]—**Electric Shop Bell.**—There are electric bells so constructed that when the armature is once attracted by touching the push, or a contact on the floor, a detent is released in the bell itself, which completes the circuit independently of push or other contact, and therefore the bell continues ringing until the detent is replaced by pulling a check-string. You will find this arrangement fully

described and figured in my book, "Electric Bells, and all About Them, pp. 93, 94, and 95.
S. Bottone.

[75864.]—**Hardening Steel.**—Place your work in a bundle of leather shavings, heat to cherry red, and quench in a strong solution of salt and water, or soap suds. Les down to temper by heat moderately applied from the base. Eos.

[75865.]—**Mesmeric Sailor.**—The inquirer is not very explicit; but I take the trick to be a very old one. A query was made at the beginning of the year regarding apparently a similar one. This was answered and explained by me, and by some other correspondents in the English Mechanic of the 30th of January, 1891, under the heading "Magical Conjuring Trick" in Replies to Queries.
G. G. B.

[75866.]—**Copal Varnish.**—This is very difficult to make on a small scale, and should be kept for at least two years after it is made before it is used. It will not mix with methylated spirit; but should be thinned, if necessary, with turpentine. 999.

[75866.]—**Copal Varnish.**—Copal varnish is an oil varnish, and has no business to be mixed with methylated spirit. What, in the name of common sense, does "Copal" mean? If he wants copal varnish, he can buy it cheaper than he can make it; but for the purpose specified—"coating work in the lathe"—he should ask for brush polish, or use the best "white hard." Nun. Dor.

[75867.]—**Lighting Fairy Lamp.**—Two small chromic-acid cells with double carbons 2½in. by 1¼in. by ¼in., and single zinc between 2¼in. by 1¼in. by ¼in., fitted with lifting arrangement, will give perfect satisfaction. The covers must be fitted with indiarubber washers, and the cells must have indiarubber bands to keep the covers tightly on, if to be carried in pocket. You evidently have not read my advertisements in Sale Column, since you say you do not know where to purchase.
S. Bottone.

[75869.]—**Bichromate Battery.**—So much depends on the condition of the battery, &c., and the waste of energy by local action, that it is almost impossible to specify. Roughly speaking, you might expect to get somewhere near 700 watts from a bichromate battery consuming 1lb. of zinc per hour, and the depolariser would cost about 2½d. per hour. S. Bottone.

[75870]—**Crucibles** for gold-melting should be coated inside with fused borax before the metal is placed in them. You can only recover the gold by grinding the crucible into an extremely fine powder and washing the metal out. 999.

[75870.]—**Crucible.**—It is quite possible that crucibles behave differently when you use coke and when you use Fletcher's gas apparatus. I have only used the latter, and then the plumbago crucibles or the little special gold crucibles have answered well. Z. Y. X.

[75874.]—**Induction Coil.**—Either your secondary coil is not properly insulated, or else it is not properly connected to its terminals; or, lastly, there is a break in the secondary wire. The proportions of wire given will work perfectly well with a two-celled Bunsen. S. Bottone.

[75875.]—**Electro-Magnets.**—Both poles have the same force, hence it is indifferent which is presented to the hammer of the coil. S. Bottone.

[75878.]—**Phonograph.**—The pieces of brass rod on the ends of the guide-rods are to give a finish to them, and to serve, to some extent, in giving greater stability, and also as the brass caps add slightly to their length, enables the mandrel steel rods to be used, which are only made in lengths of 13in. The sizes of the holes in the standards are correct. The wire on the armature, where it comes close to the spokes, must be neatly bent round them, so that the wire covers entirely the outer surface of the iron ring. There is no difficulty in keeping the sides of each coil in place, as there are only four layers of wire; and if wound on tightly it will keep up until the whole ring is wound. Nothing is put between the coils. The field-magnet cores are of the same size in diameter as the yokes are in width—viz., ½in. Later on I may perhaps be able, with the Editor's permission, to give a full description of the governor; but I have not finished designing it to my satisfaction yet. I gave in the articles the principle on which it works.
W. Gillett.

[75880.]—**Hardening Steel.**—The best way to harden steel in long pieces is to dip them sideways. Possibly "Steel" gets too high a red: it should not be above a cherry-red in the dark. That, of course, does not look so bright in the daylight.
Nun. Dor.

[75883.]—**Brasswork.**—For what good purpose does "Henricus" wish to give brass the appearance of gun-metal? They are two different alloys, but I believe it can be done by eating out the zinc from the surface by means of dilute sulphuric acid, leaving the copper to give a higher colour. What is the object? Nun. Dor.

[75884.]—**Electrical Nomenclature.**—The terms "volts" and "ampères" are the units of electrical pressure and quantity respectively. Volts and ampères, or, shortly, E.M.F. and C., multiplied together give us watts, and 746 watts = 1 electrical H.P. Series-wound is intended to convey that the wire on field-magnets, the armature, and outer circuit are in series—that is, form one complete circuit through which the current flows. Shunt-wound means that the field-magnet coils are in shunt with the brushes, forming a branch circuit for the current. Compound-wound is a combination of series and shunt. The commutator or collector is that part of the machine on which the brushes bear, and the bars of this (the collector) form the terminals of armature coils. Continuous and alternating currents signify that the current for the motor must be continuous in direction, while alternating currents are used for machines specially made for this form of current. The currents generated in all armatures are alternating; but the commutator rectifies these, and delivers the current in a continuous flow. If you want to go deeper into the subject, obtain a good textbook, and until you have perused this thoroughly leave electric-plant fitting alone, or you will be landed in a hopeless muddle. F. Askew.

[75884.]—**Electrical Nomenclature.**—A small treatise of about 400 pages octavo would be required to fully elucidate all the points anent which you inquire. Briefly, 1H.P. theoretically requires 746 watts to produce it. The watt is equal to 1 volt multiplied into 1 ampère; hence a motor which absorbs 100 volts and 10 ampères, or 1,000 watts to furnish 1H.P., wastes 254 watts, or has an efficiency of 75 per cent. "Series" wound means that the wires on the field-magnets are so connected to the terminals and brushes that the whole of the current is obliged to pass round the field-magnets, through the armature, and then back again to the source. "Shunt-wound" indicates that both the brushes are coupled to the field-magnet wires, and also to the outer circuit, so that the current splits up on arriving at the commutator, part going round the armature, and part round the field-magnets. Compound-wound machines are wound with two separate sets of wire, one coupled in series, the other in shunt. The commutator is that contrivance whereby the current is continuously supplied in the right direction to the moving part of the motor or dynamo. It is to these machines, what the slide-valve is to a steam-engine. Highest E.M.F. 100 volts, lowest 40 volts, as applied to motors, shows the highest and lowest pressures (electrical) at which the motor is constructed to work. Potential in 50 volts means that the dynamo is capable of raising the pressure to 50 volts. The volt is the measure of electrical pressure, and is about equal to that given by one Daniell cell. The ampère is the measure of flowing current; one ampère will cause most of the usual incandescent lamps to give their due light; one ampère flowing for one hour through a solution of sulphate of copper will deposit 18·35 grains of copper; continuous current, when the current flows from one terminal to the other in the same direction; alternating current, one which is flowing alternately in the one direction and the other. Read my two books, "The Dynamo: How Made and How Used," and "Electro-Motors," and you will be a wiser, if not a better, man. S. Bottone.

[75885.]—**Electrical.**—With fair precautions, there is no particular danger. Special knowledge is undoubtedly required. I have in my mind's eye the case of one who, like yourself, wished to work some pumps in a colliery in the North, and knowing little or nothing of the matter, after having got the dynamo and motor from me, lost his situation for presuming to do what he could not carry out. A person unacquainted with electrical plant, and not knowing the precautions required for insulation and proper connection, would make a hash of the whole affair. The cable must be double (viz., go and return) to allow the current to return to its source. The cable is supported on proper china or glass insulators, and if the mine is a wet one, must be incased in lead. The motor itself can be reversed by means of a suitable current reverser arrangement at the brushes, or the drum can have reversing gear. A motor can be stopped as easily and as suddenly as a steam-engine by switching off the current. The speed can also be reduced.
S. Bottone.

[75885.]—**Electrical.**—The chief danger connected with electric mining plant arises from inexperienced persons attempting to do the work themselves. The manufacturers of mining plant would send a man to fix the plant, run the cables to supply current, and also instruct the person who would have to take charge of the plant—of course, providing the purchaser is willing to pay for it. It is a case of penny wise and pound foolish. By having the machinery properly laid down and run for a trial by an experienced man, a great deal of the danger may be obviated; but, of course, there would always be a certain amount of danger, as with all machinery, from inattention. The cable is double—one from dynamo to supply current to motor, and the other for return. It is usually supported on insulators of earthenware, both in the shaft and also in the galleries and workings. As regards the hauling, the direction can be reversed by causing the current to flow through the armature in the opposite direction, or, as is usual, by means of the hauling plant, which is usually fitted with reversing gear. A motor can be stopped as quickly as any other machine, and its speed can be reduced or augmented to anything in reason.
J. M. D.

[75887.]—**Sundials.**—If "Gnomon" will refer to the "E.M." of the following dates, he will find the information he wants:—April 8, 1887: a letter in this number gives instructions for constructing a horizontal dial by the graphical method. April 27, 1888: in this number a method is described of constructing a vertical declining dial, and in the number for May 18, 1888, the same example is dealt with by the geometrical method. If, after reading these, "Gnomon" is still in any difficulty, if he will put another query, I shall feel constrained, as the writer of the letters mentioned, to try and render further help. W. J. B.

[75888.]—**Balloons.**—If "Aëronauticus" refers back to my reply, he will see that I assumed *hydrogen*-gas to be used. The following formulæ is from Molesworth, p. 365:—

Let W = weight to be raised, including that of the balloon,
A = weight of a cubic foot of air,
G = weight of a cubic foot of gas employed,
D = diameter of balloon,

$$\text{then}\quad D = \sqrt[3]{\frac{W}{\cdot 5236\,D^3\,(A - G)}}$$

$$\text{and}\quad W = \cdot 5236\,D^3\,(A - G).$$

I think the measurements are in foot-lbs. A and G will vary with the temperature and pressure.
A. D. Southam.

[75889.]—**Formula Wanted.**—There is not such a thing as a stern to a hydrometer (as published); but I take it you mean "stem," and you have not mentioned which kind of hydrometer you are working with, but I suppose a "common hydrometer." The common hydrometer is always the same weight, therefore will sink to different levels in different liquids. Suppose each division of the stem to be $\frac{1}{1000}$-part of the volume, and suppose that when the instrument is placed in a fluid whose sp.gr. is s, 10 divisions of the stem remain above the surface; and when it is placed in a fluid whose sp.gr. is S, 30 divisions remain above the surface. Then—

$$\begin{aligned}(1{,}000 - 10) &= \text{Weight of first liquid displaced.}\\ &= \text{Weight of hydrometer.}\\ &= \text{Weight of second liquid displaced.}\\ &= (1{,}000 - 30)\,S;\ \text{or } 990s = 970S\ \frac{s}{S}\\ &= \frac{970}{990}.\end{aligned}$$

Hence, if s be known, S may be found, or vice-versâ. Example: If common hydrometer floats in alcohol with 11 divisions above the surface, in ether with 80. If sp.gr. of alcohol be ·8, find that of ether. Then—

$$(1{,}000 - 80)\,s = (1{,}000 - 11) \times \cdot 8.$$
$$\therefore\ 920\,s = 791{\cdot}2.$$
$$s = \frac{791{\cdot}2}{920} = \cdot 86.$$

Your formula is the first part, before the example. I advise you to learn it well, as it is always turning up in S.G. C. G. M. Bennett.

[75892.]—**Cleaning Sink Pipes.**—A strong potash solution, used very hot, will answer your purpose very well.
Brighton. T. C. Smith.

[75892.]—**Cleaning Sink Pipes.**—Use a strong solution of washing soda, add it to hot suds, and stir in an ounce or two of Jeyes' Perfect Purifier. Use this mixture very hot—twice a month is sufficient. Eos.

[75892.]—**Cleansing Sink Pipes.**—Stop the pipe in some way, and fill with a warm solution of common washing soda. After soaking some time, use a "broom" similar to those used for sweeping the flues of kitcheners. After that, if wanted very clean, fill up with a weak solution of hydrochloric acid (spirits of salts), and then swill out well with water. It will be as clean as a "new pin."
Nun. Dor.

[75893.]—**Leclanche.**—Zinc in porous pot. Space between outer jar and pot to contain carbon-plate and manganese mixture. Salammoniac solution in porous pot. Advantage, lower internal resistance. F. Askew.

[75893.]—**Leclanche.**—I have just dissected some old cells in which the zinc was the inner element. The arrangement was very simple, the zinc being in a centrally-placed porous pot, and the space between the two jars being tightly packed with the usual carbon plate, coke, and manganese.

The whole of this negative element was sealed in with pitch, two tiny glass funnels being inserted for the escape of gas, &c. These were dead cells whose efficiency I made no attempt to determine; but the modern arrangement strikes me as far simpler and more accessible. W. YARROW.

[75894.] — **Shunt - Winding a Gramme Dynamo.**—Put 8lb. No. 20 on the field magnets, and connect up in shunt. S. BOTTONE.

[75895.]—**Shrunken Woollen Goods.** — The Technical Instruction heads in *Laundry Work* have lately exhibited the treatment of woollen goods previous to washing; they are immersed in a bath of liquor ammoniæ, diluted with water, by which all contraction is obviated. I cannot say if it will do for old shrunk pieces. EOS.

[75896.]—**Hysteria.**—So far as one can judge from the few symptoms given, I consider (homœopathic) hyoscyamus tincture No. 3 the most likely to be beneficial, especially if there is much nervous excitement. Two drops of the tincture should be taken in a tablespoonful of water regularly for a month night and morning, on rising and retiring. P. FERRUM.

[75899.]—**Compressed Air.**—One cubic foot of dry air at 32° Fahr. weighs 12¾oz. under a barometric pressure of 30in. of mercury. If the pressure were doubled, 2c.ft. of air would be compressed into the same space, and the weight would consequently be doubled. 999.

[75900.]—**Transformer.**—To MR. BOTTONE.—Presuming you know how to make an ordinary induction coil, I would advise you to wind the primary with, say, 10lb. No. 16 d.c.c. wire, and the secondary with about 8lb. No. 10. The insulation must be most carefully attended to. If the current supplied is a continuous one, the transference must have a contact-breaker attached to it like any other coil; if the current supplied is alternating, no contact breaker is required. I learnt what little I know of drawing from Cassell's "Popular Educator." S. BOTTONE.

[75902.]—**Resistance, Adjustable.**—A slide form of resistance is easier for an amateur to construct. Arrange a number of coils in box, and take ends to metal studs, the ends of which project above the cover of box. An arm is now pivoted at the centre, and when moved round makes contact with one or the other of the studs. F. ASKEW.

[75904.]—**Telephone.**—You would not get much benefit by inserting a battery in the circuit. First get the instrument to work without, and when right you can insert a battery, so that the current in flowing round the poles strengthens them. If the bobbins are on the S. poles, current should flow in the direction of the hands of a watch when looking on the tops of magnets. MICK.

[75905.]—**Engine Query.**—To get a satisfactory reply, you should send the necessary particulars—i.e., boiler pressure, cut-off, diam. of cylinder, length of stroke, and number of revolutions per minute, &c. I presume the choice lies between adding condenser to present engine or non-condensing compound. How much power do you require? On sending particulars shall be happy to help you. W. W. C.

[75908.]—**Punching Sheet-brass Patterns.** —You will require a punching machine to stamp out your washers, which would cost you about £10. You could have your punch and dies made so that you could punch all the holes at once; but I could not give you any idea how much the punch and dies would cost without seeing the patterns. E. SNOW.

[75908.]—**Punching Sheet-Brass Patterns.** —Your best plan would be to procure one or two presses sufficiently strong to do the work, and then set some girls on the work who have been at it before. The blanks would be cut out first, then screw-holes, &c., punched in after. Any die-sinker, if you show him patterns, would give you a rough estimate of cost of a set of tools for punching, all of which could be done by hand. H. ROBINSON.

[75909.]—**Dry Cell.**—The battery is evidently that known as Scrivanow's. It ought to light a small lamp well, but not for long, when it will require a rest. A small pocket accumulator is about the best to use. MICK.

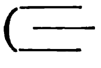
[75910.]—**Taxidermy.**—Steaming over a vessel of boiling water is the mode employed by the trade. I have actually softened the wings of lepidopterous insects by these means, floating the specimen on a sheet of cork. EOS.

[75911.]—**Resistance in Electro-Motors.**—As a general rule, the resistance of the F.M. wires in series machines should be two-thirds that of the armature wires. In the shunt machine, the resistance of the fields may be much higher, in fact anything between 100 and 400 times that of the armature. See my book "Electro-Motors," for fuller details as to why and wherefore. S. BOTTONE.

[75912.]—**Epileptic Fits.**—If "H. A." cannot obtain the advice of a good homœopathic physician, or until he can, he might let his son take two baryta carbonica pilules No. 6 four times a day—viz., night and morning, and about noon and 4 p.m. If the latter is troubled with an eruption on the face, shoulders, and chest, and occasionally with boils, the medicine is probably the cause. P. FERRUM.

[75913.] — **Speed of Electro-motor.** — The efficiency of electro-motors decreases greatly when speed is reduced; therefore use (if possible) gear wheels or belts to get the desired speed.
Brighton. T. C. SMITH.

[75914.]—**Magneto Machine.**—Magnets capable of lifting 10lb. or 12lb. will give the necessary current and voltage to light a 15c.p. lamp. You had best use a Siemens H armature, about 1¼in. diameter and 6in. long, wound with No. 22 wire, lying longitudinally between the poles thus—



The magnets would cost from 12s. to 15s. Such a machine could be driven by hand from a suitable wheel. Of course, it would not be so cheap to make, so effective in action, or so easy to drive as a small dynamo of the same power, a set of fitted castings for which can be supplied for 15s. See my advertisements in Sale Column. S. BOTTONE.

[75915.]—**Wimshurst Machine.**—Your Leyden jars leak; they are either of bad glass, or else are pasty on the outside and inside. S. BOTTONE.

[75915.] — **Wimshurst's Machine.** — Charles White will find all his trouble with the Leyden jars arises from the bad quality of the glass. I have found many of the cheap soda-water glasses to offer almost free conduction of electricity. Whiteness is no proof whatever of the insulating quality. The tinfoil being in three pieces matters nothing. Get good quality glasses from Powell's Glass Works, Whitefriars, and then you will obtain all you want. I use their soda-water glasses to make Leyden jars with loose coatings; they answer splendidly—only, being thin, they are apt to crack if too fully charged. J. W.

[75916.]—**Cleaning Old Coins.**—Boil your coins in a strong solution of potash and scratch-brush, which will remove all dirt, grease, &c., then dip the silver ones in a cyanide solution, and the copper ones in dipping acid for a few moments, rinse, scratch-brush, rinse again, and dry in hot box dust.
Brighton. T. C. SMITH.

[75916.]—**Cleaning Old Coins.**—Copper specimens are thoroughly cleaned by immersing them in a weak solution of muriate of ammonia, scrubbing with an old nail-brush, and rinsing in a bath of carbonate of soda and hot water. Silver coins should be boiled in acidulated water of lemon-juice, taken out in half an hour, scrubbed with the nail-brush, and then boiled in soapsuds; again scrubbed, and then rinsed in boiling water. Only dirt and oxide are removed by these processes. *Experto crede.* EOS.

[75919.]—**Stoneware Pots.**—You might try the following, which answers well for glass. Bind the place at which you require a fracture with ordinary lamp-wick, soak with paraffin, and ignite. Allow the jar to attain a great heat, and then plunge into cold water; a crack may result. I doubt your success on stoneware, but you can do no harm by trying. F. ASKEW.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75316. S.E.R. Loco. "Onward," p. 97.
75332. Dyeing Glass, 98.
75335. Polishing Bosses of Wood Rollers, 98.
75336. Engine, 98.
76346. Engine for Lift, 98.
75347. Patent Resonating Gongs, 98.

75537. Wool Winder, p. 184.
75540. Osbo-Premier Battery, 184.
75544. Thickness of Metal Pipes and Cylinders to stand Steam Pressure, 184.
75668. Estimation of Lead as Sulphate, p. 185.
75569. Medical Coil, 185.
75575. Model Screw Propellers, 185.
75576. Camber, 185.
75589. Engine, 185.
75591. Organ Pipes, 185.
75596. Mason's Stamps, 185.
75597. Iron Chuck for Brushmaker's Lathe, 185.
75598. Fan for Forge, 185.
75601. Furness Railway Co.'s Engines, 185.

QUERIES.

[75920.]—**Linesman's Galvanometer.** — Will some reader kindly tell me how to wind the coils in a linesman's detector galvanometer for intensity and quantity, and also the amount of wire?—A. GEORGE.

[75921.]—**Optical Lantern.**—Can anyone tell me how to make a parallel-beam nozzle, giving size and focal lengths of lenses? I have a Gilchrist lantern with 4-wick paraffin lamp. Is it possible to get a good parallel beam from this, or is the limelight indispensable?—R. E. S. A.

[75922.]—**Electro-Motor.**—Having made the carcase of an electro-motor, according to the drawings of Edison's, for the phonograph, I shall be very thankful for the following information. 1. As to the size and quantity of wire to wind it with? It is a multipolar motor, having four magnets, as per sketch. They are 1¼ wide by ⅜ thick. The dynamo is a Gramme ring, with eight divisions and ¾ thick. 2. What battery power will be required to drive it? Also, what power will I be able to get from such a motor?—MANCHESTER.

[75923.]—**Problem.**—I find the following in a book I am reading:—

$$x = \frac{2195 + \cdot 182236}{\cdot 008727} \times [\cdot 984708 - (\cdot 625 \times \cdot 173648)] = 18301.$$

Is not this answer wrong? As I work it out, I make it 220,396.—PUZZLED.

[75924.]—**Strain on Engine Belt.**—I wish to find the strain on engine driving belt, which is double leather 12in. wide and ¾in. total thickness. The engine has one cylinder, 16in. diameter by 2ft. 6in. stroke, running at 90revs. per minute and giving out 80I.H.P. The strap pulley on crankshaft is 5ft. diameter, and the pulley on the line of shafting is 3ft. 9in. diameter. If leather link-belting were substituted for the plain belt, would one 12in. wide answer the purpose, bearing in mind the loss of gripping surface?—SYDNEY.

[75925.]—**Foundations.**—Will some reader kindly inform me how to calculate the size and depth of concrete foundation necessary to support a tank on four columns? The base of each is 2ft. by 1ft. 6in., equal 3sq.ft. area—

7 tons of tank
18 ,, water
5 ,, girders and columns
30 tons total = 7½ tons on each column base.

Also, if the above were placed on brickwork, how to calculate?—SYDNEY.

[75926.]—**Harmonium—Manual Coupler to.**—Will any of "our" friends advise me the form of coupler suitable for a large pedal harmonium, that I wish to connect the upper to the lower keyboard, or what is termed Swell to Great. It has six stops—three at each side, like an organ. Five stops act on five sets of vibrators of sixty-one reeds each, and one stop on one set of vibrators to Swell, and there are two sets of pedal reeds in a box at bottom of instrument, and twenty-nine pedals, which act without any stop when the pedal board is pushed in position. The lower keys are fixed at their ends, and control five pallets, and are 21in. long, and the upper keys are 14in. long, and are worked on a pin at centre, and carry the action to back of instrument, where the upper set of vibrators are placed.—HAMPTON.

[75927.]—**Small Biunial.**—I intend to construct one of these with some 2½in. condensers which I have. Will one of our correspondents advise in the following points? Should I gain much by compounding condensers? They are at present about 2·5in focus. I intend to use limelight, which should give a 12ft. bright picture, should it not? My front-lens tubes are brass, 1·4in. diameter inside, 1·5in. long, sliding in brass sockets and flanges. What focus objective would probably be best for a 12ft. picture at (if possible) about 10ft. distance, and what distance from slide? Also, if not asking too much, to give a dimensioned sketch of best jet for the purpose, as I should make these myself? The lantern to be mahogany lined with metal, and the slides mostly from my own photos.—L. W.

[75928.]—**Crystallisation.**—It would be interesting to hear opinions of your competent correspondents on the following problems bearing on crystallisation, which I have never seen alluded to:—Fill a circular and a rectangular bottle with, say, a saturated solution of iron sulphate. Lower the temperature to a certain extent, and recrystallisation will take place in the latter, but not in the circular bottle. Last autumn I filled a number of small bottles (about 6oz.) in preparation for winter work at photography. All the solution in the rectangular bottles recrystallised, but not a sign of it in the circular. Again, does the transition from the liquid to the solid state, when ice is formed, occupy time? Resistances to the action of all natural laws exist, and it would therefore demand time for the formation of a crystal of ice. If such be the case, there must be an intermediate state when water is neither solid nor liquid, and it should be, theoretically, possible to produce and observe it.—D. HARBORD.

[75929.]—**Dynamo.**—I have a dynamo finished all but the winding, upon which I require a little help. The wrought armature is 4in. external diameter, by 2in. wide, and ⅜in. thick, with 144 turns of No. 18 d.c.c. wire in a single layer, laid in grooves half diam. of the wire. The field-magnet is a single-coil one (all cast iron), core 3in., diam. 2in. between shrouding, depth of shroud from outside to core (or depth of wire space) 1in. What gauge and quantity of wire should be wound on field-magnet for a shunt machine, and what would be the probable output? Also, how ought I to wind a similar carcase for working as a motor when the exciting currents equal 100 volts?—SUB. FROM No. 1.

[75930.]—**Gas-Engine.**—I use a 3½-horse Otto gas engine (silent), which, though it starts easily enough in the daytime when it has been running, requires to have the gas-bag filled and emptied three times when starting on Monday morning, and after any one day's standing idle. Gas-bag is about 30ft. from meter. Gas is passed through a vessel containing cotton wool, saturated with benzoline. Air-mouth is in a cart-shed outside building containing engine. Should be very pleased if anyone could give me their experience if they have had a similar trouble, and suggest a remedy, and should like to know if this is a common experience?—Shunt.

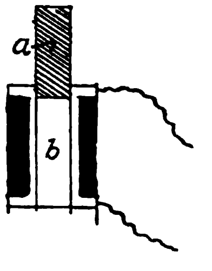
[75931.]—**Gases.**—Will any of your able correspondents kindly give me the particulars for preparing a saturated solution of (1) hydrogen, (2) ether and sulphuric-acid gas in water?—Apprentice.

[75932.]—**Fairy Cave.**—At a forthcoming bazaar for charitable purposes it is desired to have a "fairy cave," to be lighted with small incandescent lamps, illuminated fountain, &c. We have no difficulty concerning the lighting of the cave; but we are unable to find a nice, pleasing design for the cave itself. Can any of "ours" oblige by referring us to any book likely to assist us in arranging the interior of the cave, or will they kindly give their ideas on the subject? Unless the general design is suitable and attractive, all the labour (free) expended will be utterly wasted. We thought perhaps an opening in the apparent distance could be somehow managed with mirrors, or perhaps a miniature waterfall. Can a magic-lantern be utilised?—A. Bosquet.

[75933.]—**Dynamo.**—I have designed a dynamo of the following size: Field-magnets are 14in. long by 10in. diameter, armature 13in. long by 12½in. diameter by 2¼in. thick; it is of the Edison-Hopkinson type. I want to wind it and to get all the light I can from it. The speed is limited at 500 revs., that being the most I can get. I should be glad if anyone will show me how to work out Hopkins's formula, and to apply it to that size of a dynamo, and also state how I get at the size of wire for the shunt and armature shunt-wound dynamo?—A Mechanic.

[75934.]—**'Scape Wheel.**—To Lord Grimthorpe.—On page 124 of Sir E. Beckett's book on Clocks, &c., it is stated the distance of lifting-pins should not be more than a 40th of E.C. (that is distance of pallet-arbors from 'scape-wheel centres). This distance is so small, I think there must be a mistake. Will Lord Grimthorpe explain?—Enquirer.

[75935.]—**Electro-Magnet.**—In the sketch, *a* is an iron core. I wish to draw it into the bobbin *b* with the greatest possible force. The bobbin is full size. The diameter of *b* may be reduced to half if better. Can any of our readers say what size wire, also amount, would do best, and what kind of battery would work the magnet for half an hour or so, and recover itself? The latter must be very lasting.—G. M.



[75936.]—**Paraffin Spray for ½H.P. Boiler.**—Can any reader kindly inform me how to fit up a small boiler, with paraffin spray to be used as fuel? I understand that the paraffin is sprayed on by a small jet of steam. Please say how the spray is started before steam is up.—D.

[75937.]—**Telephone.**—I have bought at a sale what was represented to be a complete set of telephone instruments. The transmitters are a couple of square boxes with sloping covers, in which is mouthpiece, and microphones under. Each one contains a small induction coil, a hook to hang telephone on, several binding screws, and a pressel; but it is all disconnected. There is no wire or connection at all from one part to the other. It appears to have been picked to pieces. Can some friend tell me how to join it up? The pressels seem to have acted as a switch, as there is a metal catch holding the spring when not in use; but when used to call up, it is released by the pressure from the top catch, and presses on the bottom plate. The hook also makes contact with a metal plate top or bottom, whether the telephone is on or off. The receivers are of the Bell pattern, but shorter. They appear to be all right. Also the two bells and batteries.—A. P.

[75938.]—**Gilding China and Metal Ornaments.**—Can any of our readers tell me what gold is used, and how it is mixed, for gilding china ornaments and cups and saucers? I have a large quantity of cast-iron articles which are enamelled (Aspinal's) in various colours. The prominent part of castings I gild; but cannot make it look anything at all like the gold on crockery-ware. I use best gold bronze, and mix it with gold size and turps. Again, Christmas and birthday cards, and also some show cards, are gilded, and look first rate. I shall be glad if any of "ours" can give me any information, as my castings are for ornaments, and without the gilding comes up to the mark, they do not look at all well.—Gold.

[75939.]—**Bleaching Guttapercha.**—Is there any way of bleaching guttapercha?—A.

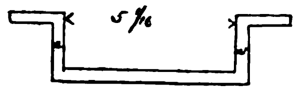
[75940.]—**Medical Coil.**—Will Mr. Bottone or Mr. Allsop be kind enough to give full sketch of coil, with tube regulator for primary and secondary currents, tube about 7in. by 1in.; and what kind of wire, and how much on each section? as I should like to make one on that principle.—Amateur.

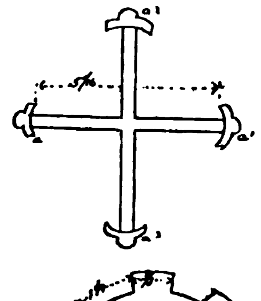
[75941.]—**Floor Contact.**—Will Mr. Bottone give a sketch of floor contact to ring electric bell? I want to fix under floor at front door, so as when anyone steps on mat, bell will ring? A drawing will oblige.—Amateur 2.

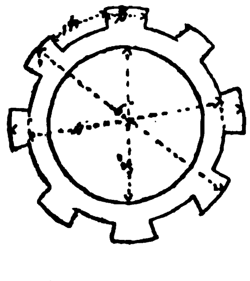
[75942.]—**Indicator.**—Would Mr. Bottone reply with sketch how to make the following:—An indicator which would indicate the opening of a door some 50 yards distance?—Bloemfontein.

[75943.]—**Brick.**—I would feel greatly obliged to anyone who will give me their experience as to the best machine—whether a horizontal pug mill, or a double-knife mixer.—for manipulating clays after passing through the rolls?—Tile.

[75944.]—**Link Motion.**—Can any reader explain the following? I have bought books without end, and cannot find it. The radius of the link is usually taken from the centre of the shaft—which most people know; but how do you find out where to connect the eccentric rods on to the link? For instance, you can make the link any length; but you only want your block to travel so far, so that it will not move the valve more than the required distance. For instance, you might connect them at A B or C D, and C D would be too much, and A B too little. How do you find this out? or could you give a simple method for finding same? What size are receivers generally made in compound engines? What is the rule? or how can you find the area? How much greater should the area of your receiver be to the area of your cylinder?—Practical.







[75945.]—**To Mr. Bottone.**—I have been trying to make a small dynamo to the instructions given in your book; but there must be something wrong with it. When it is connected with the galvanometer, and I begin to turn, the needle reflects a little; but if I go on turning, it goes back to its first position. The insulation is good, and the brushes seem to be all right. I have 7lb. of No. 16 c.c. wire on the field-magnets, but owing to the armature being turned rather small, I have only got 6oz. of No. 20 s.c. wire on it. Is the fault in having too much wire on the field-magnets in proportion with that on the armature? Any information I shall be pleased to receive to help me out of my difficulty.—A. Swallow.

[75946.]—**Vacuum Tubes.**—To "E. E. B.," Leicester.—Would the above gentleman, if still a reader, give a few practical details as to the construction of vacuum tubes? I think he promised to do so at the completion of his articles on the manufacture of Sprengel pumps in No. 1299.—H. G. D.

[75947.]—**Dynamo for Small Accumulator.**—Shall be glad to have dimensions of a small dynamo to charge a 4-volt accumulator for pocket, and to be driven by small motor from water service. Simplex shape. Is it necessary to use a Gramme armature? Say sizes and quantities of wire, please.—Accumulator.

[75948.]—**Skeleton Leaves.**—Can any correspondent give a precise and reliable process by which skeletons of delicate leaves, and also of hard seed-vessels, can be made? In case any solutions are required, please give correct proportions.—999.

[75949.]—**Gas Engine.**—Can I add tube firing and compression on a Turner vertical gas-engine, which has slide-valves, allowing the latter to remain for admission and exhaust? Some practical hints will oblige.—Enquirer.

[75950.]—**Greenhouse.**—Instructions for heating greenhouse, 12ft. by 6ft., with hot-air or water pipes, with illustrations for fitting up the same, will greatly oblige.—Baker.

[75951.]—**To Mr. Thos. Fletcher.**—Will Mr. Fletcher be so good as to say how much air 16c.p. coal gas will take to make a smokeless flame, as in Bunsen burner, and what are the relative heating powers of gas so diluted and Dowson water-gas, and oblige—C. D.

[75952.]—**To "F.R.A.S."**—On page iii., for each month, in *Nautical Almanac*, is given the log. of radius vector of the earth. How can I get sun's distance from this? The characteristic of the log. suddenly changes from 0 to 9,—in October, for instance. Also, how can I get exactly the sine. of 8 848"? The rule says, after other things, subtract ½ of its log. secant. But in Chambers' Tables there is no log. sec. below 1 minute.—Alcyone.

[75953.]—**Turning Commutator.**—Will someone tell me what is the proper speed and shape of tool to insure a good job? It is a 3¼in., 60 segment mica insulation.—Apprentice.

[75954.]—**Blueing Small Steel Articles.**—What is the best way to "blue" small steel articles, such as galvanometer needles, screws, one or two at a time?—Apprentice.

[75955.]—**"Greater Britain" Loco.**—I read with great interest the short article on the L. and N. W. engine, "Greater Britain," and should like to ask your correspondent, "North-Western" if he will kindly furnish me with a sketch of the engine?—C. S. Lake.

[75956.]—**Electro-Magnet.**—I wish to make an electro-magnet, with ¼in. core, 2in. long. How much wire, and of what gauge, should I use to exert an attractive force of 1lb. on an armature 3-16in. distant? Also, what cell power is required; it being assumed that the power has to be exerted once an hour over a circuit of two miles?—Noved.

[75957.]—**Water-Gas.**—Would some of your readers kindly tell me why it is that steam, in passing through incandescent coke, soon reduces the temperature, while atmospheric air tends to raise the temperature? Theoretically, it appears to me that water vapour, containing a larger proportion of oxygen and being at a higher temperature than air, ought to raise the temperature instead of reducing it; but no doubt there is a weak point in my theory somewhere. Wishing to obtain water-gas on a very small scale, I should like to know how small a weight of coke will decompose water-vapour? If I were to construct a very small model apparatus on the usual lines, could I produce with it water-gas in small quantities?—Ignoramus.

[75958.]—**Pianofortes.**—I am desirous of procuring the smallest made instrument, and should be obliged if anyone could tell me whether four-octave pianos are made by any of our best makers? I observe that the writer of letter 32922 calls 6¾ octave pianos "toy" instruments, and regards even one note less than seven full octaves as an injury. But, except for concerts or professional reasons, who really requires such great instruments? In ordinary home music, who wants even a six-octave piano How seldom are the lowest and the highest octave ever made use of. In cutting off, in this way, an octave from the extreme base and another from the extreme treble, we still have left all that is essential—the middle four or five octaves, and get a much more conveniently-sized instrument.—S.

[75959.]—**Telescope.**—Will any readers give me their opinion on my telescope? I find on focussing a sunspot in the centre of field, when it gets to the edge it is slightly out of focus, but can be focussed clear there, but then is wrong in centre again. Is this in eyepiece or o.g.? On watching a star it seems sometimes round, and then suddenly, especially when approaching the edge, it seems to blaze like a firework, the centre apparently spinning round with various colours. Is this the air? for I live in centre of a town, and of course have to observe over chimneys; but I observe same later when some of the fires must be out. Will any town observer give me any hints? I may add that when definition is momentarily good I can see Rigel double, but fail with Vega. My instrument is 4½in., and named Cooke and Sons, York. Are they, or were they, good makers? Is there anywhere where I could get the o g. tested?—Cornwall.

[75960.]—**Saturday Moons and the Weather.**—Will "F.R.A.S." or other able correspondent kindly tell me on what dates during the last 40 years there has occurred what is called the Saturday moon—viz., a moon that begins quarters and ends on a Saturday? And, also, can anyone give me any information as to the state of weather during such periods—rough, fine, or otherwise?—Bob, Torquay.

[75961.]—**Electric Lighting.**—I require about 30c.p. light. Would it be better to have, say, a 60c.p. dynamo and run at less speed, than to have a 30c.p. dynamo and run at full speed? Which would be best—to have three lamps 10c.p., or six lamps 5c.p.? My idea is to light two rooms—one with 20c.p. light, and one with 10c.p. light.—J. H., Newcastle.

[75962.]—**Regulating Damper.**—I require to pass a material at a uniform speed through a liquid solution, and wind it on a spindle driven by the engine, but find that as the material increases on the spindle, thus increasing the diameter at each revolution, I am pulling the material faster and faster through the solution. How can I regulate the driving power, so as to obtain a uniform speed through the solution?—Puzzled.

[75963.]—**Power of Engine.**—Could any readers give me the power developed by a small compound engine (tandem inverted cylinder)? High-pressure cylinder 1¼in. bore, low pressure cylinder 2¼in. bore, stroke 1½in., revolutions 150, pressure of steam 30lb.; exhaust open to atmosphere.—E. Dunn.

[75964.]—**Coating Iron with Brass.**—Having to make a very large number of sheet-metal stamped goods, should like to know whether it would be more economical to make same out of sheet-iron, and afterwards coat them with brass, than to make wholly out of brass? Thickness of metal about 1-25in.; would require a moderately thick coating of brass, as goods would get some handling. I understand that brass may be deposited by electrolysis from a solution of its constituents. If this is correct, should like to know how cost and wear compare with the dipping process? How is the frosted gold appearance on brass goods produced?—One Who Does Not Know.

[75965.]—**Precipitating Gold.**—I have dissolved some 22c. gold in nitro-muriatic acid, but I am stuck how to precipitate it down from the nitro-muriatic solution into chloride of gold. Kindly inform me how this is to be done? I have a good system of electropating in silver, without battery, which will stand for years. I get my chloride of silver by dissolving pure silver in nitric acid, then adding water and salt in strong solution, which precipitates the silver into white flakes.—J. H. F. A.

[75966.]—**Making Sulphate of Ammonia.**—I am working a plant for making the above, and what I want to know is, just before my salt is ready to fish out from my saturator, it is what I call in a "soapy" state. When it is like this, ought I to get them out, or leave them in until they dry (this I do now)? I am under the impression that, when the salt is in the former state, it contains more acid than when in the latter. Am I right in believing this to be the case?—Foreman.

[75967.]—**Strength of Electro-Magnets.**—Would Mr. Bottone, or others, kindly give me sizes of reels and cores of magnets, together with the gauge of wire, to wind them with, to lift the following weights a height of ½in.: 1½lb., 3½lb., 7lb., and 14lb. I would like to know the rule to work out the above particulars myself?—J. R. B.

[75968.]—**Softening Bladder.**—Will someone kindly say how I can render an ordinary bladder permanently soft? Have tried water and olive oil, but they only produce temporary softness.—Hyban Brewsey.

[75969.]—**Hydrochloric Acid.**—In using the formula for this acid in an equation, should it not be H_3ClO, i.e., $HCl_1 + H_2O$, like that for sulphuric acid, viz.: H_2SO_4, as in an anhydrous condition it is destitute of acid properties like SO_3.—Hyban Brewsey.

[75970.]—**Repairing Engine.**—I have bought an old engine to work lathe at home. I find she wants some little repairs, including new eccentric sheave and rod. Will some reader answer how large do I want the sheave, and what distance must centre of shaft be from inside straps on small side, the ports being ¾in., exhaust 1in.; and after having set the sheave how to get the right length of rod? Please tell me how this scale is worked?—Eccentric.

[75971.]—**Arc Lights.**—Will some of your experienced readers kindly give me their assistance in the solution of the following? Can arc lamps be run off a Crompton compound-wound machine? If so, how many lamps and what candle power will be required to light a workshop 140ft. by 40ft., the lamps 12ft. from the ground? How many 16c.p. incandescent lamps as regards current are equal to 1 arc lamp, as my machine is a 900-light one, and I have 820 lamps now on?—Commutator.

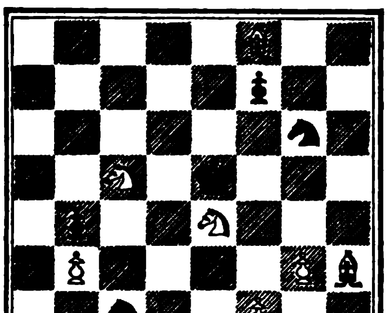
[75972.]—**Accumulators.**—To Mr. Bottone.—I have four different sizes of accumulators, and want to ascertain the storage capacity in each case. They are single cells, with E.P.S. plates:—A, 5 5-12in. by 7 5-12in.; B, 3¾in. by 2¾in.; C, 3¼in. by 4¾in.; D, 3¾in. by 3¾in. Any information will oblige.—Storage.

CHESS.

All communications for this column to be sent to the Chess Editor, at the office, 332, Strand.

PROBLEM MCCLXXXII.—By A. Fellows.

Black.



White.

White to play and mate in two moves.

Solution to 1280.

White.	*Black.*
1. K to Q 7.	1. Any move.
2. Mates accordingly.	

NOTICES TO CORRESPONDENTS.

Correct solutions to 1280 by Alex. Anderson; to 1279 by W. T. Hurley, W. L. Martin, A. Andersen, R. W. Houghton, C. S. Bright, A. Fellows.

T. A. Wallis.—1280 cannot be solved by 1 R to Q 6.

John Johnston.—You have been credited with two solutions to 1277. The tourney ended with Problem No. 1277.

F. L. Wardale.—In 1280, after 1 Q to Q 7, Black replies P to R 4 and escapes.

C. S. Bright.—Glad to hear you will compete in new solving tourney, which commences with the above problem, and will last for 13 weeks.

. By an oversight, Mr. Billington's solution to 1272 was omitted. His score should be 63, which entitles him to the first prize; Mr. Johnston (60) comes second; and Mr. Jay (58) third; the others are as given last week.

. The new tourney commences with this week's problem. All solvers may compete without entrance fee. Same conditions as the last. Solutions must be received within the fortnight, except from abroad. The prizes offered are:—1, Greenwell's "Chess Exemplified"; 2, Pierce's "Chess Problems and Supplement"; 3, Baxter's "Chess Problems"; 4, Rayner's "Two-move Chess Problems." The above are only offered provided, at least, twelve compete. The same rules as to scoring, &c., as in the previous tourney—that is, for two-movers, two marks; three-movers, five marks; if duals in the latter, two marks for each dual, three for triplets, &c.; for second solution, two marks. A problem, if impossible of solution, is cancelled from Solution Competition. Key moves need only be given—except in three-movers where there are duals, &c., when these must be given fully. The tourney will last thirteen weeks.

. We also offer for the best original two-mover which shall be published during the Solution Tourney, a copy of "Pierce Gambit, Papers and Problems"; and for the best original three-mover a paper-bound copy of "English Chess Problems," provided not less than five three-movers are sent in and published. Solvers are invited to pass short criticisms on each problem.

ANSWERS TO CORRESPONDENTS.

. *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

. Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, November 25, and unacknowledged elsewhere:—

W. Hughes.—*Liverpool Weekly Mercury.*—Experiment.—S. J.—Clock.—W. B.—Eight Years' Reader.—C. C. E.—Difficulty.—Apprentice.—W. B. M.—San Franciscus.—J. H. N.—Jas. Johnstone.—T. R. D.—O. J. L.—Aston.—Alltfab.—Kensington.—H. O'B.—H. C. B.—W. H. Milligan.—A. E. B.—Reeds.—W. C.—J. W.—Northwards.—An Old Reader.—R. J. Jackson.—A. S. L.—J. H. Trusscott.—N. D. La Touche.—A. D. Southam.

Derby. (It has been stated many times that to melt indiarubber is to spoil it, especially if melted in a ladle over an ordinary fire. You do not say whether the rubber is pure or vulcanised, nor whether you want the plugs of vulcanised rubber. The process is to masticate the rubber and mix it with sulphur, and when well kneaded it is put into a flask or mould of the required shape, and placed in a vulcaniser, where it is "cooked" for some time. As you want a few only, it will probably be cheaper to cut them; but any of the indiarubber workers will make them cheaply if a model is sent.)—R. B. (Mitchell's "Manual of Practical Assaying," edited by W. Crookes, and published by Longmans, 31s. 6d., is an excellent work of its kind; but possibly Phillips's "Assayer's and Explorer's Companion," Trübner, 21s., would suit the purpose better. Metallurgy is generally treated apart from assaying. Phillips's "Elements of Metallurgy," Griffin, 34s., is a practical treatise on extracting metals.)—Improver. ("The Safe Use of Steam," Lockwood and Son, Stationers' Hall-court, E.C., 6d., will be of much assistance; but as to the methods of making joints, cleaning, and looking after it generally, you must obtain practical instruction. If you sent queries on special points, no doubt readers would help you.)—Perplexed. (If you have a work on algebra, it probably explains its purpose in the preface. The same remark applies to "Euclid."—Indicatorr. (There is the float, which can be so arranged as to operate an alarm whistle when the water gets low.)—Mechanic. (We must refer you to details already given in back volumes, or to experts who will give the information for a small fee on receipt of details of the measurement and quality of the castings.)—C. B. (For dry batteries, see the indices of back volumes and p. 255, May 12 last, and p. 556, Aug. 14 last.)—Sub. from No. 1. (All sorts of dynamos have been described in back volumes—including the best. Why not make one of those, instead of experimenting with a pattern which will certainly not give better results?)—Loco No. 3. (Full descriptions of the different brakes have been published several times, and can be found in various books—such as Stretton's "Safe Railway Working," and descriptive pamphlets issued by the brake companies. If by "Metropolitan" you mean the underground line, several brakes are used on it. The hand brakes can be applied separately.)—Handicapped. (Essence of lemon is made by mixing the oil in eight times its bulk of the purest rectified spirit, adding some clean-cut rind of fresh lemons, and digesting for a couple of days. Then it must be carefully filtered, and kept in stoppered bottles.)—Utility. (No gas-engine—or any other engine, for that matter—will go long "for four days without requiring attention." Our experience of gas-engines is that they require rather more attention of the two than steam-engines; but there are, of course, many advantages in their use. The best oil, we find, is that sold by the United Asbestos Co., Dock House, Billiter-street, E.C.)—W. P. (Either through the joints being what is known as double, or from an absence of the synovial fluid, or lubricant between the rubbing surfaces.)—Anxious. (Ordinary kerosene or burning oil will do; but Messrs. Jones and Co., Viaduct-street, E., advertise in the Sale Column pure spirits of petroleum expressly for use on the hair. Rub it in with the hands, or with a piece of rag.)—Provisional. (The patent rests with the applicant who is prior in date; but he cannot recover any damages for infringements made during the time which elapses between Application and the Sealing of the Patent. If there is any reason to suspect infringement, better procure the Seal at once, or there may be a case to fight in the courts. Besides the Rules, you should procure the Act.)—Workman. (You can see the specifications at the Patent Office Library, and all necessary forms can be obtained at law stationers. The answers to your questions have been given many times. It is exactly in "drawing up their own specifications" that so many fail. It is of great importance to have the "claim" clearly and definitely stated. An agent, from his experience, knows just how far to go.)—N. M. D. (A little vinegar and water will probably remove the hard ink from the rubber stamps. They should be cleaned periodically.)—Gamma. (Cottam's Star Atlas, or "Charts of the Constellations," is about the best, and the smaller size will probably suit you. But what is meant by a "beginner," and what sort of a telescope have you? It is published by Stanford, Cockspur-street, Charing Cross. Perhaps one of Proctor's Atlases, published by Longmans, would do; or Peck's "Constellations, and How to Find Them," published by A. E. Peck, Edinburgh.)—Organettes. (The methods of producing tune-bands for musical instruments was described by Mr. Wenham in Vol. XXXIX. For cutting perforated strips for organettes, see p. 474, Feb. 1, 1884. Unless something very special is required, it is cheaper to buy than to cut for oneself.)—Plumm. (If you have been a reader for so many years, you must know that the question has been answered many times. Any of our advertisers who deal in electrical goods can supply you with magnets.)—M. A. (We have an idea that we answered you not long ago. The process consists in the removal of the carbonate of lime by precipitating it in tanks, which is accomplished by adding cream of lime. It has been described many times, and is known as Clarke's process. We think you can see the process at work on a large scale at Canterbury. The water from the main supply must be pumped into a tank, and the carbonate of lime precipitated. When that is effected, the water can be pumped into a service cistern, and the deposit can be cleared out of the tank.)—Porcelain. (They are trade marks. Mrs. Palliser's "China Collector's Pocket Companion" might give the mark, as it contains more than 1,100 illustrations of marks and monograms. It is published by Sampson Low and Co., Fetter-lane, E.C.)—Doubtful Batt. (Whatever your cells may be, they cannot be so suitable for the proposed work as chromic-acid cells. They seem to have been experimental cells, judging by the brass tubes.)—Jan. (Show it to an expert in precious stones.)—M. W. Stevens. (Write Barrows and Co., Banbury, and say the *Building News* suggested you should do so. They generally have second-hand machinery of the kind you inquire for on hand.)—Consumptive. (All such remedies are delusions. Read the Medical Column in the *Weekly Times and Echo*, and you will get well without quacking yourself. Fresh air night and day, moderate exercise, and proper food will do all that is wanted.)—E. A. W. (Enough said already!)—A. D. L., G. G. B., Far Away, E. F. (In type.)

Important to Invalids.—Thousands of people have, by wearing Harness' Electropathic Belt, been completely cured of nervous exhaustion, impaired vitality, rheumatism, gout, sciatica, liver and kidney diseases, ladies' ailments, &c. Copies of testimonials, pamphlet, and consultation free on application to the Medical Battery Company, Limited, 52, Oxford-street, London, W. (corner of Rathbone-place).

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OUR EXCHANGE COLUMN.

The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.

Wanted, to exchange small Donkey Pump, with ⅜in. ram, suitable for small boiler, for smallest size inspirator.—PRICE, Hampton Wick.

Telescope, Equatorial, 6in. aperture, by Sir Howard Grubb, finder, silver circles, driving clock, position circle, slow motions, six eyepieces, illumination, micrometer, photometer. Exchange offers.—Below.

Telescope, Equatorial, 5in. aperture, by Cooke of York, finder, prismatic, illumination, silver circles, slow motions, driving clock, five eyepieces, and accessories, complete. Exchange offers.—Below.

Telescope, Equatorial, 4½in. aperture, by Alvan Clark, equatorially mounted by Cooke, finder, gunmetal circles, verniers, and microscopes, slow motions, four eyepieces. Exchange offers.—Below.

Telescope, Equatorial, 6½in. reflector, by Horne and Thornthwaite, London, hour and declination circles, slow motions, clamps, finder, six eyepieces, Barlows, solar, diagonal, &c.—Below.

Telescope, 3in., refractor, Unifiler Micrometer, by Grubb; Wedge Photometer, by Hilger, 8½o g., Electric Hand Lamp, two Cameras, pair Telephones, Astronomical Diagrams.—Below.

Microscope, Binocular, large, by Crouch, magnificent instrument; also Monocular by Powell and Lealand. Exchange offers.—Apply Box 20, Post Office, Liversedge. List 3 stamps.

Printing Press, prints 9in. by 15in., cost £12. No use to owner. Exchange to value of 40s.—W. GORNALL, Damside, Pilling, Garstang.

Eight-day English Clock Movement, one or two wanted, any condition, with or without cases. Good exchange.—Write JOHN SAYER, Mechanic, Bowes, Darlington.

Wanted, good half or whole-plate Camera Lens, and dark slides, also accessories. Approval for electrical exchange.—WOOD, Vinyards, Chelmsford.

New Ediswan Lamps, brass holders, switches, roses, brackets, bought for cash or exchanged.—BOWRON.

Any kind of small Electric Apparatus bought.—G. BOWRON, 93, Praed-street, London, W.

"Encyclopædia Britannica," 20 vols., "Popular Encyclopædia," 14 vols. Exchange for Books on Electricity or Mechanics.—JOHN COLLIER, Leamington.

Splendid Horizontal Engine, 2½ bore, 4in. stroke, metallic ring piston, all bright. Exchange for small slide Lathe. Particulars stamp.—MILES, 89, Gresham-street, Leicester.

Wanted, good 3in. Leg Vice, large bench vice, or offer, for a few good TOOLS, &c., to value.—CARN, 54, Dieppe-street, West Kensington.

Wanted, Engine and Boiler, about 3in. stroke (or either). Offer SOCIABLE or 54in. Bicycle, both Singer's, grand machines.—Below.

Wanted, either of Above. Many things to offer, and part cash.—H. COUNSELL, Faringdon, Berks.

Wanted, Safety Wheels, any kind. Can give either Violin, Dynamo, Engine, Boiler, Electro-Plating Apparatus, or various other articles.—165, Rock-terrace, Derby-road, Nottingham.

Small Magic Lantern, with 80 pictures, some moving, including man eating rats, &c. Want Gem Air-Gun or offers.—BUTTERWORTH, Tutbury, Staff.

Telescope, 32in. long, with tripod stand; also Violin dated 1620. Exchange Bicycle, Lever Watch, or offers.—WISEMAN, 92, Copenhagen-street, N.

Wanted, good Photo. and Stamp Album, ENGLISH MECHANICS to value in exchange.—Post Office, Lower Ford-street, Coventry.

477 Nos. of "English Mechanic" (914 to date). Exchange for Medical or Shocking Coil, with regulator and bottle battery, complete.—E. COOKE, Abersychan, Mon.

Exchange Cassell's "Work," monthly, up to date, for good ½-plate double-dark Slides or Lens.—B., 28, Blakesley-street, Commercial-road, E.

Splendid 1in. throw Crank and Guides. Anything to value of 5s.—B., 28, Blakesley-street, Commercial-road, E.

Model Horizontal Engine, 1in. bore, 2in. stroke, link reversing gear, splendid worker. Offers wanted.—F. ROBINSON, 67, Agamemnon-road, West Hampstead, N.W.

Model two-cylinder Launch Engine, ¾in. bore, 1in. stroke, link motion, reversing gear. Offers.—As above.

Large Joiner's Cramp, wrought iron, flat thread screw. Several volumes ENGLISH MECHANIC, bound and unbound. Offers.—As above.

Spark Coil, ½in spark and battery, worth 25s. Take anything useful to value. Other electrical goods to barter.—SMITH, 651, Bolton-road, Bradford.

Pair of Lathe Heads, 5in. centre, value 15s., for 10in. Circular Saw, 1in. bore hole, and boring bits.—Below.

Telescope, four-draw, value 10s. 6d., and cash for Tool Chest, about 2ft. 6in. long.—E. HIGGINS, 5, Earl-street, Watford, Herts.

Vertical Engine (launch type) and vertical cross-tube Boiler, s.v. cylinder, 2½in stroke, 1½in. bore, flywheel 8in. diam., engine base 7in. by 3½in., height overall 1ft. 3in., boiler 1ft. 3in. by 7½in. diam., force pump and fittings. Exchange to the value of £5 10s. Also a pair of blocks and Falls, two and three sheaves, with about 140ft. of chain. Wanted, a 6ft built Launch Hulk, or would sell.—C. N. PAGE, 117, Woodgrange-road, Forest Gate, E.

Wanted Crank Shaft, rough or finished, for engine, 3in. stroke, for DISC CRANK. solid on shaft, nearly finished, 1in. throw.—W. GRANT, Battle, Sussex.

Old Violin, bow and case, excellent tone. Want to exchange for Electric Apparatus.—J. BARKER, 17, Clarendon-road, Higher Crumpsall, Manchester.

Vertical Galvanometer, second hand, in good condition, brass framework, steel pivots, ivory bobbins, cost 30s. Offers.—RICHARDSON, 157, Normanton-road, Derby.

Vertical Slide-valve Engine, inch bore, 2in. stroke, iron boiler, 9 by 5½. Exchange. Lathe or Lathe Castings preferred.—Brook Villa, Raunds, Thrapston.

Pair Acme Skates, size 11, no worse than new, cost 4s 6d. Exchange small Cylinder or pair Eccentrics.—C. WILFORD, Ferryhill, Durham.

"Engineering," September, '89—July, '91, complete, supplements, unbound, clean, nearly four volumes. Offers Mechanical, Electrical.—J. ANDERSON, 3, Baffin-street, Dundee.

Lathe, 2½in. centre, stand, treadle drills, chuck; two doz. small Incandescent Lamps. Exchange for sets of Lantern Slides.—Charcoal Works, Bispham-street, Liverpool.

Safety Bicycle, semi-diamond. Wanted, small Gas-engine or Lathe.—H. MARSHALL, Hawthorne-street, Smethwick, W.

I want to exchange four vols. **"Old and New** LONDON," cost 50s., for Parallel Vice, good Violin, or anything useful to mechanic to value 25s.—J. GILES, 44, Boss-street, Horselydown, London, S.E.

For Electric Lighting.—60yds. covered wire, two switches (four and five-way), one wound armature for dynamo.—PAYER, Sunnyside, Endsleigh-road, Ealing Dean.

Wanted, good Lathe, 4½in., back-geared, slide-rest, fitted complete. Give valuable exchange.—CARTWRIGHT, Yeadon, Leeds.

Pair of new Limelight Jets, safety blow throughs, also 6ft. gas bag, good condition. What offers?—SWIGG, 36, Drummond-road, Bermondsey, London.

Set of Model Engine Castings, value 7s. 6d.; Galvanic Battery, complete, as new, value 9s. 6d.; Lever Alarm Timepiece, value 7s. 6d.; Geneva Watch, value 15s. Exchange offers. Particulars, stamp.—HARRIS, East-street, Crediton.

Lathe, 8in. centres, 6ft. iron bed, back-gear, slide-rest, chucks, &c., for wood or metal turning, good as new, cost £30. Wanted, a 3½ Screw-cutting Lathe, or offers. See sale column.—STEVENS, 33, Foster-street, Maidstone.

Dynamo, 60 volt, 8 ampères, fields wound with 28lb. wire, weight about ½-cwt. What offers.—Above.

Halse's Medical Coil, with dial and batteries, cost £10 10s. Camera wanted or offers to value £5.—JNO. SHARPLES, 24, Follywell-street, Blackburn.

½-plate Landscape Camera, a rapid rectilinear lens, rack and pinion adjustment, morocco bellows, brass bound, one double slide. Exchange value 35s.—HALMSHAW, 76, Orchard-street, Bradford.

Amateur's Workshop, with 6ft. lathe, 3ft. 6in. bed, good order, bench, tools. Exchange for Pneumatic or Cushion-tired Safety, or sell.—E. O., 21, Banneston-road, Catford.

½-plate Camera and Dry Plates, Silver Geneva Watch. Will exchange for Carpenters' Tools to value of £1, or offers.—184, Well-street, Birmingham.

Horizontal Engine, 1in. bore, 2in. stroke, parallel bars, and balanced crank. Offers wanted in boilers.—A. BELL, 6, Benson-street, Linthorpe, Middlesboro.

Brass lever Safety Valve, suit ½-horse-boiler, beautiful pattern; also ½in. Bell Steam Whistle. Exchange lot.—HALMSHAW, 76, Orchard-street, Bradford.

Pair of Bell Telephones, wood cases, good speakers. Exchange for good Vibrating Bell, about 3in. dia.—JAMES COXON, Hairdresser, Cheadle, Staffordshire.

Tin Canisters, half-gross, clean, 3 by 6½ high. Exchange for anything useful.—SMITH, Bowling Green-row, Woolwich.

Cylinder, 11in. stroke, 3½ bore, turned and bored; eccentric and connecting rod for same. Exchange small Force Pump or offers.—GOSNAY, Park-street, Horbury, near Wakefield.

New Grindstone, 1ft. diameter, with trough, mounted on large treadle sewing-machine stand, with flywheel. Exchange value £1, worth 50s.—Below.

New Fishing Rod, four sockets. Offers.—A. KING, Engineer, Sheerness.

Piano Wanted, in exchange for handsome **Safety** BICYCLE, balls throughout, latest improvements, nearly new, faultless. Will give cash. Maker's warranty.—111, South-street, Greenwich.

Air Gun, in good condition, with slugs and darts, Quackenbush make; cost 48s. What offers? Small lockstitch Sewing Machine preferred.—HENRY EBBAGE, Framlingham, Suffolk.

A number of **"English Mechanics,"** from March, 1889, to present date; "Model-Engine Making," by J. Pocock; "Practical Mechanics," by J. Perry, M.E. What offers in exchange?—T. A. PERKINS, Church-street, Whittlesea.

Good powerful-toned double bass **Banjo,** quite complete, very attractive, being nearly 2ft. across the hoop. What offers?—STEEL, 74, Goldstone-road, Hove, Brighton.

Eight-cell Bichromate Battery. Also 5c.p. Lamp. Exchange for Foot Bellows. "Sprague's Electricity," or offers.—HARRY MALE, 36, Dunstan's-road, East Dulwich.

Wanted, Bench Lathe (small), back-geared, with slide-rest. Will exchange 5-string BANJO, new, cost six guineas, splendid instrument. Approval.—BENNETT, Moreton, Dorchester.

"Bourne on the Steam-Engine," Watts' "Elec. Metallurgy," Barry's "Railway Appliances," "Amateur Mechanics," Vol I. Wanted, two Electric Bells, complete, or ENGLISH MECHANICS, or any books.—J. W. DEAR, Baldock.

Horizontal Engine, ¾ bore, 1in. stroke, copper boiler. Exchange for Fret Machine, complete.—JAMES UNDERWOOD, Leighton Buzzard.

I will exchange 16c.p. Ediswan Lamp and 5c.p. Lamp, quite new, for ¼-plate detective Lens or anything useful.—CLYDE, Eglinton Lodge, Eglinton-road, Plumstead, Kent.

Lathes and all kinds of Machinery bought, sold, and taken in exchange.—S. SMITH, 3, West-street, Soho, W.C.

Piano, Broadwood Grand Trichord. Also Ariston Organette and tunes. Offers.—STUART, 39, Russell-square, W.C.

"English Mechanic," 1842, Vol. LII., to date, unbound; 50 numbers "Work" to date. Exchange Mechanical Textbooks or offers.—F. DAVISWORTH, 60, Ellerby-lane, Leeds.

Hand Force Pump, gunmetal, good condition. Exchange Brass Instruments.—WILLIAMS, 107, Great Dover-street, London, S.E.

Zither, splendid tone, silver machine head beautifully carved, ivory sound hole. Exchange to value £5, Brass Instruments.—WILLIAMS, 107, Great Dover-street, London, S.E.

Upright Brass Pump, fixed between two ornamental iron standards, 6in. stroke, 2½ cylinder, has a 14in. flywheel. Offer as part exchange for 4½in. Slide-rest or centring chuck. Letters to—W. H. F., 4, Vine Cottages, Acton, Middlesex.

THE SIXPENNY SALE COLUMN.

Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.

New Illustrated Price List of Screws, Bolts and NUTS for Model Work, drawn to actual size, sent on receipt of stamp.—MORRIS COHEN, 132, Kirkgate, Leeds.

Millar's Electric Depot, 14, Deansgate, Manchester.—Best of everything electrical. Large stock. Low prices Catalogues 3d

Wheel-cutting and Dividing to 12 inches diameter, in brass only.—CASSO, Belinda-street, Hunslet, Leeds

Manchester Electrical Stores.—BENTLEY and Co., 17, Newton-street. Bells, Cells, Wires, Fittings. Best and cheapest

"Heat is Simply an Overflow from the EARTH." Post 2d.—HUMPHREYS, Cambria-street, King's-road, Fulham.

Geo. F. Chutter, Engineer, Birmingham, oldest established works in the trade. Electro-plating and Polishing Plant.

Dynamos, highest efficiency, vats, fittings, and every requisite for Plating and Polishing all metals. Estimates free.

Mackies, Limited, Sole Manufacturers of Mackie's Patent Spring Pulleys, 70,000 in use. Berks Iron Works, Reading.

Kidney Complaints, stone, gravel, inflammation, Botanic receipt, and full instructions 7 stamps.—BOTANIC, 124, Stockwell-road, S.W.

Brass Name Plate, 9 by 4½in., engraved, 4s. 6d. Any size to order.—GILKES' ENGRAVING WORKS, Reading.

Brass Window Plate Manufacturer.—Any shape or style engraved, complete. Lowest prices.—GILKES' ENGRAVING WORKS, Reading.

Stencil Plates for sack, box, and ticket marking. Brushes and inks.—GILKES' ENGRAVING WORKS, Reading.

Tam o' Shanter Hones.—Fine, medium, sharp qualities—razor, knife, joiner's—1s. 3d., 1s. 6d., and 2s., according to size, post free. Try these famous hones.—TAM O' SHANTER HONE Co., Dalmore, Stair, Ayrshire.

The "Talmer" does the Best. A perfected hand camera. Pamphlet, 2 stamps.—TALBOT and EAMER, Blackburn.

Cycle Balls, crucible steel, 4s. per gross; large quantities less.—W. GWINNETT and Co., Temple-street, Wolverhampton.

Turning Woods.—Ebony, boxwood, zebra, lignum vitæ, rosewood. 5s. and 10s. parcels assorted.—HARGER BROS., Settle, Yorks.

Fretwork and Carving.—Catalogue of all tools and materials with 1,000 illustrations, 6d.—HARGER BROS., Settle.

Repousse, leather, picture framing, and burntwood work. List of tools and materials free.—HARGER BROS., Settle.

Write for King, Mendham, and Co.'s (Bristol) new ILLUSTRATED CATALOGUE, 6d. Acknowledged to be invaluable to amateurs. See front page.

"The Wimshurst Machine," by W. P. Mendham, gives theory of action and many experiments. Post free, 1½d.—KING, MENDHAM, and Co.

Telephones and parts of same, and Carbon Transmitters.—KING, MENDHAM, and Co., Bristol (see front page).

Dynamo Wire, best quality, double cotton-covered. Sample 1d.—F. E. HOLLOWAY, 35, Summerfield crescent, Birmingham.

Oculist's Prescriptions accurately executed. Spectacles from 1s. per pair.—NORMAN, 178, City-road. Established 1846.

Malleable Iron Castings by our new process. Clean, sound, and strong as steel.—DRONFIELD CASTING COMPANY, Sheffield.

Astronomical Telescopes, Apparatus, Stands, Racks, Finders, made to order.—CLARKSON, 28, Bartlett's-buildings, Holborn-circus, London.

Astronomical Eyepieces, any power, 15s. each. Barlow lens to increase power of eyepieces, 20s.—CLARKSON.

Astronomical Telescope, 3in. Solomon, on table stand. 75s., another 85s., equatorial 75s., revolving diagonal, £3.—CLARKSON.

Cooke (York) Combined Diagonal, forming either sun or star diagonal, new, 35s., cost 55s.—CLARKSON.

Dollond's 3in. Astronomical Telescope, finest quality, with finder, on stand, and three eyepieces, £12 10s.—CLARKSON.

Troughton and Simms' grand Transit, Silver Circles, new condition, £15, cost £45, adjusted by them.—CLARKSON.

Equatorial Reflector, 9½in.. Calver was paid £60 for it, complete, with slow motions, £25.—CLARKSON.

Astronomical Telescopes.—Several second-hand Telescopes of various sizes.—CLARKSON, 28, Bartlett's-buildings, Holborn-circus, London.

Theodolites and Levels, by Troughton and Simms and others, for sale. Some lent on hire.—CLARKSON.

Microscopes, binocular and student's, several by Beck, Ross, Crouch; also objectives and apparatus.—CLARKSON.

Monograms, two-letter, 9d. per doz.; also a Typewriter for 10s. 6d.—PENNINGTON, Fountain-street, Bradford.

Electric Pushes, Bells, and Appliances Manufacturers.—F. E. EMERSON, 46, Maplin-street, Mile-end, London, E.

Fretworkers, before ordering elsewhere, should send one stamp for illustrated catalogue of wood and miscellaneous tools.—CONTINENTAL TOOL DEPOT, 7, Bull Ring, Birmingham.

Mica (Talc) for all purposes.—F. WIGGINS and Sons, 10, Tower Hill, and 102, Minories, London.

"Practical Dynamo Building: How to WIND FOR ANY OUTPUT," by Frederick Walker. Illustrated. Second edition. 2s., postage 1½d.—ILIFFE, 3, St. Bride-street, E.C.

"Tables and Memoranda for Electrical ENGINEERS," by Frederick Walker. Illustrated. Interleaved white paper for notes. 2s., postage 1d.—ILIFFE, 3, St. Bride-street, E.C.

Printing Presses and Type, complete, from 10s. Quick, simple, and very useful.—ADAMS BROTHERS, Daventry.

Cheap Rubber Stamps.—Full name, 1s.; Address, 1s. 6d. Warranted best work.—WHITE, 64, Lothian-road, Brixton, S.W.

Organ Metal Pipes, voiced or unvoiced, lowest prices.—G. SHIELD, 81, Newton-road, Spark Hill, Birmingham.

Telephone Receivers, double pole, speaks well. Large stock. Buy direct from the makers, and save middle profits.

Carbon Transmitters, unmounted, post free, 2s. Mounted in polished walnut box, with induction coil, &c., 12s. 6d.

Telephone Induction Coils, resistance 150 to 200 ohms, 5s. each. All telephonic stores and sundries in stock.

Electrical Indicators a speciality. Largest stock in the provinces. Bell fitters please note, and obtain samples.

During November, Our Illustrated Catalogue will be posted free on application.—SUNDERLAND and Co., Manufacturing Electricians, Halifax.

Unpublished Trade Recipes.—Profits simply enormous. Nearly 8,000 unsolicited testimonials. Lists, free. STANLEY (Box 1), Billson-street, Poplar, London.

Screws, terminals, and turned parts in large quantities for mechanical and electrical trades. List, trade card.—BUTLER.

Bolts and Nuts for Model Work. Illustrated list, 1d. Large illustrated list, 2,900 varieties, 2d.—BUTLER.

Screws! Screws!! Screws!!!—Special low quotations to large buyers.—BUTLER BROS., Bentham-road, South Hackney, London.

Brass Model Engine Castings—Locomotive, Horizontal, Launch, Beam, Vertical. List 2d.—WOOD, Dalley-street, Broughton, Manchester.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, DECEMBER 4, 1891.

PRACTICAL ELECTRIC-LIGHT FITTING.—X.

By F. C. Allsop.

Author of "Practical Electric-Bell Fitting," "Telephones: their Construction and Fitting," "Electric-Bell Construction," &c.

Cables and Wires.

IN selecting a cable or wire for electric-lighting purposes, we must keep in view the fact that it should fulfil the following conditions. First, the conductor should have a high conductivity, or, in other words, offer but little resistance to the flow of electricity; and, second, the material with which it is covered should possess high insulating properties, durability, flexibility, and mechanical strength.

For the conductor we have but little choice; for copper, either in the form of tape, single wires, or stranded, stands without a rival. Other metals may be cheaper, and one has a higher rate of conductivity, but the resistance of the former, and the heavy price of the latter quite preclude their use.

As regards the material with which it is insulated, we have the choice of three substances—1st, fibrous material such as jute, hemp, or cotton saturated with waxes, resins, or oils; 2nd, guttapercha; and 3rd, indiarubber. The first of these must be rejected (except for use in specially dry situations or for temporary work), since the fibrous material with which the conductor is wrapped or braided are necessarily of so hygroscopic a nature that if exposed to any dampness they rapidly absorb moisture, and thereby lose their insulating properties. It is true, however, that such conductors, during the process of insulating, can be passed through a bath of insulating compound at a temperature above the boiling point of water in order to drive off the moisture, and allow the pores to fill with compound. But to maintain it in this condition it becomes necessary to inclose the conductor in a lead tube, and we have then a conductor with an outside metal sheath, which cannot be recommended for general electric-light work, or, at any rate, for indoor work, or for use with alternating currents.

Turning now to the second insulating material, or guttapercha, we find that if we intend to have a good durable cable this must also be discarded. Guttapercha, at the outset of electric lighting, was very largely employed; but an extended experience has proved that under general conditions it is unsuitable. This is owing to (1) because it will not stand a temperature above 100° Fahr. without becoming soft, and when this occurs the copper conductor, owing to its weight, will de-centre; and (2) because in cold weather, or if placed in dry situations, it becomes brittle and full of innumerable little cracks. In fact, a conductor insulated solely with guttapercha can, it will be found, after having been left some time in a dry place, readily be stripped of its insulation by pulling it between finger and thumb. Since the fibrous material is altogether unsuitable, and guttapercha cannot be relied on except in moist or damp situations, in which places, when taped and tarred, it is fairly durable, we find our choice of insulating material considerably narrowed down—in fact, it only remains for us to inquire whether indiarubber fulfils the required conditions; and, if so, to see what qualities of rubber are the best to use, and how it should be applied to the conductor.

We come, therefore, to indiarubber, and as regards its properties as an insulating material for cables and wires, we cannot do better than to quote the remarks of the Sivertown Company, one of the first to introduce this class of insulation, and whose cables have a world-wide reputation for high insulation and durability:—

Fig. 73.

Fig. 74.

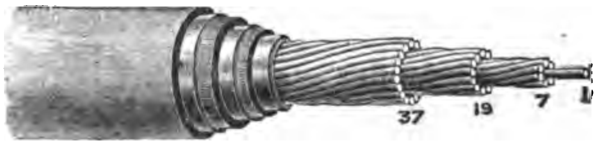


Fig. 75.

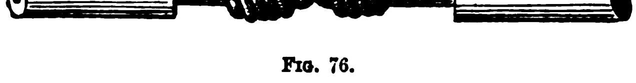


Fig. 76.

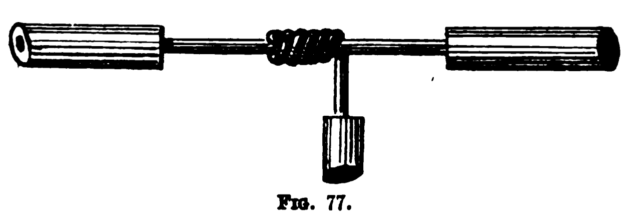


Fig. 77.

"The most important desideratum in an electric-light cable is durability—the power in the material employed of resisting physical or electrical change due to variation of temperature or the presence of moisture, acids, or gases; and after that the higher the insulation the better, so long as it is not obtained at the expense of durability. High insulation by itself is by no means the most important requirement, it being much better to use a material giving a fairly high insulation if that insulation is permanent, coupled with great durability, flexibility, and mechanical strength, than one of higher insulation but less durability. So long as the insulation is high enough to prevent the leakage exceeding a small fraction of 1 per cent. of the total current, any loss from this cause may be ignored; and the actual value of the insulation resistance, if fulfilling this condition, would be of little moment, were it not that the electrical test gives us a valuable indication of the state of the cable itself, any serious drop in the insulation resistance showing that the cable is deteriorating, or that there are faulty joints or connections somewhere in the circuit.

"It will be seen from the remarks made when discussing other classes of insulating material that durability, high insulating properties, flexibility, and mechanical strength are all necessary, and that the material should be homogeneous and waterproof, and capable of withstanding considerable variation of temperature without cracking or softening. All these requirements are fulfilled by a first-class vulcanised rubber. It is important that the rubber employed should be of high quality, as otherwise it will not be so durable. Unfortunately, durability, high quality, and high price all go together, the best rubber and the most carefully collected being that from the district of Para, which is also the most expensive. The high price is, however, only in first cost, as the extra lasting qualities of the cables and the freedom from faults will always repay in the long run the extra cost of a cable insulated with a first-class rubber, carefully mixed and applied to the cable, vulcanised, and tested. When first used for insulating cables, the rubber in an unvulcanised state was cut into strips and wrapped spirally round the conductor, this being the easiest way of applying it, and requiring only very simple machinery. A cable made in this manner is by no means satisfactory, as the covering is not homogeneous or waterproof. The application of a little heat—as, for example, by dipping the cable in hot water—will make the overlapping edges stick together, so that for the time it appears to test well in water; but this very sticking together is the result of the rubber commencing to decompose, and the decomposition, once started, will rapidly increase, especially at high temperatures, and will eventually destroy the rubber, both mechanically and electrically.

"The experience of the rubber manufacturer has, however, shown him a way of treating the rubber, so as to prevent decomposition setting in as the result of the application of heat, unless a very high temperature is used, at the same time rendering the rubber mechanically stronger. This process, which is termed 'vulcanisation,' consists in mixing the rubber with sulphur, and then raising this mixture to a high temperature, which melts the sulphur and causes it to combine with the rubber. The vulcanised rubber so obtained, if made from a high-class rubber like that obtained from Para, carefully mixed and laid on the cable under great pressure by the aid of special machinery, fulfils all the necessary conditions, being durable, flexible, mechanically strong, waterproof, homogeneous, capable of standing a high temperature, and last, though not least, a high-class insulator."

To make a satisfactory and lasting job, therefore, we find that we must employ one

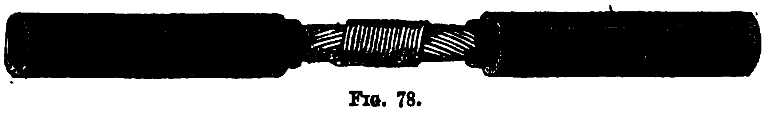


Fig. 78.

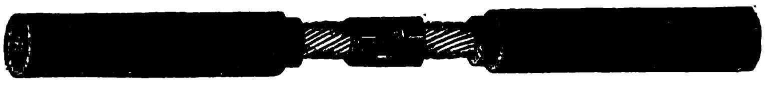


Fig. 79.

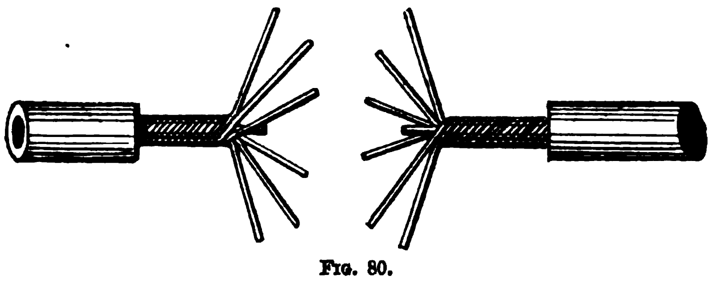


Fig. 80.

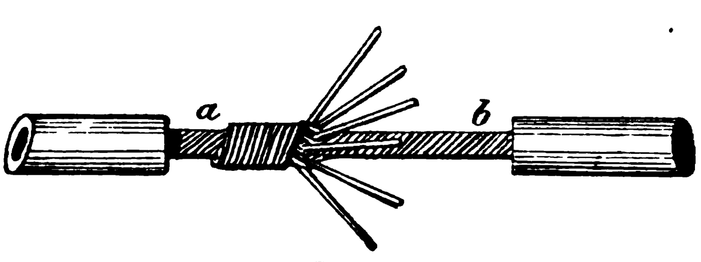


Fig. 81.

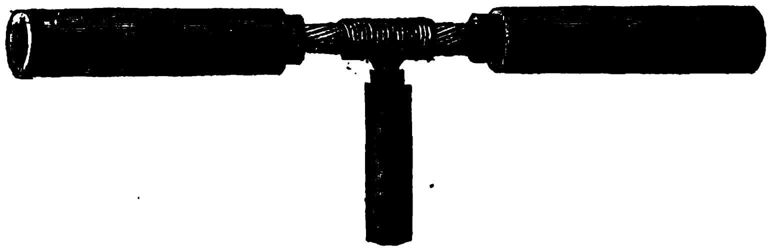


Fig. 82.

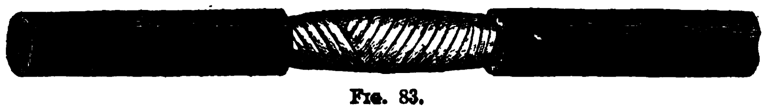


Fig. 83.

of two classes of insulation, either (1) vulcanised indiarubber or (2) pure rubber, this last being only used in dry situations or where cheapness is a great desideratum.

The copper conductor of all the best cables and wires are now supplied ready "tinned," which enables a much better joint to be obtained, and also insures a cleaner connection for the terminals of switches, cut-outs, and distributing boards, where sweating sockets are not employed. For the branch wires a single conductor of No. 22, 20, 18, or 16 B.W.G. is employed; but it is better, and most fire insurance companies insist that a smaller single wire than No. 20 or larger than No. 18 be not employed. If a larger-size wire is required, then a 3/20 or 3/22 should be employed, as these are more flexible and not so likely to snap or crack as a solid wire of large diameter. Cables are made up of a number of wires consisting of 3, 7, 19, 37, or 61 strands of No. 20, 18, 16, or 14 B.W.G., according to the diameter of the conductor required and the number of lamps to be supplied. A branch wire of about No. 14 gauge is shown in Fig. 73, with the covering pared back; while Fig. 74 shows the same wire with the ends frayed, thus showing the different wrappings of insulation. Fig. 75 shows four different-size cables—1, a 7-strand; 2, a 19-strand; 3, a 37-strand; and 4, a 61-strand cable—these different sizes being called 7/16, 19/14, 37/18, or 61/12, according to the gauge of each separate wire and the number of strands.

Proper Size of Conductor for a given Number of Lamps.—Every conductor of electricity offers some resistance to the flow of electricity, and this resistance varies directly as the length of the conductor, and inversely as its sectional area. Thus if a 100ft. of a certain cable has a resistance of 10 ohms, then 200ft. of that same cable would have a resistance of 20 ohms. Also, if a cable of a certain sectional area has a resistance of 10 ohms, then a cable with double that sectional area would only have a resistance of 5 ohms. If we take a conductor with a sectional area of one square inch and send through it a current of 1,000 ampères, we shall have a current density throughout that conductor of 1,000 ampères per square inch. By calculation and experiment it has been found that this current density of 1,000 ampères per square inch is the current density that can safely be employed for copper electric-light conductors, and as a general rule may be taken as a basis for calculating the right size of conductor for a given number of lamps. It is well on the safe side, for, as a matter of fact, a current density of double that amount could be employed without any appreciable rise in the temperature; but other things besides rise of temperature must be taken into account, and the basis of 1,000 ampères per square inch of conductor is the one that most nearly meets these other requirements. To find the proper size cable for a given number of lamps, we first ascertain the total current required by these lamps, and then find out what size of cable will carry that current and not allow the current density to exceed 1,000 ampères per square inch. The following table gives the composition of the insulating covering of th two classes of wire before mentioned, and the safe current and number of lamps th different size cables will carry, so that by glance the correct size cable for any numbe of lamps can at once be ascertained.

Pure Rubber Insulation.			Vulcanised Rubber Insulation.		
150 Meg-ohms.			300 to 600 Meg-ohms.		
Insulated one coat prepared cotton tape, indiarubber, a second coat of prepared tape, braided tarred flax, and coated preservative compound.			Insulated pure indi rubber, then vulcanis indiarubber,indiarub coated tape, and th whole vulcanised t gether, braided, tarre flax, and coated pr servative compound.		
Size of cable. Legal stndrd gauge.	Safe working current at 1,000 amps. per sq.in.	No. of 100-volt 16c.p. lamp.	No. of 100-volt 8c.p. lamps.	No. of 50-volt 16c.p. lamps.	No. of 50-volt 8c.p. lamps.
	Ampères				
22	·6	—	1	—	—
20	1·0	1	2	1	1
18	1·8	2	3	1	2
16	3·2	4	9	2	4
7/22	4·4	6	12	3	6
7/20	7·2	10	20	5	10
7/18	12·8	20	40	10	20
7/16	22·9	33	66	17	33
19/18	34·9	50	100	25	50
19/16	62·4	88	176	44	88
19/14	97·3	145	290	73	145
19/12	164·7	235	470	118	235
37/14	190·7	272	544	136	272
37/12	321·7	460	920	230	460
Approx. current in ampères required per lamp		·7	·35	1·3	·7

Another thing to be taken into consideration in determining the proper size of conductor for a given number of lamps is the distance between the lamps and the source of supply—i.e., the converter, dynamo, or accumulator. For a cable of sufficient size for, say, 100 lamps, with the lamps 100 yards from the source of supply, would require to be considerably increased in size if the distance were 500 yards, owing to the increased resistance. Increase of length means increase of resistance, and increased resistance means a diminution in the brilliancy of the light. This can be overcome by a slight increase in the E.M.F. at the supply end; but even if it can be done, it entails a constant waste of current in the mains, so it is preferable to increase the size of the cables. The necessity of doing this, however, will not frequently happen, as the mains from all the electric supply stations are brought just outside the door, and the converter is usually in the basement of the building, so that for all general house circuits the table will hold good.

Jointing Wires and Cables.

We now come to one of the most important operations in laying the wires, viz., that of joining two conductors, or tapping on branch ones to a main. Too much care cannot be exercised in seeing that every joint, before it is left for finished, is electrically and mechanically perfect. It has several times before been pointed out how a loose or imperfect contact gives rise to resistance, which resistance will manifest itself in heat. A bad or improperly made joint rapidly heats up when the current is turned on, and next to "short circuits" nothing is more likely to be the cause of an electrical fire than bad joints in the conductors. Be careful, therefore, to see that sound, thoroughly well-made joints, and not merely "surface-soldered" ones, are obtained.

As regards the much-disputed question as to whether resin or killed spirits should be used as flux for soldering electric-light wires, there is much to be said on both sides. The fire insurance companies in this country insist that nothing but resin should be used, while the American fire offices just as rigidly insist on the use of spirits. The reason put forward by the Americans for the rejection of resin are not complimentary to the electric-light wireman. They argue, and perhaps not without reason, that only one man in every ten knows how to make a joint with resin, or if they do know, will not take the trouble. The secret of a good joint with resin is a clean surface, resin having no power to remove dirt or grease, whereas spirits exercise a cleaning action on the wire, which insures a good joint being made. The number of wires eaten through by the spirits are so few, that they consider the danger from fire from such causes is considerably less than those from poor joints with resin.

There is certainly much truth in the above remarks, for it is by no means an easy task to make a joint in, say, a 37/12 cable with only resin for a flux, the inside strands getting so dirty from burnt resin, &c., before they have time to get sufficiently hot to take the solder, that it is almost impossible to get a joint that is soldered *right through*. Moreover, if the simple precaution is taken of washing the joint with a little ammonia and water when finished, and afterwards to thoroughly rinse it, there need be no fear of any after-action on the wires. For all wires up to seven strands, however, there is not the slightest difficulty in getting a good soldered joint with resin; but with the larger cables it would, the writer thinks, be advantageous to allow a judicious use of spirits.

Fig. 76 shows the method of joining two single wires. The insulation of each wire must be neatly bared with a knife for about 1½in., care being taken not to nick the wire, and the ends scraped quite bright. They are then twisted together, the one round the other, as shown in the figure, tightened up with the pliers, and carefully soldered.

Fig. 77 shows the method of tapping on a branch wire, the end of the branch wire being twisted round as shown, and soldered.

Joints in stranded conductors or cables can be made in three ways—1st, scarfed; 2nd, with a special clip; and 3rd, spliced—this last being the best, and the one now generally employed. In Fig. 78 is shown the scarf-joint. To make this the ends of the cables are bared for a length of about 4in., the separate strands cleaned, tightened up with the pliers, and carefully soldered together. Then with a file the end of each cable is bevelled off, so that they will meet and form one conductor. Some No. 20 binding wire is now procured, and the ends of the cable being held together by one person, the joint is tightly bound round with wire as shown in the figure, and afterwards soldered. In all joints in stranded conductors care must be taken to see that the joint is thoroughly heated, so that the solder runs right through.

The clip or socket joint is shown in Fig. 79, and is made as follows: The ends of the cable are bared of their insulation, cleaned, tightened up, and the different strands soldered together. A special tinned clip of the form shown in the figure is next procured, the two ends of the cable slipped inside, and the whole soldered together.

The Marion or spliced joint is shown in Figs. 80 and 81, the method joining a 7/16in. cable being shown. It requires a little practice to make it neatly and compact, but when properly made it constitutes a perfect joint, and one that will stand great mechanical strain. The ends of the cable are first prepared as shown in Fig. 80, being bared of their insulation for about 6in. One or two turns are now taken with some binding wire about 3in. from the end, and the strands unwound to this wire, cleaned, and bent out radially. The length of the strands should, when bent out, be double the length of those shown in the figure. The centre wire is then cut out close up to the other wires, and the ends are ready for coming together as shown in Fig. 80. The two ends are then brought together until the centre strands butt, the projecting ends of the one cable passing between those of the other. The ends of cable *b* are then wound round the body of *a*, and the end of *a* round the body of *b*. The joint is then tightened up, soldered, and it is complete. In Fig. 81 the joint is shown half-completed. Fig. 82 shows how one cable is tapped on to another, this joint being called a T-joint. The cable on to which the other is going to be joined is bared of its insulation for about 6in., and the ends of the other are wrapped round as shown in the figure, half being wrapped one way and half the other.

The joints being soldered, the next thing is to insulate them, another operation that requires considerable care. No chain is stronger than its weakest link, and it is little good having a well-insulated cable if the joints are badly insulated. To insulate a joint properly, it should first be roughed over with a file, to make sure there are no projecting points of solder, and the insulation neatly tapered off with a clean knife. We then get ready the materials required, which consist of some pure rubber tape (½in.), a box of indiarubber solution, and some ½in. or ¾in. (according to the size of the joint) prepared tape. A little of the solution is first rubbed over the joint and ends of insulation with the finger, and a foot or so of the rubber tape cut off the roll, which, after being warmed by passing over a spirit-lamp, is wrapped tightly round the joint, one turn overlapping the other, as shown in Fig. 83. Another spread of solution is put on over the rubber tape, which, in turn, is followed by a second layer of rubber tape. After putting on another layer of solution, the joint is finished off with a layer of the prepared tape. With the single wire one layer of rubber tape will generally be found sufficient. When insulating any joint, great care must be taken to see the hands are cleaned and free from any metal filings.

(*To be continued.*)

REVIEWS.

Star Groups: a Student's Guide to the Constellations. By J. Ellard Gore, F.R.A.S., M.R.I.A. London: Crosby Lockwood and Son.

ALTHOUGH this work is intended for the use of students, it is printed in a rather expensive style on thick paper, a leaf being devoted to the description of each constellation, and a leaf to the map itself. All stars to the sixth magnitude are inserted, Flamsteed's numbers being appended to the small stars. In the description of the Constellations some account is given of the more interesting objects in each, while clearly-shaped symbols indicate on the maps the magnitudes of the stars. For clearness, the Milky Way is omitted. Two maps show, on an equal-surface projection, the brightest stars in the Northern and Southern Hemispheres, and, being numbered, serve as a guide to the maps of the Constellations. The stars and their names, or numbers, are in white on a black ground, and there are special symbols to indicate variables and star clusters. The work will be very useful to many, as it does not need instrumental means to understand the Constellations by its aid, though a small binocular is not without its advantages.

Optical Projection. By Lewis Wright. London: Longmans.

We mentioned recently in the "Scientific News" the issue of a second edition of this work, which is a treatise on the Use of the Lantern, by one who has made it a study. All who wish to understand the construction of a lantern, and to form an idea of what can be done with it, will find the required information in this work. Naturally the author starts with the optics of his subject, and points out that it is a mistake to suppose that the image on the screen is formed by the lens, for the power of forming an image really resides in the rays of light which render the object visible. That is the fundamental fact to be grasped before a lucid idea of the principles of optical projection can be mastered, and the full powers of the many ingenious apparatus now available can be utilised by the demonstrator. Mr. Wright explains in detail the parts of a lantern and the various accessories which have been devised for use with different illuminants, as well as the general manipulation of the lantern. A chapter which is of much interest to many is that on the projection microscope, which is followed by others showing the value of optical projection in other branches of science. The volume is freely illustrated, and will undoubtedly be found of much value by demonstrators, lecturers, and others who can find a use for the powers of the optical lantern.

Light. By Sir Henry Trueman Wood, M.A. London: Whittaker and Co.

This work does not pretend to be anything more than an elementary treatise; in fact, the author assumes that the reader is unfamiliar with mathematical methods, and is without any previous knowledge of the subject. His book forms one of a series in a library of popular science: will be useful to the student, and interest the reader who merely wishes for an account of the principal phenomena of light, with explanations of its effects as seen in photography, fluorescence, polarisation, &c. An appendix contains a list of works dealing at greater length with the subject, and will be found of much assistance to the student who wishes to become better acquainted with the science of light.

The Practical Telephone Handbook. By Joseph Poole. London: Whittaker and Co.

Although the author of this work touches briefly on the history of telephones and telephony, it is rather as a manual of practical telephony for those engaged in such work that it will be valued. The various forms of batteries and telephones are described, with illustrations; but it is the details of fitting-up poles, arranging circuits and switch-boards, testing for and locating faults in line wires, with methods of making joints, that will be appreciated—in short, it is a textbook for those who are engaged in, or seeking employment in, the practical department of telephony. The volume is freely illustrated, containing more than two hundred illustrations, many showing the electrical connections of the instruments. Mr. Poole was chief engineer to the late Lancashire and Cheshire Telephone Exchange Co., has had much experience of the defects of lines and apparatus, and gives the best methods of remedying them.

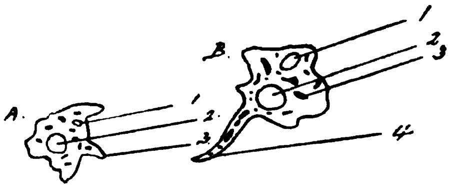
We have also received a new edition (the fourth) of *The Working and Management of* *an Electric Railway*, by George Findlay (London: Whittaker and Co.; George Bell and Sons), a work which has rapidly risen into a prominent place as a readable and, at the same time, authoritative treatise on the working of one of the most important lines in the world. It has been revised and enlarged, and is freely illustrated. —— *Exercises for Technical Instruction in Woodworking*, designed and drawn by H. Jay, arranged by E. R. Kidson (London: Longmans), are three cases containing cards, on which are drawings showing technical details of carpentry, &c., which may be useful to apprentices engaged in the woodworking industries.——*A Village Class for Drawing and Wood Carving*, by Gertrude Martineau (London: Longmans), is really intended as "hints to teachers," and will be found of great service to those teachers who are without special knowledge of the methods employed to train children in the art of drawing.——*The Elements of Coordinate Geometry*, by William Briggs, B.A., and G. H. Bryan, M.A. (London: W. B. Clive and Co.) is one of the "tutorial series" of works issued by the University Correspondence College, and is specially adapted for those students who do not aspire to mathematical honours. The authors have had much experience in preparing students for examinations in the University of London, and have had exceptional opportunities of appreciating the difficulties of beginners: they have therefore set out to assist the student as much as possible, and they have succeeded in producing a work which will be found especially useful to home students. —— *Arithmetical Physics—Magnetism and Electricity*, by C. J. Woodward, B.Sc. (London: Simpkin; Birmingham: Cornish Brothers) is by the Principal, Chemistry and Physics Department, Municipal Technical School, Birmingham, a teacher who puts what he has to say as concisely and clearly as possible.——*A Graduated Course of Natural Science*, by Benjamin Loewy, F.R.A.S. (London: Macmillan), is an experimental and theoretical textbook for use in schools and colleges, with "questions" appended to the chapters.——*Condensed Mechanics*, by W. G. Crawford Hughes, A.M.I.C.E. (London: Crosby Lockwood and Son), is a work dealing concisely with the mechanical principles which underlie engineering work, and as it does not require more than about the first stage of mathematics, it will commend itself to many students. —— *Architectural Perspective*, by F. O. Ferguson (London: Crosby Lockwood and Son), is a practical work for the draughtsman, illustrated by progressive drawings, which will show the novice how to draw the different parts of a large house.——*A First Book of Electricity and Magnetism*, by W. Perren Maycock, M.Inst.C.E. (London: Whittaker and Co.), is, as its title implies, an elementary work; but it contains sufficient for the candidate in the first stageof the examination of the Science and Art Department. ——*Mechanics of Engineering*, by Dr. Julius Weisbach (New York: John Wiley and Sons), is a translation of the second edition of Vol. III. of a textbook which is well known in German technical schools.—— *Notes on Building Construction* (London: Longmans) is Part I. revised and enlarged of the new edition of a work which is recognised as the best textbook on the subject in the English language. Some portions of Part II. have been transferred to this part which forms the first stage or elementary course, and well studied should pass any candidate in the examinations of the Science and Art Department. —— *Electricity*, by Linnæus Cumming, M.A. (London: Longmans), is the third edition, revised, with additions, of a work which found much favour as a schoolbook, for which purpose it is well adapted.——*A First Book of Mechanics*, by the Rev. J. G. Easton, M.A. (London: Cassell and Co.), is stated on the title-page to be "for young beginners," a phrase which may probably mislead some, for the young beginner must have at least a rudimentary knowledge of mathematics; but having that, he will find Mr. Easton's work a very useful stepping-stone to the larger treatises on the subject.

PRACTICAL MICROSCOPY FOR STUDENTS.—IX.

By Frederick Davis, B.Sc.

One of the simplest forms of cell, as a starting point for physiological study, is that known as the Amœba. This organism may be found in mud; the white corpuscles of the blood also resemble this protozoon in a marked degree—in fact, they may be considered identical.

In the case of the yeast-cell previously studied, we found the plant was capable of building up, from its inorganic plasma, organic bodies, that is, proteids; but in the case of the Amœba, we find it is essential to its vitality that these proteids exist ready formed in the plasma in which it lives; its work during life apparently being to split up these proteids, and elaborate them in such a manner that they become available for the purpose of its own nourishment. It may, therefore, be fairly assumed the Amœba may be considered "animal," whilst the "yeast-cell" is vegetable.

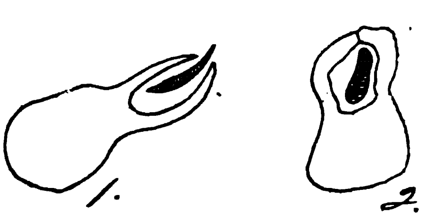


A, Amœba.—1, Vacuole; 2, Nucleus; 3, Pseudopodium.

B.—1, Vacuole; 2, Nucleus; 3, Particles of matter imbedded in substance of Amœba; 4, Pseudopodium.

It is not possible, however, to draw a sharp line of demarcation between these great kingdoms; the fact being that the one kingdom diverges so beautifully into the other that our most eminent biologists would shrink from expressing a definite opinion upon so important a point. It is generally considered that the Desmidæ hold a position intermediate to these kingdoms.

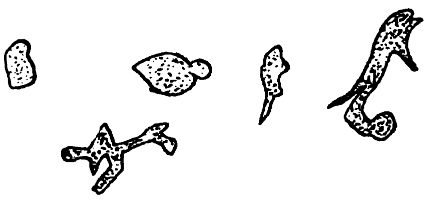
If we examine with the ¼in. objective the curious mass termed the Amœba, we cannot detect the presence of any external wall or sac, as in the yeast-cell; but we find the whole body to be composed of a gelatinous substance in its entirety, and possessed of a nucleus, and sometimes vacuoles. Imbedded in this gelatinous substance we see a large number of little granules, tiny portions of shells or diatoms, and various little masses either undergoing digestion or ready to be thrown off after the nourishment has been extracted from them. The Amœba, floating about in its plasma, and coming in contact with any body containing "proteids" ready formed, will extend a pseudopodium (a kind of leg), and envelop the particle which it intends seizing upon, and drawing the remainder of its body after it, will entirely incase the granule, diatom, or other substance in its gelatinous mass. Here a process of digestion occurs, and when all nourishment available to the Amœba from the granule has taken place, the remaining portion is gradually pushed by the contractile power of the Amœba to its external portion, and expelled. It will be seen from this description, and from observation under the instrument, that this cell or Amœba has neither mouth nor anus, but in each case improvises these necessaries. The student will observe, although there is no external wall or sac, yet the external portion is a little more dense in its character than the internal portion. It will also be seen the vacuoles are filled with a fluid, and when a pseudopodium is extended, if in the vicinity of the vacuole, the fluid contained therein adapts itself to its altered shape. If we pass a slight current of electricity through the plasma containing Amœba, we shall see them contract, and, as it were, shiver, resembling very much the contractility of human muscle when subjected to an electric current. If the current is too severe we shall find the Amœba give one long shiver, and then die. After death, coagulation takes place, and apparently may be compared to the rigor mortis of human beings; but whether the same change takes place is a disputed point, and whether the coagulation in the case of the Amœba is produced by myosin, is not yet definitely known.



1, Amœba swallowing Diatoms; 2, Amœba closed with Diatoms in its substance.

This uncertainty makes us think, with all our knowledge, how little we really know, and, although towering to great heights, yet suddenly we find ourselves dethroned, and compelled to state, in a miserable fashion, that "we don't know," even over a little thing like this. I may mention that myosin is a form of globulin modified syntonin, and is coagulated at about 55° Centigrade. We know that if we heat the Amœba to 50° C., death takes place; it is probable, therefore, that this globulin, namely, myosin, is really the cause of the coagulation.

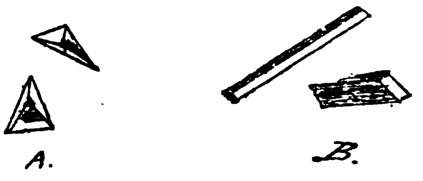
In speaking of the external portion of this jelly-like mass, I stated it appeared to be more dense. This is termed the ectosarc, and the inner portion the endosarc. Later on, in studying other forms of animal life, we shall frequently have occasion to use these terms. They should, therefore, be well understood and borne in mind. For the purpose of proving the whole of the Amœba is chemically the same, let us stain with either iodine or magenta solution: we shall observe the entire mass will be stained throughout, and not, as in the yeast-cell, a part only.



Various Forms of the White Corpuscles of the Blood.

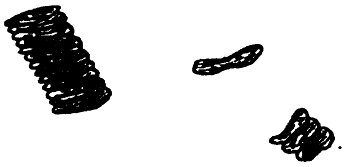
If the student cannot find these organisms in mud, let him prick his finger with a clean, sharp needle (not with a pin), collect the blood upon an ordinary slip, and examine with the ¼in. objective: he will see moving about in the plasma between the red corpuscles a few white corpuscles. For purposes of study these compare favourable with the Amœba obtained from mud. It must be borne in mind, however, they are comparatively few—about one white corpuscle to three hundred red, that is in the healthy subject; but in certain diseases, especially of females, we find their number greatly increased, as in anæmia, leucocythæmia, &c. The white corpuscle is about $\frac{1}{3000}$in. in diameter. Occasionally the Amœba becomes encysted, that is, a kind of case is formed externally; it is then quiescent, and ceases to extend pseudopodia. In reviewing blood we will not treat the subject so much from a physiological point of view as from a microscopical one, although of, course, it is necessary for a right understanding of the latter to know something of the former. We may consider blood to consist of a plasma in which red and white corpuscles are suspended, the plasma is said to consist of serum and fibrin-ferment, paraglobulin, and fibrinogen. Paraglobulin is by some physiologists called fibrinoplastin.

It is these latter, namely, the fibrinogen and paraglobulin in combination which formerly were considered to cause the phenomenon known as coagulation and the formation of fibrine; but the researches of my friend and teacher, the late Dr. Wooldridge, of Guy's Hospital, has modified this view greatly. It is probable, therefore, the phenomena of the coagulation of the blood will shortly be referred to other causes than those mentioned above—namely, to the presence of lecythin. In ordinary human blood placed upon a slide we shall see, during coagulation, the red corpuscles have a tendency to run together, as it were, into a roll, that is face to face, so that they resemble, in a marked degree, piles of coins: these are called rouleaux. In observing an individual red corpuscle, we find it to be about $\frac{1}{3200}$th of an inch in diameter, possessed of no nucleus, doubly concave, and thinner in the centre than at the edges, or, more properly speaking, its periphery.



A, Crystals of Hæmoglobin from Guinea-pig; B, Crystals of Hæmoglobin from Human Blood.

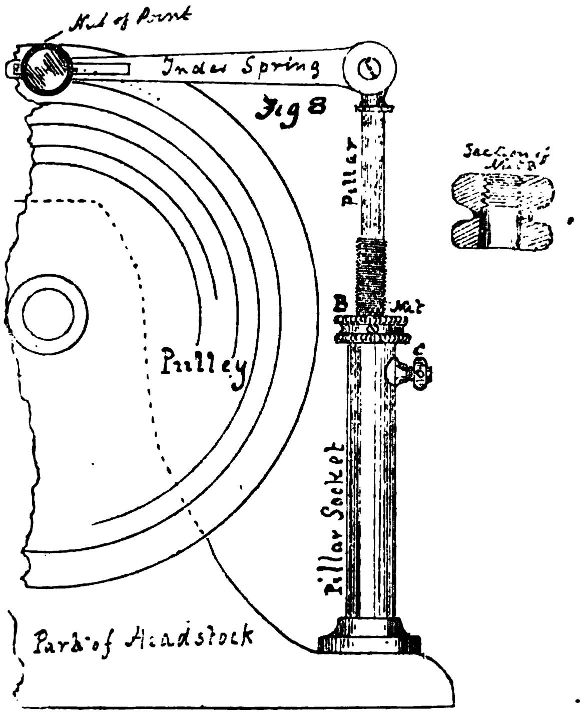
The colour of the red corpuscle is assumed to be produced by a substance termed hæmoglobin, a compound of hæmatin and globulin. This hæmoglobin may be separated, and crystals of hæmatin obtained for purposes of microscopy, by treating the blood of the rat in the manner to be described later on. Of course, the crystals may be obtained from human blood, but the crystals are more easily obtained from rat's blood. Hæmatin appears to the naked eye as a dark brown powder, but when examined with the $\frac{1}{4}$in. objective, we find its true character is crystalline. The figures represent their salient points. It should be remembered, however, according to the animal from which the blood was obtained, so the form of crystal will differ. In the Mammalia their form is generally prismatic. The hæmoglobin may be obtained from rat's blood by placing a drop of the blood upon the slide; allow it to coagulate, then place a drop of water upon it, stir about with a needle, and let a little of the fluid fall upon another slide; in a few minutes, upon evaporation the crystals will fall, and may be examined as described. The student will remember the white corpuscles of the blood are nucleated.

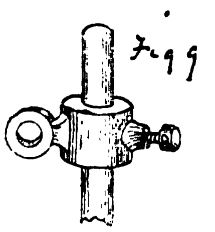


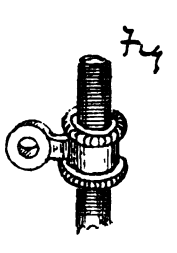
Rouleaux of Red Blood Corpuscles.

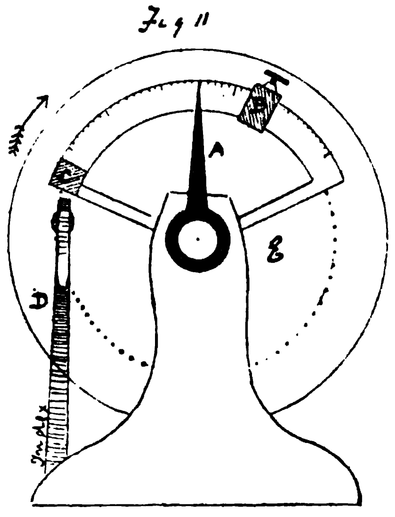
THE LATHE INDEX.

I HAVE drawn here three methods of making an adjustable index pillar, either of which will answer the end in view. I am not supposing the mandrel fitted with tangent screw and segment engine, because that will of itself hold the division-plate securely, irrespective of an addition to the index peg. The first illustrates the plan I spoke of in my last paper. The pillar has upon it a screw-thread, which need not be of very fine pitch, and is raised and lowered by the ferrule B, Fig. 8. A longitudinal slot in this screw into which falls the rounded end of a clamping screw, C, prevents the screw pillar rotating upon its own axis. Fig. 9 reverses Fig. 7, and is still more inexpensive. The socket which receives the tail-pin of the index spring is made to slide upon a turned cylindrical pillar, upon which it can be clamped at any desired height. Fig. 10 shows this modified in a manner similar to the last. A screw is cut upon which the socket piece slides, and the latter is retained at the desired height by two ferrules or nuts, one above and the other below it.









And now let me pass on to a contrivance designed in the first place to help any such blind bat as myself to count the dividing-plate holes; it is, at any rate, a simple aid to that work. At the back of the front standard of the headstock is fixed an arc, or quadrant, supported by two arms, and this is to be painted pure white. At one end, C, it has a block in one piece with it—or a pin;—it is, in fact, merely a fixed stop of some kind. B is another, but this one may be clamped at any part of the arc by a screw. On the mandrel is a pointer, fitted spring-tight, to be easily moved by hand, but still sufficiently tight for the mandrel to carry it round A. It can be fitted at the back, just behind the arc, but it then needs a double bend to bring its end in front of the arc. The hand is to be painted jet black. D is the index spring, represented in its usual place. I should mention that the arc need not exceed, as a rule, the quadrant of a circle, as the apparatus is less needed when a large number of holes are to be passed over at one time. The *modus operandi* is as follows:—Place the index-point D in the zero hole of the circle to be used, i.e., in a hole from which a start is to be made; pull down the hand, or pointer, till it rests against the block, or stop, C. Now move the division-plate the required number of holes, which will carry the hand with it towards the movable stop, and this is to be fixed at the place at which the pointer stops when the given number of holes have been passed over. At each separate count, therefore, the pointer will traverse this space. All that is needed is to pull back the pointer to the block C when the index-point is readjusted and placed in its right hole, and then the moment it is lifted and the division-plate and pulley advanced, the black pointer will be plainly seen moving over the white arc till it reaches its movable but clamped stop. As soon as it just touches this, it will be known that the right hole is reached for the index-point to drop into. The cost of this affair is almost nominal, as it can be made of any available material—even white card for the arc, and tin for the pointer; but at the same time it is better to use brass and steel, as it is never satisfactory to muddle up lathe apparatus which may be often required, and there is no pleasure or satisfaction in it. A lathe, if it is worth anything, is worthy to be fitted up at all points as a bit of precious machinery, which, indeed, it really is; and I would only recommend such materials as cardboard and tin while experimenting. But if it is found on trial that any experimental design bids fair to be successful in practice, then, I say, set to work with really suitable materials, and make a workmanlike job of it at once.

It must be understood that this is not meant to act as a self-acting index, but only as a cheque to the ordinary counting. I may say, moreover, that as I chiefly aimed at visibility, I wanted a black pointer on a white arc, and the original idea was to get an arc bigger than the division plate, that the hand might move over a larger space. Hence I had another notion—viz., to set up a big white clock-face of a thing in front of me, and carry a cord from the lathe pulley over fair-leaders to drive the hand of this tell-tale clock. There is no cord on the lathe pulley while the division plate is in use, and matters could easily be arranged to carry the hand over a larger space on the clock-face than that between the holes passed over on the division plate. Another plan I am about to follow is to attach a magnifier to the index spring by a suitable clip so arranged as to enable me to focus the holes and numbers engraved upon the division plate. No doubt other eyes need some one of such devices, though I know a man of 93 years who has not yet taken to spectacles, and can read with ease even by lamplight. I confess I envy him, and, what is more, I am afraid that the very necessity of peering into division plates does not by any means improve one's sight.

Division plates are indeed a terrible trial in many ways, and if some really simple and *inexpensive* self-acting counter were devised there would undoubtedly be no lack of buyers; but it is a matter by no means easy of solution, as I can state from experience. For many a time and oft I have plodded over it, and when an arrangement has suggested itself offering apparently every advantage in the way of simplicity, it has proved utterly useless when details have been carefully gone into. A ratchet and pawl, for instance, attached to the pointer illustrated, which pointer would thus also become a handle, would pull round the mandrel at each setting; but as there must be as many teeth in the ratchet as holes in the outer circle, since the pawl must at least advance one notch each time, such ratchet cannot be made small enough to fit on at the base of the pointer, and an apparently simple plan cannot be thus arranged. And so it has been with many other designs. Hence I suppose that of Evans remains triumphant. It looks "a lot of it," it is not inexpensive, and so, as usual, the majority of lathe men have still to undergo the tedious process of counting, and to spend many an hour in executing the blind man's puzzle.

P.S.—When I wrote the paper on the above subject, I stated that I was having one attached to my own lathe. I eventually adopted the pillar at back of head-stock drilled to receive the cylindrical stem, which carries the spring proper in a fork at its upper end. This rising adjustable pillar is clamped by a thumb-screw. I sent a rough sketch to the Brittannia Company, leaving it to them to settle the method of attachment and size of the parts, knowing that they would do this better than I could myself. The headstock has come back, and it is due to the makers to say that the work is excellently done, and fully answers my expectation. Instead, however, of mounting my own division plate upon the pulley, they decided to make a new gun-metal pulley, division-plate, and all, and the ten circles were drilled to pattern with perfect truth. I could hardly have believed the improvement it has made in ease of reading and manipulation of the index, and with the point of the latter fitted to a slot in the end of the spring, as sketched in my paper, I find it perfectly easy to adjust the latter for setting the eccentric or dome chuck perpendicular, and for similar purposes of an adjustable index. I am more than ever convinced of the advantage of a pillar adjustable for height, as it stands to reason that if the index spring can be set horizontal in any circle of holes, it will hold the pulley more securely than it would in any other position. As others may profit by a somewhat unorthodox affair which I have also adopted in the matter of overhead, I will include it in this postscript. I have never liked the tension bar and pulleys arranged below the roller. Unquestionably Mr. Evans is right in placing them above; but although I have long wished to do so, I did not see my way to setting up a new overhead, nor could I transpose the shaft and tension bar as I experimentally tried to do. It often happens, indeed, that one retains apparatus not altogether satisfactory, simply because it is fitted up and would entail undesirable expense if removed. Such was my own case, but noticing a short time ago a well-placed beam over the lathe, but at right angles to it, and in a line with the middle of the bed, I decided on the following plan:—I obtained from the blacksmith a bar of 1in. round iron bar, one end of which, after filing it up bright, I inserted in a hole bored in the beam, so that the bar stood out above the lathe-bed, and parallel with it, about 6ft. from the ground. Upon this bar, which extends from the middle of the lathe-bed to the head-stock, and perhaps 6in. further, I slipped the sliding-block which carries the tension bar and its pulleys, having removed them from their old position for that purpose. So excellent is the result that, although a friend volunteered to give me gratis a new overhead, I declined it. The fixed beam seems utterly to absorb all vibration, and is in that respect very much to be preferred to a tension apparatus fixed to, and a part of the lathe itself. I may mention here that the proof given by H. and Co., that their system of overhead is the best, applies to this one. I can, without hurry and with the greatest ease, count and readjust the index, and put my foot back on the treadle before the flywheel has ceased to revolve. But then, the lathe is undoubtedly a very good one, the flywheel is not balanced, and the overhead shaft is on hard centres, and runs very easily. I suppose each turner swears by his own lathe; and as to overheads, that is generally settled by the lathe-maker to whom the order is given. A few still cling to the swing-swang—"F.A.M." for one, H. and Co.'s customers adopt the form made by that ancient firm, and Evans delights his customers with that which now bears his name. It were hard to say which is really the best; but either will produce marvellous results in the hands of a capable workman. At present it seems I have a beam in my own eye, and am satisfied.

O. J. L.

PRACTICAL PHOTOGRAPHY FOR AMATEURS.[*]

By S. R. Bottone.

§ 58. THE exposure in the camera is one of the most important parts of the operation of taking a picture, whether it be on collodion or any other sensitive surface. The duration of the exposure depends so much upon circumstances that it is almost impossible to lay down any hard and fast rules. It will depend on: 1. The aperture of the lens. 2. Focal length of lens. 3. Amount of light. 4. Sensibility of collodion. 5. Whether the lens be single or double. In the folowing *résumé* the collodion is supposed to be of the most sensitive quality, freshly made according to the recipe given above. (The wider the aperture of the lens in proportion to the length of the focus, the quicker-acting will it be. In speaking of the aperture of the lens, it must be borne in mind that the clear opening through which the light enters is here intended; consequently, if a diaphragm or "stop," with an aperture of 1in. in diameter, be placed in front of a lens, even though the lens were 4in. in diameter, *its* aperture is thereby reduced to 1in.) Therefore, a lens of 2in. aperture and 5in. focus will require a longer exposure to produce the same effect than a lens of 2in. aperture and only 4in. focus. Owing to the thickness and the number of surfaces which the light has to pass through, a compound lens, such as a portrait, a rectilinear, or a doublet lens will be somewhat slower-acting than a single lens of the same focus having a corresponding aperture. The more of the violaceous rays there are present in the light, the more "actinic" (photographically active) will it be; so that although there may be more apparent light on one day than another, there is not necessarily more actinic power, for ordinary bright light is rather richer in the yellow rays than the violaceous. The most favourable light for photography prevails in the spring and early summer months. In those seasons a clear blue sky, with a few flocky white clouds, will be found to give the most rapid pictures. Taking such a sky as our standard, and supposing the solutions to be at the temperature of 60° Fahr., the following will be the approximations to the exposures required:

1. For pictures in the open air:—No stop on the lens.[†] ¼-plate lens, about 1⅝in. in diameter, 4½in. focus. Exposure with sun on the object, 1/10 of a second; exposure without sun on the object, 1 second. ½-plate lens, about 2⅜in. in diameter, 7in. focus exposure, with sun on the object, 1 second; exposure without sun on the object, 2 seconds. 1/1-plate lens, about 3¼in. in diameter, 10in. focus—exposure: with sun on object, from 1 to 2 seconds; without sun on object, 4 to 6 seconds.

2. For portraits under glass (no stop on the lens).—¼-plate lens, about 1⅝in. in diameter, 4½in. focus, exposure from 10 to 30 seconds. ½-plate lens, about 2⅜in. diameter, 7in. focus, exposure from 15 to 45 seconds. 1/1-plate lens, about 3¼in. diameter, 10in. focus, exposure from 30 to 60 seconds.

(N.B.—Lenses, the visual and actinic foci of which do not coincide, are somewhat quicker-acting than those which are perfectly corrected; but the difficulty of remembering to allow for the differences in focus renders this advantage nugatory.)

Having, therefore, decided the exposure which it will be desirable to give, the operator gives a final glance to the image on the ground glass in order to insure its being an accurate focus, carefully removes the ground glass frame, without disturbing the camera, places the cap on the lens, and puts the dark frame containing the sensitive plate in the groove just vacated by the ground glass frame; taking care to replace it so that the draw-up shutter faces the lens. Holding his hand on the top of the dark frame, with the other hand he pulls up the shutter, as far as it will come, and turning it back on its hinges proceeds to uncap the lens as lightly as possible, so as not to impart vibratory motion to the camera. He then counts the number of seconds that it has been determined to expose the picture to the action of light, after which he replaces the cap on the lens, closes the shutter, removes the dark frame from the camera, returns with it into the dark room, where, having closed the door, he commences the operation of development.

§ 59. Having removed the plate from the dark slide, he takes it up again by the same corner with which it was held during collodionising, and, holding it in a perfectly horizontal position over the dish in the centre of the table, he distributes over its entire surface, by means of a backward movement of the right hand, a sufficient quantity[*] of developing solution, which he will have previously poured out into one of the developing glasses. If the plate be not entirely covered with the solution at one sweep, lines are sure to show themselves where the solution did not touch; while, if by too sudden a splash, some of the nitrate of silver adhering to the plate be washed off, the picture will be fainter in those parts; so, to insure equal covering, it will be well to observe the following precautions:—Let the measure be held in the right hand, so tilted that the liquid nearly runs out, and having placed it above the end of the plate nearer the left hand, let it be drawn rapidly but steadily backwards. If the plate has been held horizontally, the liquid will almost certainly cover the whole of it. By slightly but quickly tilting the plate, the fluid may be made to flow to any spot not covered before the developing action commences, which action, however, begins almost instantly with the developer of the strength given above. Should any difficulty be found in getting the solution to flow in an even sheet, the beginner may reduce the amount of sulphate of iron (in the developing solution) to 60 or even to 30 grains to the 4oz., until he has acquired the happy "knack" of flooding the plate without leaving any bare spaces, and without spilling the solution. When he has acquired the requisite dexterity, a return to the normal formula is recommended. Still keeping the plate in a horizontal position over the glass bottom developing dish, the picture will (if sufficiently exposed) quickly be seen to appear; the high lights first, then the middle tints, and lastly the deepest shadows. When every detail is well out, the action of developing must be stopped by thoroughly washing the plate (still held in a horizontal position) under a stream of water until a drop from the plate allowed to fall on the tongue no longer tastes inky.

THE KENYON PIPE.

A NEW pipe has always an attraction for the smoker. We have illustrated many, and still, as recent discussion shows, the smoker is not happy. The "Kenyon," of which a sketch is given, claims to be a dry pipe, free from those noisy and noxious accumulations of moisture which are often so intensely disagreeable in pipes of the ordinary bore. There is a little silver or nickel valve, about ½in. from the bole of the pipe, and this, it is asserted, gives vent to the back-draught along the stem, which, coming straight from the mouth, is charged with moisture, and

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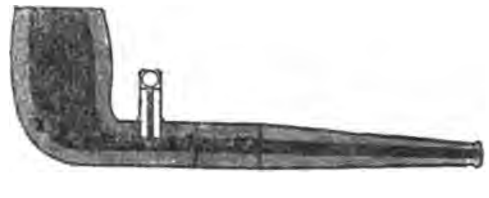
[*] All rights reserved.

[†] Portrait lens understood.

[*] The quantities requisite for the different sized plates are approximately here given: ¼-plate, 2dr.; ½-plate 4dr.; 1-1 plate, 6dr.



mainly introduces it into the pipe. Mr. H. M. Stanley has had an opportunity of smoking the pipe, and declares it to be "a capital invention." Here is the letter which the explorer caused to be addressed to Mr. Kenyon:—

"34, De Vere Gardens, W.

"Sir,—Mr. Henry Stanley desires me to thank you for the patent pipe which you have been so good as to send him, which he considers a capital invention, and with which he is much pleased.—I have the honour to be, sir, your obedient servant,

"S. Kenyon, Esq. "Leonard K. Wilson."

The pipe is cheap and durable; but there is a very unpleasant smell from the material of which the sample sent to us is made. This, of course, does not affect the principle of the invention. The patentee is Mr. S. Kenyon, 6, Nether Hall-road, Doncaster.

HOW TO MAKE A VIOLIN.—VII.*

By W. Pickering.

THE wood being now thoroughly dry and smooth, the reader may put on the foil or sizing. The following preparations will give abundant diversity of tint, according to the number of coats applied:—

Asphaltum dissolved in wood naphtha; ditto, with a little sandarac added.

Aloes and mastic, dissolved in spirits of wine or wood naphtha.

Sandarac in ditto, coloured with a little hay saffron.

Canada balsam, dissolved in wood naphtha; one or two coats will give a delicate straw-colour.

Double-boiled linseed oil, rubbed in before a fire until the wood will take no more, and left to dry. If it does not all dry in, the places where too much oil has been applied may be wiped over with a rag dipped in spirit.

The best sizing of all, in my opinion, is gamboge, finely powered, and dissolved in turpentine. This will take some days to dissolve, and the bottle should be frequently shaken. It will give a bright clear yellow, and may be adminstered plentifully. As before remarked it will be deepened by each extra coat. A brownish yellow will be given by adding a pinch of asphaltum.

When the sizing has been completed the work should be hung up in a warm place and left for some days to get properly dry, after which the outer coating may be commenced. Be careful not to flood the brush. Each time you take up varnish drain or scrape the brush over the edge of the saucer into which you have poured a little. A shallow ointment pot is even better than a saucer, being much firmer. Draw the brush in one direction over the instrument, and do not go over the ground with a second coat until the first is thoroughly dry. Alternate coats may be applied crosswise, and as to the number of coats your own taste will tell you when to stop. After three or four coats you will find that each deepens the tint considerably, but it will be as well to keep on until you have got the tint somewhat deeper than you desire it to remain, as an allowance must be made for the rubbing down, which in most cases is desirable. Varnishing is not by any means an easy process, and you will most likely find in the first attempts that you have got darker patches here and there. Do not attempt to deal with these now; but when you have got a fairly thick covering, hang up the instrument again, and allow the varnish to harden. When this has been accomplished, take a bit of the finest glass-paper and a little thin mineral oil, and operate gently on any inequalities. Then wipe with a clean rag and rub dry. Afterwards put a few drops of the double-boiled oil on a bit of rag, and rub the varnish all over, and keep rubbing till dry.

The reader may feel surprised that I have hitherto said nothing about amber, which is generally supposed to be one of the chief ingredients in Cremona varnish; but, to tell the truth, I look upon "amber varnish" as a figure of speech merely, traceable, no doubt, to a certain amount of resemblance in colour—certainly not in texture. I do not believe that an atom of the amber that we are acquainted with, ever entered into the composition of the varnish of Cremona. It seems much more probable that that beautiful and diaphanous covering, which commands in certain instances a goodly number of pounds sterling per square inch, was the result of combinations of the materials before enumerated, or some of them, aided, no doubt, by the purity of gums and the brilliant climate in which they were mixed and applied. It is not impossible that a common body varnish was procurable at the local oil-shop, and received more or less of final touch in the way of colour from each individual fiddle-maker, according to his fancy. I am aware, of course, that experimenters have, in recent times, succeeded in fusing amber and getting it into varnish; but this is no proof that it was used in Cremona. In the time of Stradivarius there was an article in the market called "amber," which is described in Jacob Berlu's "Drugs Unlock'd" (London, 1690) as "a very fine and fragrant liquor of the same condensity as Strasbourg turpentine, of a pale reddish colour; it comes from Ægypt, Chios, and the Straits." Possibly this is what is now known as Chio turpentine.

I will now leave the "gentle reader" to his experiments. If my instructions have been somewhat inconsecutive and of the "run-and-read" character, it is owing to the fact of their having been written at intervals, between the hours of business of an entirely opposite nature, and if there be any point on which the reader wishes for further information, I shall be happy to supply it to the best of my ability; and I propose, with the Editor's permission, to do so in the English Mechanic, whether the queries reach me privately, or through these columns.

To begin with "T. S. J.," who remarks that I have said nothing about "air-space." That is true, and the reason that I have passed it is that I do not want to trouble the reader with what I regard as one of the many ultra-scientific notions which have been started with the view of accounting, if possible, for the superiority of the Cremona instruments. If the amateur keeps tolerably close to the dimensions given, the instrument will not be far wrong in the matter of air-space; and it will be remembered I stated that if built on a larger scale, the instrument would develop into the tenor character of tone. Some years since I experimented on this head by filling instruments with pearl sago, and weighing the sago after it was withdrawn. This can easily be done by taking down the strings, and wrapping a napkin, or a duster, round the waist of the instrument, keeping it tight over the *f*-holes with an elastic band or two, and then running the sago through a small funnel into the tail-pin hole. I tried a Stradivarius and a Guarnerius, both high-class instruments, and of splendid tone. The Strad held a little over ¼lb. more than the del Jesu—a fact which was rather unfortunate for the air-space theory of exactly 512 vibrations, and tended to make me cling the more to my notion of reducing thicknesses before varnishing, in the manner I have already indicated.

"Thin plates." I have never found them to be coincident with great "carrying" power. To "carry" effectively in a large hall a violin must be stoutly timbered, and although it may not sound loud under the ear, and may even appear "sleepy," it will be found to spread into every corner of the room.

"Thinness at edges of *f*-holes." This is no guide as to the general thickness of the table, as many of the earlier makers habitually bevelled the inner edges of the *f*-holes.

"W. W. F.'s" query as to the advisability of staining the wood is already referred to.

"Orderic Vital." I always read with pleasure the contributions, clear and sensible in style, and interesting in subject matter, of this correspondent, and think that his suggestions as to the measurement of old violins by ordinates and abscissæ would be not only valuable, but absolutely necessary in a case in which it was intended to make an *exact copy* of an "old master"—or, rather, I should say, of a particular specimen of an old master, for the old makers seldom repeated their exact lines—a fact which would seem to argue that they were either not wedded to any special outline, or that they were always experimenting, or both. I doubt very much if any two instruments by, for instance, Stradivarius, could be found which would prove to be *exactly* alike—I mean in outline and model, of course, and without reference to colour or varnish. During the whole of his long career Stradivarius appears to have varied his style, more or less, in each instrument. Some difference, slight though it be, is discernible, either in the outline, the contour, the channel, the corners, or the edges, and I can scarcely agree with "Orderic Vital" as to the important part played by outline in the matter of tone. The well-known "box" fiddle of Prof. Savart would seem to negative this. That historical instrument was in shape a trapezoid, roughly about 13½in. long, 8¾in. at the widest, and 3½in. at the smaller end, with ribs or sides 1⅝in. deep. It was tried against a high-class instrument, by a professor, with professors and scientists as judges, and the reports record that it was difficult to say which instrument carried off the palm, the benefit of the doubt being given in favour of the "box" fiddle.

Again, the fine "long Strad" recently photographed in Mr. Fleming's admirable magazine, and which was sold a short time ago for £650, is an instrument that I know well. It is of very delicate outline, and differs in that and several other important points from the massive works of the "grand" period to an extent which is most remarkable; but it has, nevertheless, the real "Strad" tone in an eminent degree.

Further, a Gaspar da Salo violin is crude in outline, and immeasurably inferior in outline and finish to a "brothers" Amati; but in grandeur of tone knocks the latter "into a cocked hat."

Knowing full well how instances of this kind can be multiplied, I am afraid that I fail to recognise much benefit from the scientific measurements proposed by "Orderic Vital," at any rate, as far as tone production goes. Would it not be more satisfactory that the amateur should not set himself to slavishly copy anything, but rather seek to disprove old prejudices by striking out a fresh line, and endeavouring to break new ground?

As to the letter of "Scio," November 13, which the Editor kindly dignifies by the name of criticism, but which I cannot help regarding as animus, I at first decided to pass it unnoticed; but lest it should be considered that his remarks are unanswerable, I will deal with them as shortly as possible, and leave the readers of the "E.M." to form their own verdict. Discussion and criticism I will always cheerfully respond to; but mere vilification, jibes, and sneers have on me as much effect as water on back of duck. Only a few weeks ago, in writing to a valued friend, I lamented that my articles on fiddle-making had produced no discussion. His reply (somewhat prophetic) was that the papers were so concise and practical that there was no room for any. "But," he added, "wait till you get into the realms of theory or discovery, and you will then be likely to catch it hot"—or words to that effect. Well, a week or two afterwards I offered my readers a dose of theory and discovery combined, possibly upsetting a good many ideas and prejudices. It is not, however, on this ground that I have apparently trod on "Scio's" toes, but, fortunately, on matters which I am sure most readers of the "E.M." are quite as well able to judge as either I or "Scio." This gentleman — or gentlemen, I can't make out which, as he uses the first and third persons alternately, writing sometimes as "I" and sometimes as "we" — shows unfairness, to give it the mildest term I can think of, in referring to Fig. 16, p. 53, about which he jeers, but conceals the fact that in the succeeding chapter I disclaimed that diagram, which I attributed to some error or accident on the part of the artist, and that another diagram was substituted for it on p. 108.

Animus again in his remark about "public-house spills." If I were to reply that nowhere in my writing can he find any reference to the words he uses, I should write the literal truth

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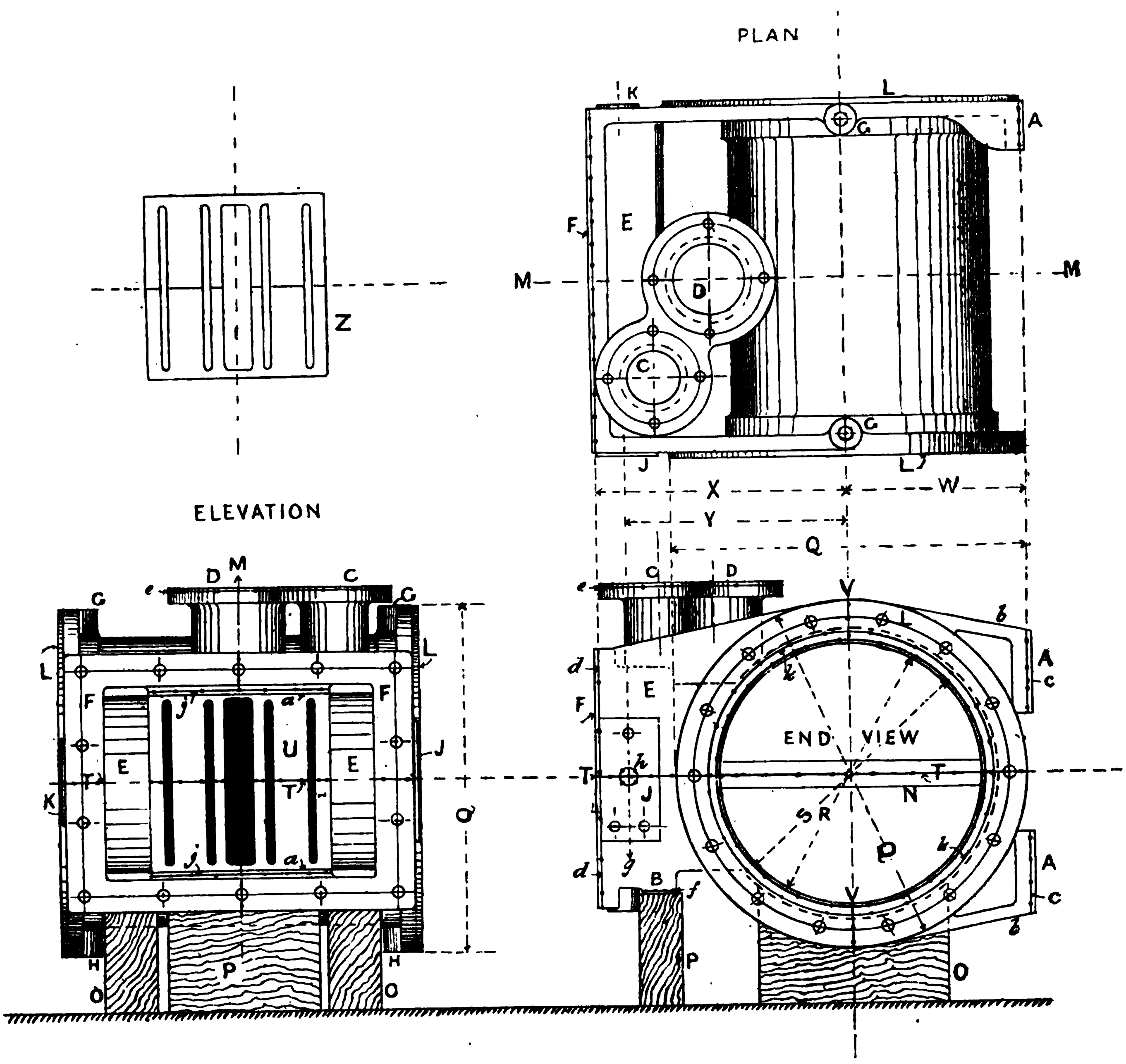
FIG 58



What I said was, "at some of the tobacconists," &c. Of course I don't want to quibble, but merely to draw attention to his wilful distortion.

"Scio" seems slightly mixed as to "contour" and "outline," which he appears to regard as one and the same thing, whereas they are nothing of the kind.

It is no compliment to the intelligence of the "E. M." readers to imply that they do not know the use of templets. He has apparently not caught the meaning of my suggestion, and may with advantage read the paragraph again. As to "leading my readers along the most difficult path," "Scio" must not gauge their intelligence by his own standard. I have a much higher opinion of "E. M." readers.

It would appear as if "Scio" has read that which he has been "criticising" in a somewhat superficial manner. He says I "seem to have taken a thorough disgust to the gouge," whereas I tell the amateur how to make his own gouges, and, moreover, *give a diagram*, Fig. 28.

As to his assertion of the "recognised position of the *f*-holes," he can surely have never been in contact with other than the ordinary trade instruments, which are frequently so much alike as to give one the impression that they have been struck out with a die. I maintain that there is no such "recognised position." Each of the old Italian makers varied considerably in the way of setting the *f*-holes, and as to form, posture, and position were guided by the pattern of the outline, and general style of each separate instrument.

As to "Scio's" "geometrical method of obtaining outlines," I may say that I fortunately possess good eyesight, and have used it whenever and wherever possible on high-class violins, but have never been able to discover anything approaching geometrical accuracy in the outline of a good Italian instrument, but *the very opposite*, and I should be glad of any reader of the "E. M." who may be the owner of, or have access to, a Stradivarius, to declare in these columns whether the outline curves of *both sides* of either back or belly are exactly alike, or the reverse. It is a fact well known amongst experts that such agreement never occurs. The finest instruments appear to have been the outcome of free-hand drawing in which especial care was taken that the design should not be of the stilted character which "Scio" advocates.

The manner in which "Scio" sneers at my improvised tools—the purfling tool for instance, leads me to fancy that he may be in the trade, and is therefore annoyed that I should indicate a way of making an implement for 1½d. for which he would like to charge half a sovereign; but I have always been under the belief that a great charm of amateur work was to make one's own tools.

"All practical men," says "Scio," "select *hardest* wood possible for the soundpost." This must surely apply only to his own locality, as it has always been the dictum of certainly the three most "practical men" in London that the *softest* pine should be used.

Although I specify particulars of certain violins I have made, and their peculiarities, this "critic" says: "It would appear Mr. Pickering never made a violin in his life, or he would certainly have discovered that it is *almost impossible to varnish a violin after the finger-board is glued on.*" After this final example from the "practical man" I must beg to be excused any further discussion with him. Such nonsense (and there are several other instances), I am happy to say, seldom gets into the columns of the English Mechanic.

Possibly "Scio" will respond to the Editor's invitation and send his geometrical method. Let us hope it is not the well-worn scheme of Bagatella or of Galbusera, first given in Wettengel's "Lehrbuch," published in 1828, and done to death in half a dozen books on the violin published subsequently. This method might be useful in such places as Mirecourt, or the Black Forest, and other localities where violins are manufactured by the gross, and where each portion is made by a separate workman (in many cases by workwomen), and the parts sent into the fitting shop to be glued up.

FITTING.—X.

It would hardly be right to omit an engine cylinder from typical examples of lining out. Yet a cylinder presents less difficulty than many other pieces of mechanism that might be named. Some machine frames, for example, are vastly more difficult. Yet cylinders come more frequently in the line of amateur work than perhaps other jobs, and I will therefore take just one by way of example. Those of our readers who have back numbers can see the lining off of a loco. cylinder in Vol. XLIX. p. 406. The present example is the low-pressure cylinder for a compound horizontal engine.

In Fig. 58, A A are flanges by which this cylinder is bolted to the high-pressure one. B is a foot for bolting to bed-plate.

The bed-plate in this example is built up of plate and angle. There is a corresponding foot on the high-pressure cylinder.

C is the steam-inlet from the high-pressure cylinder, D is the exhaust-pipe, E is the steam-chest, F its flange, G indicator bosses, H pet cock bosses, J facing for front valve-rod guide, K facing for hinder ditto.

In a cylinder of this type these matters have to be looked to:—That the faces A and F are parallel, and at correct distances from the bore, that the flanges A and F are at right angles with the faces L L, and the centre M of the ports midway between the faces of the flanges L L, that the widths of the ports and of their separating bars are correct to width, and at exact right angles with the cylinder bore, and that the bore is in winding with the guide-strips *a a* of the valve.

In this, as in other examples, it must be remembered that if I describe one method of lining out, a different mode, or modes, of procedure would be adopted by different men. It is the general or broad outlines only of these methods that need be insisted on.

We will suppose the central cored hole to have been bridged, N, at both ends, with wood or iron, and all the surfaces to have been whitened. The cylinder will then be set on the lining-off table. It does not lay in actual contact with the table, but must be supported. The best way to block it up is on two pieces of wood, O O, hollowed to the radius of the body. The overhanging steam-chest must be also supported upon a cubical block, P.

Now the centres of the diameter Q of the flanges and facings, the centres of A A, and of the flange F respectively will be pricked off with compass calipers or with compasses. The point of the scribing-block is then set to one of the centres thus pricked off, and if, in moving the point along, and if necessary wedging the casting up more to one side than the other, each of the three centres is at the same height, then there will be no need to average the main centre line that passes through the three points. But the probability is that these separate centres will not be in line, but that the cored hole R will not be central with the faces A A and F. If the hole is out only a little, no alteration of the centre for boring S will be necessary; but if it is out much, and especially if the hole is not circular, or if the allowance for boring is very scant, then it will be necessary to move the centre for the bore upwards or downwards, of course throwing the centres of the faces A and F out also. Of the two, it is best to throw the face F out less and the face A more, because the edges *b b* can be dressed off with chisel and file, while it is very undesirable to throw the valve-face out of centre at all.

It may happen that the three centres may be in line on one end of the cylinder, and not on the other. But the great point always is, in any case of this kind, to keep the centres of the outside edges of Q, and of F, as nearly in alignment as is practicable, without unduly diminishing the amounts required for machinery. These amounts in work of this character are ⅛in. on all faces, so that two cuts, one rough, one finishing, can be taken off.

Now scribe the horizontal centre line T all round the cylinder, across ends, L L, flange F, and body, carrying the line also across the valve-face U within the steam-chest.

But before this line is scribed very deeply, or centre-popped, it is necessary to test the truth of the faces A A and F. For, if they are so much out of perpendicular that they will not hold up to dimensions, then it will be necessary to tilt the casting out of its proper horizontal plane, and so throw the centre line T out of true centre with the faces A A and F, in order to make the faces stand square enough to give sufficient metal for machinery to size. It is a pity to have to resort to such a measure, but cylinder moulds made as they so largely are, with drawbacks and cores, cannot always be depended upon for accuracy within ⅛in.

But in any case, having the horizontal line T settled, the next step is to set up the vertical centre line V with a square from the marking off table, in the centre of the circle formed by the outside of the flange Q, if possible. But it may happen that the distances W and X of the faces A and F from this centre are greater or less than they should be. Then the centre V may have to be moved slightly in one direction or the other, only, however, within the limits of allowance for machinery. Both ends of the cylinder will be tried in similar fashion, and when the positions of the centre lines and faces are fixed, the verticals *c* and *d* for machining are scribed up from the edge of a square.

Immediately following, the line *e*, representing the planed faces of the flanges of C and D, and the line *f* on the ends of the flange B will be scribed.

The centre *g* of the valve-rod will now be raised at the distance Y from the cylinder centre, and the holes *h* struck on each end.

There is one other matter before the cylinder is moved, and that is the lining off of the edges of *a*, against which the valve slides. We have the centre line T already scribed. It is only necessary now to mark off a line corresponding with that centre line upon a block like that shown in a previous article, and also two other lines, corresponding with the planed distances *j j* of the guide strips, and transfer these last two lines from the block to the strips in the manner before described.

And now the cylinder casting can be removed from its packing for centre popping and machining. A witness line will be struck at *k*, about ⅛in. or ¼in. outside the line for boring, and all the scribed lines will be marked with centre pops at intervals of about ¾in.

The lining out of the valve-face U, excepting that of the guiding strips *a a*, is, of course, not done until the face has been planed over, and that face is not planed until after the face F of the steam-chest has been planed. Then the valve face is planed parallel with it, and the guiding strips *a a* are planed. A templet, *s*, is then cut out to fit within the strips, and to lie upon the planed face. Slots are cut in the templet of the same size as the ports, and the widths between the slots correspond with the widths of the port bars. This is laid upon the planed face, and the lines scribed through the slots represent the edges to which the ports have to be milled, or chipped and filed. Sometimes, where only one casting has to be marked out, a templet is not made, but the lines representing the port edges are set out with dividers, and scribed with a square from the planed guide strips.

When, as frequently happens, the ports and port bars do not come out to very accurate dimensions, the differences must be averaged, and less or more be taken off some of the edges. Once upon a while the valve edges may have to be slightly altered to adapt them to altered dimension. But the allowance given for machining is usually quite sufficient to allow enough margin for moulders' inaccuracy.

The ends L L of the cylinder flanges are not usually lined off all round. It is sufficient, after testing their vertical truth or inaccuracy, to mark the length over finished flanges in one spot. When the cylinder has been bored, the flanges are faced at the same setting; usually with a star-feed arrangement upon the boring-bar. Since the cylinder is not moved, the facing of the flanges is bound to be at precise right angles with the bore; hence the reason why lining out is not necessary here.

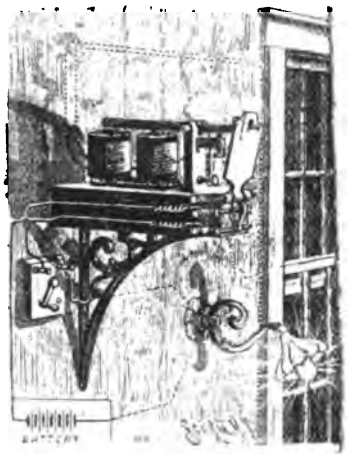
After all the flanges have been faced, the centre lines for the stud holes are struck round on flanges L L and F, and the centres of the holes divided out, their diameters struck, and centre popped ready for drilling.

Other matters—as the lining out of the tapping holes for the pet cocks and for the indicator plugs—call for no comment; because they offer no difficulty after the main lining out has been mastered.

J. H.

AN ANNUNCIATOR FOR BURGLAR ALARMS, &c.

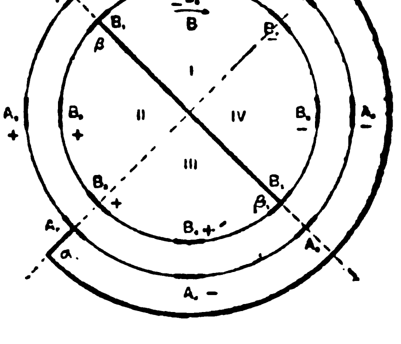
A CIRCUIT-CLOSING attachment for annunciators, by means of which an electric-lamp will be lit when the annunciator-drop falls, is shown in the illustration. It has been patented by Mr. Lambert F. Fouts, of Trinity Mills, Texas. In a standard projecting from the base plate on which the electro-magnet is mounted is fulcrumed an armature lever, extending over the magnet and through a mortise in the annunciator-drop. The drop is pivoted to incline slightly forward, and so that it will fall by gravity when released from the catch on the outer end of the armature lever, which is held down and normally out of contact with the magnet by a spring. Supported within the path of the drop, as it falls when released by the catch, is a contact spring attached to one of the wires in a circuit in which is included, as shown, a battery, an electric-lamp, and a switch. The improvement is designed for use in a burglar-alarm or other signal system, and the circuit-closing devices and battery are connected with the terminal wires of the magnet in the usual way, so that when a sufficient current is thrown upon the magnet by the opening of a window or door, the armature lever is tilted to release the drop, which in falling strikes the contact-spring, as shown in dotted lines, closing the circuit, and causing the lamp to become luminous. The lamp is afterwards extinguished by opening the switch.—*Scientific American.*



THEORY OF THE WIMSHURST MACHINE.*

THE Wimshurst machine was invented about 1883, and its use has spread rapidly on account of its possessing the valuable properties of quick self-excitation, certainty of action in all weathers, and entire absence of reversal. Its theory is, however, very little understood, and M. Gariel, in his "Traité d'Electricité," has gone so far as to say that it is not possible to give it in a satisfactory manner.

It can be ascertained by experiment that a Wimshurst machine works perfectly when the combs and discharging rod are drawn back, and the action of the combs can, therefore, be neglected in the theory of the electrical action. If the distribution on the plates of the machine when it is in motion be investigated, it will be found to be as indicated by the signs in the diagram. In order to prove this, Mr. Wimshurst has constructed special apparatus.



One of these instruments, the "sparking machine," is an ordinary one simplified, and consists of two glass plates carrying a large number of tin sectors very close together; these are put in motion with the fingers on a common axle held in the hand; each plate is furnished with a conductor placed along a diameter. As soon as the discs revolve, the

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* By M. G. Pellissier, in the *Journal de Physique*.

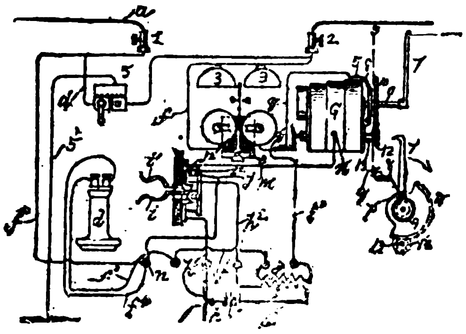

Fig. 1.

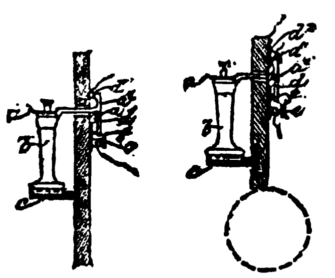

Fig. 2.

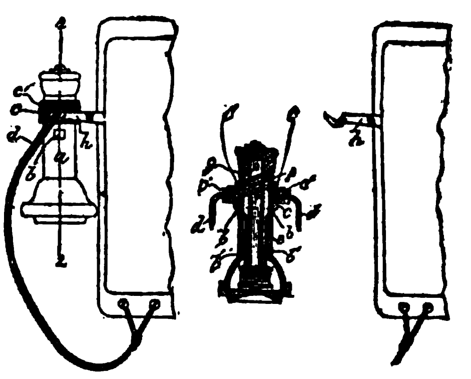

Fig. 3.

sectors become surrounded with halos, sparks fly from point to point, and, when viewed in the dark, a very fine effect is presented. The other instrument only differs from an ordinary machine in having its plates made of an elastic material; when in motion they are seen to attract one another in quadrants I. and III., and to repel in II. and IV.

In the following paper we have sought first to explain how the distribution shown in the diagram can be set up, and then how it is that the charges rapidly increase. In Fig. 1, the front plate is represented by the inner circle; $B_1 B_2$ are the sectors, of which we will assume there are eight; $\beta\ \beta$ the diametric conductor. The outer circle represents the back plate, $A_1 A_2$ its sectors, and $a\ a$ its diametric conductor. The two wheels turn in opposite directions with the same velocity.

Let us consider one of the sectors, A^1, of the back disc at the instant that it is opposite the diametric conductor, $\beta\ \beta$, of the other plate; and we will assume that a sector, B_1, of the disc in front is at the same instant in contact with the brush, β.

Let us suppose, without inquiring the reason, that the sector A_1 has a weak positive charge; it will induce on B_1 a negative charge, and then proceed itself toward a_1. When it arrives at this point, that is to say, after revolving through 90°, B_5 will, on account of the opposite directions of rotation of the two plates, have arrived opposite the brush a, which will be in contact with the sector A_5, while B_4 will be opposite A_1 at a. The charge carried by B_1 will induce on A_5 a positive charge, while A_1, which is positive, will be discharged to earth, since $a\ a_1$ is not insulated.

After a further rotation through 90°, A_5, carrying a positive charge, will take the place of A_1, while B_1 and B_5 will change places. The series of actions just explained will be gone through again, and since the induced charges are less than the original, the machine would soon cease to work.[*]

But A_1 does not act only on the sectors of the second plate, but also on the neighbouring sectors $A_2 A_3$; when they come in contact with the brush a_1 the positive charge flows to earth, and they leave the diametric conductor with a negative charge, which they carry toward the brush β_1. This brush acts by induction on the sectors of the second plate, which acquire a positive charge, and turn from the brush β_1 in a clockwise direction.

Thus it is sufficient for the sector A_1 to have at the start a slight positive charge in order to bring about the distribution shown in the diagram. All the sectors of the back plate situated on the left between the brushes a and a_1 are positively electrified; the opposite sectors on the same plate are negative, while on the front plate all the sectors at the top between β and β_1 are negatively electrified, and the opposite sectors at the bottom are positive. In the top quadrant I. the charges are of opposite sign, and attract one another; the same holds good for III., while in II. and IV. the charges are of the same sign, and repel one another; and if combs be placed at these points, the one on the right will collect negative electricity and that on the left positive.

It remains to examine how these charges go on increasing. To do this, let us take the machine in any position whatever, and consider the electrical actions that are taking place on any sector, say B_1, in contact with a brush. This sector is under the influence of (1) the negative sectors, B_8, B_7, B_6; (2) the positive sectors, B_2, B_3, B_4; (3) the positive sector, A_8, A_1, A_2 of the back disc. Since the two first sets are symmetrically disposed, they neutralise one another, and the action of the three sectors, A_8, A_1, A_2, alone remains; each of these tends to give it a charge nearly equal to its own in quantity, but opposite in sign. The sum of these actions will give to B_1 a charge that is approximately three times its original charge.

The same thing holds good for the other sectors, A_3, B_3, B_7, and is renewed for each of the sectors successively. The charges will thus go increasing in consequence of the mutual reactions up to a point that is determined by the leakage. The action of the machine being independent of the combs, it will continue to work when the knobs of the discharger are separated beyond the sparking distance. This is the explanation of the valuable property that the Wimshurst machine possesses of never failing nor reversing, as is often the case with Holtz and Voss machines.

It is necessary to add to the actions just considered the effects produced on the glass, which are far from being negligible; indeed, the Wimshurst machine can be made of two plates of polished glass, and with combs instead of brushes at the extremities of the diametric conductor. The initial charge has to be given by means of an external source, placed, for example, opposite A_1.[*]

This form of Wimshurst machine recalls a Holtz of the second kind; the German *savant* had, in fact, made, in 1869, a model of this apparatus, with two diametric conductors in the form of a cross, one before each plate;[†] he even added[‡] that this machine could be made self-exciting by placing metallic sectors on the plates and substituting brushes for combs on the diametric conductors. It appears that Mr. Wimshurst was unaware of Holtz's work when he invented his machine.

The chief part played by the sectors seems to be to facilitate the self-excitation and to diminish the effect of atmospheric moisture. The greater the number of sectors, the more rapid is the excitation; thus, with eight sectors, or any less number, the machine has to be excited from an external source; with 16 or 18, it rapidly excites itself under almost all atmospheric conditions; while with 40 the action is so energetic that it is very difficult to prevent the machine exciting itself, even under very unfavourable conditions as to moisture. At the end of a half turn of the handle, Wimshurst machines are completely excited.

The one point that remains obscure in the theory of influence machines is the origin of the original charge. It has been ascribed to (1) a residual charge on the plates, (2) electrification of the plates by friction with the air, (3) electrification of the metallic sectors by the natural electricity of the different layers of air, which are at unequal potentials, (4) electrification by contact.

Without denying the existence of these various causes, the last appears the most probable, more especially since the self-excitation is only present in machines furnished with metallic sectors and contact-brushes, e.g., Bennet doublers, Topler, Voss, Thomson, and Wimshurst machines. It would be interesting to have exact experiments on this subject.

HOWARD'S IMPROVED TELEPHONIC APPARATUS.

In the accompanying engravings, Figs. 1, 2, and 3, are illustrated several improvements in telephone apparatus to be used in a subscriber's station, recently patented by Mr. James H. Howard, of Medford, Mass. Fig. 1 illustrates an improvement by which, when the apparatus is in its normal position, the resistance of the receiving telephone magnets is short-circuited, and the resistance of the generator armature is also short-circuited, thus leaving interposed in the line resistance only the bell magnet, and thus materially decreasing the resistance of the line. When, however, the receiver is removed from its hook, it is automatically cut into the line by a spring switch, so that conversation may be heard. A similar automatic arrangement applied to the magneto generator cuts its armature into circuit when a crank is turned to ring the bell. As illustrated in the diagram, Fig. 1, the receiver *d* has been removed from the hook, and in this condition the line current will pass from the main line *b*, through conductor *f*, bell magnet, wire f^1, f^4 and f^3, and out on line *a*, the microphone shown at *h* having its circuit automatically closed by the approach of the two spring controlling arms i, i^1. When, however, the telephone is inserted between these arms, their contacts are forced apart, thus causing arm i^3 to bridge two contacts at j^1, and short-circuit the telephone by leading the line current by way of *b*, *f*, bell magnet, wire *q*, spring contact 5, to a segmental contact on the magneto crank-shaft, next to the frame of the magneto, by wire m^1 across the closed bridge just described, by wire *m* and f^3 to main wire *a*. The generator shaft has mounted upon it an insulating disc in which is a single-contact stud upon which the insulated spring 8 bears when the apparatus is at rest, thus closing the short circuit just traced and cutting the magneto armature out of the line circuit. When, however, the crank 7 of the magneto is turned, the spring 8 leaves the contact and rubs upon the surface of the insulated disc, thus opening the short circuit and cutting the armature of the magneto into line by way of spring q^1 and wire m^1. The crank-shaft of the magnet is controlled by a coil spring, so that the signal is sent in by the reaction of said spring after the crank has been turned by the subscriber. It is claimed that greater ease and accuracy of signal can be maintained with this structure than where the magneto armature is driven directly by the hands of the operator, and it enables a repetition of calls with accuracy, so that one of the subscribers may be called by a repetition of the number of rings.

Fig. 2 illustrates an improved hook designed by the same inventor for telephones. In this no dependence is placed upon the weight of the telephone to cut it out of circuit; but in order to avoid failure of springs a positive action is secured by providing a shelf *c* upon which the telephone rests, and having a fork *a* forced inward by the interposition of the telephones, so as to open the circuit. When, however, the telephone is removed, the fork drops its own weight, being assisted by a spring, *f*, and cuts the telephone into circuit.

Another device invented by Mr. Howard for cutting the telephone out of circuit is illustrated in Fig. 3. The coil of the telephone has its two ends terminating in contact-plates *b b* on the outside of the instrument. A sliding ring is pressed by the tension of a spring so as to cover these contact-plates when the telephone is removed from the supporting hook, so that under these conditions the plates *b b* will be engaged by corresponding contacts on the ring and the coil will be in circuit, and conversation can be heard. When, however, the telephone is hung upon the hook, its weight is sufficient to overcome the tension of the coil spring, thus forcing the ring out of contact with the plates *b b* and cutting the coil out of circuit. The circuit is completed by the arms of the hook *h*, which form a short circuit to wires *d* which lead from the line to the telephone.—*Electrical Review* (N.Y.)

SAFETY DRILL AND TAP-HOLDER.

Of all the labour performed in the machine-shop, that of tapping is one of the most laborious; and although tapping machines have been in use for some time, yet they are generally neither designed nor intended for general work, and it is a singular fact that it is only very recently that any attempt has been made to do the work by any other method than that used fifty years ago. Of late, several devices have been made for the purpose, intended for use in the upright drill, and doing the work by power, thereby effecting a great saving in time, as well as doing the work more accurately than was formerly the case. The safety drill and tap-holder herewith illustrated is made by Beaman and Smith, Providence, R. I. In construction, the holder is very simple. There is nothing to break or get out of order, and no complicated parts, and its operation is easily understood. If properly used, it is impossible to break either drill or tap, and the change from one to the other can be made instantly, and without stopping the machine. The holder consists of a body G [illegible], threaded upon the outside, and recessed to receive the friction socket A, with the taper shank fitted to the spindle of drill or lathe. The friction socket A receives the drill socket E and the tap sockets D, and it is held between two pieces of vulcanite fibre F, and driven by the friction obtained by tightening the friction cap B, so that the friction produced will be sufficient to drive the drill or tap, but will slip so soon as the tap bottoms. Then, by reversing the motion of the driving spindle the tap is withdrawn. The tap socket and tap being driven by feathers, prevents all danger of stripping the thread. Special taps, as shown, are recommended, but special tap sockets can be furnished to take the usual square shank hand taps.—*American Machinist.*

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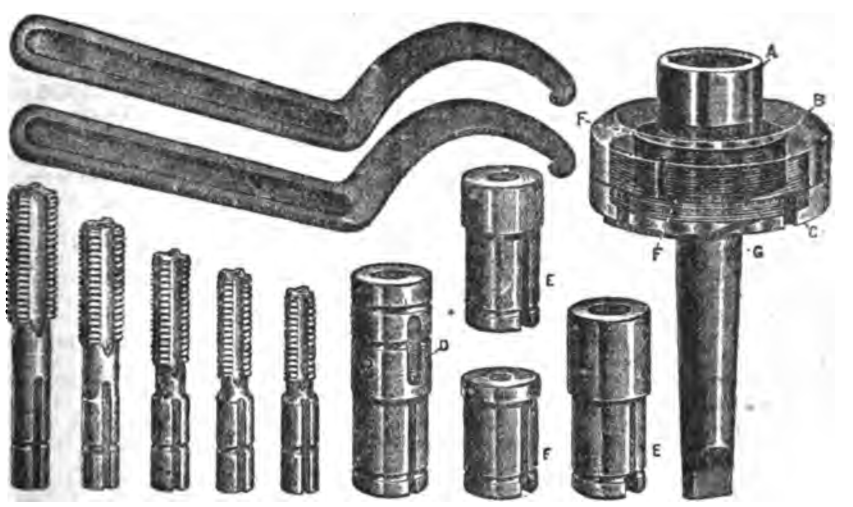
[*] This, in fact, is what happens when combs are placed opposite $A_2 B_2$ and $A_6 B_6$ and are put to earth. If the theory of the machine under these conditions be examined, it will be seen that the second series of phenomena about to be described do not take place; the charges then diminish in geometrical progression, while the operations increase in arithmetical. It is this which points to the office of the combs in the electrical reactions.

[*] In the ordinary machine, when the brushes do not touch the sectors, the machine can be made to work by starting it with a charge from an electrified body.

[†] *Pogg. Ann.*, t. cxxxvi., p. 171, 1869; Uppenborn's *Centralblatt. f. Electr.* p. 683, 1883.

[‡] *Gotting. Akad.*, March, 1876. Uppenborn's *Zeitschr. f. angew. Elekt.*, t. iii., p. 193, 1881.



USEFUL AND SCIENTIFIC NOTES.

According to Mr. Vickerman, of Huddersfield, the old worsted coating has had its day, and he prophecies that the black dress coating for the future will be woven from a combination of worsted and wool. Addressing what may be called an audience of experts at a gathering under the auspices of the Yorkshire College Textile Society, Mr. Vickerman declared his belief that a black coating for evening dress purposes would yet be produced by combining woollen and worsted, which would outvie anything yet seen. It would be light in weight, mellow, warm, and durable, with the face undertoned by a fine, neat, fancy pattern when preferred. A combination of the kind is, in Mr. Vickerman's opinion, capable of an all-round application.

A Bullet in the Brain.—At the recent meeting of the New York State Association Dr. Cronyn related a case of extreme interest as regards the tolerance of the brain to injury or even to foreign bodies. The patient was a boy who had received a bullet on the left side of the forehead just above the orbit. He was supposed by his parents to be dead. Dr. Cronyn, however, probed the wound. The probe came in contact with the bullet, a "click" was heard, and the bullet moved backward. There was then twitching of the limbs, respiration, and other signs of returning animation. Three days later the patient became conscious, but he was unaware of what had happened. The right arm and leg were at first paralysed, but gradually improved, and within three months he was able to be up. Before the accident he had been able to read and write and also to count; but after the accident he lost all recollection of even the alphabet. His capacity for calculation, however, had improved very much. In due time there was complete restoration to an ordinary condition, and the spot where the bullet had entered could scarcely be recognised, so that at a medical society at which he was shown doubt was expressed as to his having ever sustained a gunshot wound of the head. Nine years and a half after the first accident, however, the boy was struck on the other side of the head, and died in a few days. At the necropsy the bullet was found encysted in the posterior portion of the left hemisphere, lower in the brain than the point of entrance.—*Lancet.*

SCIENTIFIC SOCIETIES.

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BRITISH ASTRONOMICAL ASSOCIATION.

The first meeting of the second session of the above association was held at Barnard's Inn, on Wednesday, the 25th November, the President, Captain Wm. Noble, F.R.A.S, in the chair. The minutes of the preceding meeting were read and confirmed. A list of papers received was presented, and the names of five candidates for membership were also read out. Mr. Waugh, director of the Jupiter section, sent a book containing an interesting series of drawings of the planet by members of the section, all drawn to the same scale and on specially prepared paper, as recommended by Mr. Green.

Mr. Elger gave a short report of the work of the Lunar section, expressing great satisfaction with the high quality of many of the drawings he had received; he also read reports of the recent total lunar eclipse from Prof. Everett, F.R.S., and Messrs. J. E. Gore and Thomas Radmore. The eclipse was fairly observed in each case, but considerable difference of opinion appeared to exist as to the tint of the eclipsed portion. The moon's surface showed so much roughness at the edge of the shadow, that there was no chance of detecting the Andes.

The President remarked that he had obtained occasional views of the eclipse, and was satisfied that it would be impracticable to recognise the shadow of the Andes on the rough surface of the moon. He estimated the colour during eclipse to be a reddish green.

Rev. A. Freeman had also had occasional glimpses. The penumbra appeared to him to be smoke colour, and the tint during eclipse a bluish grey. He was also struck with the rugged appearance of the limb of the moon, particularly near the south pole, and the generally wavy outline towards the north. He noticed also a remarkable triangular elevation towards the south, which he could not identify.

Mr. Ranyard said that he had been looking up some old observations of eclipses, and he was much struck with the great variety of the colour estimates. He concluded that these variations were the result of great changes in the upper strata of our atmosphere. He proceeded to point out that the geometrical shadow of the earth was less than the diameter of the earth, and that refraction should have the effect of making it smaller still, but that, as a matter of fact, the shadow was greater than the earth's diameter, the *Nautical Almanac* estimating it at $\frac{1}{80}$th more. He concluded from this that the lower strata of our atmosphere were practically opaque to the solar rays.

Mr. Maunder remarked that at Greenwich they were always unfortunate; the eclipse was, for them, a total one in every respect. About ten o'clock the moon was just seen for a moment, long enough to bring the dozen observers who were appointed to watch it up to their posts, and then the clouds rolled together again, and everything was hidden. But though they had seen nothing of this last eclipse at Greenwich, a very interesting paper on a former eclipse, that of Jan. 28, 1888, had just been published by Lord Rosse and his assistant, Dr. Boeddicker. The net result of Dr. Boeddicker's observations during that eclipse had been to show, after making every allowance for the difficulties of the observations, that the decrease of heat had begun quite three minutes before the first entry of the moon into the penumbra of the earth—a conclusion which indicated that the atmosphere of the earth at a height of 190 miles was able to cut off an appreciable portion of the heat rays coming from the sun to the moon.

Mr. Downing asked whether any member had tried to estimate the times of the passage of the edge of the shadow over the different lunar formations; and, if so, what was the probable error of such an observation? Such observations would be very valuable, as giving the diameter of the earth's shadow.

Mr. Elger had attempted such observations, but had found them most difficult. He could not observe them within less than a minute, the edge of the shadow was so smudgy.

Rev. A. Freeman had observed such transits within five seconds.

The President suggested that Mr. Downing should remind the members of the desirability of making these observations previous to the next eclipse.

Mr. Ranyard referred to some photographs of an eclipse of the moon taken by Prof. Eastman. Curiously enough, not only did not the edge of the shadow as shown on the photograph coincide with its position as observed at the same time by the eye, but a later and denser photograph put the shadow further back.

Mr. Elger read a paper by Lieut. Molesworth suggesting the employment of photography as a means of testing the existence of a lunar atmosphere.

The President did not believe that either photography or any other method of observation could reveal the existence of any atmosphere on the moon. He had observed an occultation of Saturn, and had watched Saturn slowly pass behind the moon, every detail of its surface being as sharp and clear as an engraving—for it was a magnificent observing night—right up to the limb of the moon. The observation had impressed him very greatly, for he felt sure that had the moon possessed an atmosphere even only one or two seconds in height, it must have produced a noticeable effect. On the other hand, during an occultation of Jupiter, he and other observers had noticed a curious shading on the planet close to the limb of the moon, as if the moon had cast a shadow upon it.

Rev. A. Freeman read a paper on the "Transit of the Shadow of Titan, Nov. 21, 1891." He thought he detected the shadow at 4h. 42m. 30s., and at 4h. 46m. 20s. was certain of it. The shadow was watched until 5h. 41m. 25s., when it was but a little more than its own breadth from the preceding limb of Saturn. He wished to call the attention of observers to a transit of the shadow of Rhea on the early morning of Dec. 2.

Mr. Cottam had not observed this transit of Titan's shadow, but had observed it three times in 1861 with a telescope of 2¾in. aperture, so that a large telescope was not needed for the observation.

Mr. Schooling exhibited and described some apparatus which he had used for astronomical photography. An ordinary achromatic telescope might be readily adapted for photography, merely by fixing a plate-holder to the eyepiece tube, and moving it in and out until the photographs proved to be in focus. But a much more useful work would be to try short-focus portrait lenses. A camera with such a lens, of aperture, say, 4in. or 5in., could be strapped on to the equatorial, the telescope of which could be used as a guide. Such short-focus lenses were pre-eminently useful for photographing nebulæ, and he earnestly hoped that an additional section would soon be set on foot for co-operation and help in celestial photography. Such a section might do most good and useful work also by making lantern slides which would be most useful in illustrating papers read at their meetings or for lectures in different places.

Mr. Seabrooke said that he had given considerable attention to photographic astronomy for a number of years. He asked Mr. Schooling what was the effective aperture of his portrait-lens telescope.

Mr. Schooling said it was 5in.

Mr. Kennedy said he had found that the quickest method of focussing was to insert a plate in the camera at an angle of 45°.

Mr. Petrie cordially supported Mr. Schooling's plea for forming a good collection of astronomical lantern slides. He felt sure that such a collection would be highly appreciated by the members, and would be found most useful in popularising astronomical study.

Mr. Holmes read a paper "On the Proportion of Light Transmitted by Telescopes," in which he said that whilst many people were under the impression that a refractor transmitted the whole, or nearly the whole, of the incident light, experiments had shown him that the loss of light was serious even in a small instrument, and in a large one the loss from absorption was so great that a point might be reached when the additional light gathered would be more than balanced by the increased absorption, and no further gain in light be possible. He then gave the results of his experiments on the loss of light by reflection from the surfaces of lenses, which he estimated as 11 per cent., in the case of the four surfaces of an object-glass. His conclusion as to the loss by absorption was that it amounted to 20 per cent. in the first inch of thickness of crown glass. Flint glass absorbed less, but reflected more. He had also made experiments as to the effectiveness of reflectors, and calculated that a 12in. reflector and a 12in. refractor were very nearly equal as to light.

Mr. Maunder drew attention to the note on p. 74 of the *Journal*, which they had received that morning, in which the Council invited suggestions as to the subjects for popular or educational lectures. It was hoped that an equatorial telescope might be provided for the next meeting, and its adjustments explained, and the mode of reading its circles, &c. Twenty new members were elected, and the meeting adjourned at 6.30 p.m.

SCIENTIFIC NEWS.

THE position of Wolf's comet on Dec. 17 is, according to Dr. Berberich's ephemeris for Berlin midnight, R.A. 4h. 16m. 17s., S. Dec. 14° 50·7′; brightness 5·28, as compared with unity at time of rediscovery. A day or two afterwards the comet reaches its greatest S. Dec., 14° 51·2′.

The small planet discovered by Dr. J. Palisa, of Vienna, on Aug. 30 (now numbered 313), has been named Chaldea.

Prof. Auwers gives the sun's parallax as 8·880″, thus agreeing with the French measures, and those of Stone in 1874. Prof. Auwers gives the result of the determination from the measures of the German Transit of Venus expeditions in 1874 and 1882, during which years 754 measurements were made.

M. F. Tisserand, of the Bureau des Longitudes, has presented to the Paris Academy of Sciences a paper, in which he points out that the length of the sidereal day remains practically invariable, the increase due to tidal action being balanced by the decrease due to the secular contraction of the earth as it cools.

"Dark Structures in the Milky Way" is the title of a paper by Mr. Ranyard in this month's *Knowledge*, illustrated by an enlargement from a photograph taken by Dr. Max Wolf of the region about Xi Cygni. The same number contains the first of a series of articles by the Rt. Hon. Lord Justice Fry, F.R.S., on "British Mosses," an expansion of the discourse given by the learned judge at the Royal Institution.

The death is announced of Prof. F. S. Downing, Principal of the Civil Engineering College, Calcutta. The deceased, who was only 47, was a graduate of Dublin University, and went out to India in 1869.

That well-known flute player and designer, Mr. Richard Carte, died the other day in his 84th year. He made the modern form of flute permanently recognised about 1843, and retiring from his profession in 1850 he joined a firm of musical instrument makers. Besides other devices he invented the famous "1867 flute" as it is called.

The anniversary meeting of the Royal Society was held on Nov. 30, St. Andrew's day, according to custom, when the president, Sir W. Thomson, delivered the address, commencing with memorial notices of those Fellows who have died during the year. The Transactions contained nineteen memoirs, occupying 1,020 pages, illustrated by 60 plates, while the Proceedings contained a large number of papers, two-thirds of which are on the physics and dynamics of dead matter, and one-third on biological subjects. After referring to the Brady and the Gunning bequest, the president said he had received from Prof. Förster, of Berlin, information which left no doubt that, in the few months during which corresponding observations have been carried on at Berlin and Honolulu, latitude increased at the former, and decreased at the latter place, the amount (one-third of a second) being the same at each station. After some further remarks the president referred to the medals, which were then distributed, the Italian ambassador receiving that awarded to Prof. Cannizzaro. The officers and council were then elected.

A new edition of the statute book of the Royal Society has just been distributed to the Fellows. One statute, which has appeared on the book for about 225 years, has been expunged—viz., that which provided that the president, "being in the chair, shall be covered while speaking to or hearing particular Fellows, notwithstanding their being uncovered."

The International Congress of Experimental Psychology will be held in London on August 2, 1892, and three following days, under the presidency of Dr. H. Sidgwick. Already many distinguished students of psychology have announced their intention to take part in the proceedings.

It is probable that the United States Government will issue the invitations to the International Congress of Electricity, to be held in Chicago in 1893, through the Governments to which those invited belong. It is thought that such an arrangement will give an official character to the proceedings of the Congress, and that some uniform system of standards may be agreed upon.

A notice published in the *London Gazette* announces that the protective sections of the Trade Marks Act of 1883, in regard to inventions sent to an industrial or international exhibition, shall apply to the Chicago Exhibition of 1893, the exhibitors, however, being relieved from the conditions specified as to the giving of notice of their intention to exhibit.

It is stated that a micro-biological institute has been established at Saigon, in Cochin-China, the objects being: (1) Animal vaccination; (2) vaccination against hydrophobia; (3) the manufacture of Pasteur's vaccine for anthrax in cattle; and (4) the analysis of water, of organic liquids, and of alimentary or manufactured substances liable to alteration by microbes, or to fermentation, such as food preserves, beer, &c.

One of the trustees of the British Museum (Mr. Fortnum) has offered a munificent gift to the University of Oxford, consisting of his rare collection of objects of art, ancient and mediæval, worth £15,000, an archæological library of unique character, and £10,000 in money. One of the conditions is that the University should provide £500 a year in perpetuity to be devoted to supplementing the contributions made.

The second series of the Sunday Lecture Society will comprise the following lectures, which are delivered on Sundays at 4 p.m. at St. George's Hall, Langham-place:—On Dec. 6, Mr. Eric S. Bruce, M.A., will lecture on "Fogs and their Prevention"; Dec. 13, Prof. J. F. Blake, M.A., on "The Origin and History of the Thames"; Dec. 20, Prof. Vivian B. Lewes, on "Flame and the Causes of its Luminosity." The lectures for January are—"New Antidotes for Old Poisons," by Prof. Percy Frankland, B.Sc., F.R.S.; "The Anatomy of Suicide," by Dr. B. W. Richardson, F.R.S.; "In Search of Pharaoh," by Mr. Whitworth Wallis; and "High Life in the Middle Ages," by Mr. Willmott Dixon, LL.B.

At the Royal Victoria Hall, on Tuesday, Dec. 8, Mr. E. B. Poulton is to lecture on "The Ways in which Animals Hide Themselves," and on Dec. 15 Mr. H. G. Seeley will lecture on "Old Stones."

It is stated that, owing to the high price of cannel coal, some gas companies are trying to utilise Russian petroleum for enriching the gas they make from ordinary coal. The cost is said to be about one penny per 1,000 cubic feet of gas for each candle of increased illuminating power.

Sir R. S. Ball, the Astronomer Royal for Ireland, has written a work entitled "The Cause of an Ice Age," which will appear in the series of scientific books issued by Messrs. Kegan Paul and Co.

On Monday last Major-General Hutchinson and Captain F. Cardew inspected, on behalf of the Board of Trade, a new electric tramcar which is to be adopted by the Croydon Tramways Company. The tramcar, which, when empty, weighs 5½ tons, so it is said, is driven by two motors of 14H.P. nominal, and can attain a maximum speed of 16 miles an hour. A trial trip was made to Thornton Heath, after which the whole of the circuit to North-end, Croydon, was completed without a hitch, and the inspectors expressed themselves as being thoroughly satisfied with the experiment.

Some interesting facts have recently been brought before the Chemical Society in connection with the formation of iron carbonyl by Sir H. E. Roscoe and Mr. Scudder. Mr. Mond and Dr. Lange have also been working on iron carbonyl, and have made some perhaps important discoveries in connection with carbon monoxide.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

◆

λ OPHIUCHI — ν^2 SCORPIONIS — TEST STARS—ε LYRÆ.

[32941.]—CAPTAIN BATTERSBY (letter 32850, page 220) asks for recent measures of λ Ophiuchi. The following are some of the latest values:—

Jedrzejewicz..	41·7°	1 64″	1886.	6·4in. refractor (5 nights).
Schiaparelli ..	42·4	1·48	1887.	18½in. refractor (11 nights).
Leavenworth..	42·6	1·55	1888.	10in. refractor (4 nights).

and of ν^2 Scorpionis (7 and 8 magnitudes)—

Tarrant	49·5°	2·10″	1886.	10½in. reflector (3 nights).
Leavenworth..	48·3	2·22	1888.	10in. refractor (3 nights).

There is no evidence of change in distance since its discovery. Jacob gave 41·1° 2·13″ in 1850. I have seen it well with a 3in. refractor in England. I hope the following list of test objects will be of use to him. I have not arranged them in any particular order, nor have I given the places, as they are either in Webb or are naked-eye stars. The initials are as follows:—β, Burnham (12in. and 36in. refractors); M, Maw (6in. refractor); L, Leavenworth; Sch, Shiaparelli (8½in. refractor); R, Russell (7½in. refractor); Ta, Tarrant; Te, Tebbutt (8in. refractor):—

42 Ceti	6½	7	349·6°	1·51″	1888.	L.
ε Arietis	5½	6	202·9	1·28	1889.	L.
12 Lyncis (A.B.)	6	6½	124·9	1·57	1889.	M.
52 Orionis......	6	6½	202·7	1·53	1877.	Sch.
μ Libræ........	5	6	340·6	1·61	1889.	β.
β Crateris......	5	5	349·6	1·53	1889.	β.
Σ 2744	6½	7	168·5	1·49	1888.	L.
η Pisc. Aust. ..	6	6·2	118·5	1·61	1888.	β.
μ^1 Lupi (A.B.)..	6	6	163·5	1·78	1874.	R.
ε Chamælon. ..	6	6½	179·0	1·47	1872.	R.
36 Androm.	6	7	368·8	1·35	1891.	M.
π Aquilæ	6	7	117·8	1·45	1886.	Ta.
γ Centauri	4	4	359·5	1·73	1888.	Te.
γ Coronæ Aust.	6	6	183·0	1·61	1890.	Te.
θ Gruis	5	8	22·1	2·33	1887.	Te.
π Lupi	5	5	86·3	1·50	1888.	Te.

With regard to the smallest aperture and power with which ε^1 ε^2 Lyræ can be seen, I would refer to some experiments made by Dawes over sixty years ago. He was using one of the very best and also one of the worst telescopes he ever had, the good one being what was called a "2-foot" Dollond, of 1·6in. aperture and 19½in. focus, and the bad one a 45in. refractor of 2¼in. focus. With a power of 120 on the 1·6in. ε_1 (4) was shown "just neatly separated," and ε_2 (5 Lyræ) "in close contact." "But with the 45in., both sets were widely separated with the same power."

Nov. 27. **H. Sadler.**

LARGE METEOR, 19th NOV. — LONG-ENDURING RADIANTS — A SUGGESTION.

[32942.]—I OBSERVED a large and brilliant meteor on the 19th inst., at 6.40 local time, moving slowly from near Capella to Dubhe Ursæ Majoris, and estimated its duration at from four to five seconds. At the commencement of its course, it was almost as large as Jupiter, and increased in magnitude and brilliancy, throwing off sparks and tail as it moved along, or, rather, as I conceive, as it plunged the deeper into the earth's atmosphere. During my intermittent watches, I have seen several large meteors, both last season and this, from this important radiant, and no doubt this was another Aurigid.

Touching the question of long-enduring radiants generally, I believe if they were carefully watched as they move towards the western horizon some important information might be obtained, as, so far as I know, the eastern sky is much better observed than the western. I anticipate these radiants would be found to send us meteors long after they have passed the meridian, if only carefully looked after. It might turn out that they send us meteors the year round; and not only so, but for an indefinite period altogether, the meteors moving along divergent paths from their several centres of emanation. The region in and around Cassiopeia, Andromeda, and Perseus would, I think, be particularly worth watching. Possibly Mr. Denning would favour us with his views on this subject.

Dublin, Nov. 23. **W. H. Milligan.**

M. STAS ON THE NATURE OF SOLAR LIGHT.

[32943.]—Le mémoire de M. Stas, *Sur la Nature de la Lumière Solaire*, dont il a été question à diverses reprises dans les derniers numéros de l'English Mechanic, vient de paraitre. Il fait partie du tome XLIX. des *Mémoires* des Membres de l'Académie des Sciences de Belgique.

A. Lancaster,
Bibliothécaire de l'Observatoire Royal.
Uccle, Nov. 25.

ORGANETTES (AND PIANISTAS).—XI.

[32944.]—In describing Fig. 24 of letter IX. I mentioned the possibility of applying a somewhat similar arrangement to the construction of a pianista, and included in the Ehrlich patents are many applications of the principle. Of the apparatus as made for sale I have seen three forms described and illustrated in the price lists. The first two are alike in using perforated discs (being, in fact, the same that are used for the large-size "Ariston" organette), but differ in the mode of attachment to the keyboard, and, perhaps, internally as well. The third form employs long bands for the tunes, and is also of greater compass, comprising 54 notes, the internal parts being likewise varied to suit the horizontal position of the tune-band, instead of the vertical disc of the other two patterns.

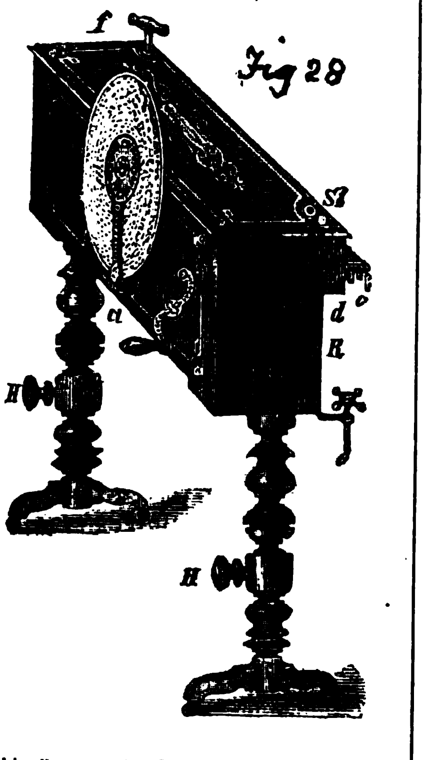


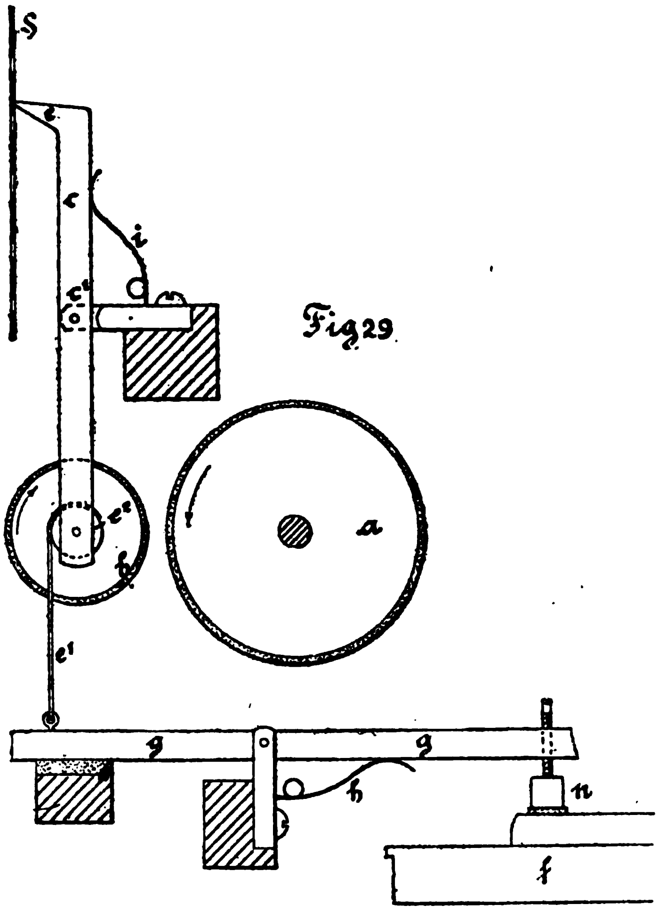
Fig. 28 shows one of the first-mentioned patterns, which, as will be seen, has an independent support as well as the gripping-screws, &c., for attaching it to the keyboard of the piano. The supports are adjustable for height, and are secured when adjusted by the clamping-screws H H. The key shown at *f* is for lowering the hammers *c* on to the piano-keys by inserting it at *f* and at *s'*.

The second pattern looks much the same, but without the legs. The compass is from G to C, with 42 hammers in both of them.

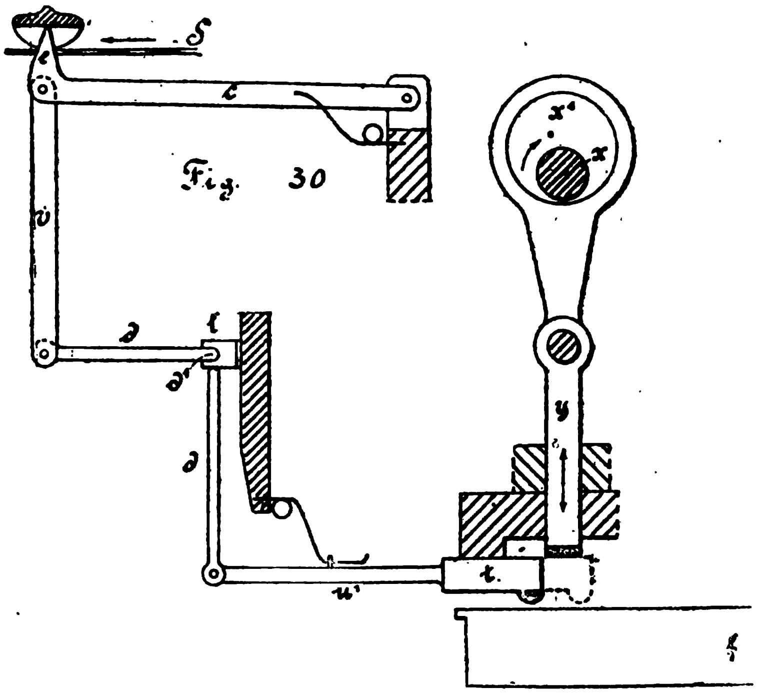
In the largest, or 54-note, instrument the tune-band passes from roller to roller, and acts on the mechanism in its passage, much as in the organette shown in Fig. 7, except that the band is rolled and not folded.

As it is impossible to show all the modifications of the internal mechanism described in the specification, I select two: the first of them on account of its simplicity, and the second from its employment of a better kind of "action" to strike the piano-keys than either of the others illustrated.

The former pattern would be used for discs, and the latter probably for the horizontal tune-bands, or for "planchettes."



In Fig. 29, *a* is a roller with indiarubber surface, kept constantly revolving in the direction of the arrow; *b* is a similarly covered roller turning on a pivot at the lower end of the vertical lever *c*. This lever is pivoted at c^1, and its point *e* is adapted to enter the perforations in the tune-disc *s* under the pressure of the spring *i*. Attached to the side of *b* is a smaller roller e^2, on to which the band or cord e^1 is wound when *b* and e^2 are caused to revolve in the direction of the arrow. To the lower end of this cord is attached one end of the lever *g g*, whose other end has a touch-screw and pad *n* to act on the piano-key *f*. The spring *h* is to restore the lever to its original position after it has done its work.



The mode of working is almost self-evident. When *e* enters a perforation, the roller *b* is thrown against the roller *a*, the band e^1 is wound on to e^2, and the piano-key is pressed down. When the perforation has passed, all parts resume their position, as in the Fig.

This arrangement certainly relieves the tune-band itself, and throws the actual work of striking the keys on the prime mover; but it is not free from defects. The rollers *a* and *b* are brought suddenly into contact, and there must be some amount of slipping (which means extra friction), till the inertia of the parts, including that of the piano action, is overcome.

Then, again, the motion of *b* will always be arrested at the same point—viz., when it has wound up the cord e^1 to the full extent; but *a* will still perhaps make a turn or two (before the rollers are separated by the falling back of the lever *c*), and thus tend to rub that particular part of the indiarubber rim of *b* more than any other part.

The patentee evidently realised this objection, and endeavoured to get over it by various expedients adapted to the different arrangements which are included in the patent. In some cases, he provides the roller *b* with a smooth surface at the point, where it comes to a stop, so that *a* shall no longer affect it. In other forms, he makes *b* of less diameter at this point of the circumference, and so on, but all have, in reality, the same fault. Since the piano-key is always trying to rise, and the spring *g* is also acting in the same direction, it is evident that *b* is *ready* to revolve in the *contrary* direction to that impressed on it by *a* whenever it gets the chance. The result is, that if there be a point where a smooth surface *commences*, or the diameter is reduced, just at that point *special* wear will occur, till the pulley and cord can pull *b* round a little farther, when a *new* place will be attacked and worn down, and so on; thus the destruction of the contact surfaces would not be avoided by any such device.

There would also appear to be another difficulty. When in Fig. 24 the perforation has carried the point *e* forward, and so brought *b* into contact with *a*, the rotation of the disc must be abruptly arrested till *e* has been carried down sufficiently far to set it free;—as the handle, however, is being constantly turned, there must be great risk of tearing the disc (especially where two perforations follow each other closely), unless the disc can yield a little. Possibly, a coiled spring, interposed in the connection between the disc and its spindle, might obviate this, but no such provision is mentioned in the specification.

I believe the particular form of the pianista in which discs are used has not been found altogether satisfactory, and this may be due to the causes mentioned. The cost is only about a third of the pneumatic construction, so it is a pity it is not more successful.

Suppose next that *g*, *g* was pivoted at its left-hand end, and that the cord, or band, e^1, was attached where the present pivot is, then when *b* was rotated, the right-hand end of the lever would be drawn up, instead of down, and with about twice the velocity of e^2's notion. This reversed action is employed to cause a sticker (attached where *n* is shown) to act on a hammer, and strike a vertical string, as in an ordinary barrel-piano. In this contrivance, the string would be struck far more forcibly than by the arrangement shown in Fig. 25, with which it may be, to a certain exrent, compared; but the defects just referred to would be quite as bad, since the reversed action of the lever does not affect the frictional apparatus.

We now come to Fig. 30, in which a quite different mechanism is employed. S is the (horizontal) tune-band, *c* the lever, with its point, *e*, to enter the perforations. To this lever, by means of the link *v*, is connected the bent lever *d*, *d*, pivoted at d^1 in the block *l*. The horizontal and vertical arms of *d* are not in the same plane, but are separated by a horizontal axis, whose length depends on the relative positions of *c*, and of the note to which it belongs. These axes form a kind of horizontal gridiron, extending lengthways of the case, the number of bars corresponding to the number of notes to be struck by the hammers of the pianista. The object, of course, is to collect the levers *c* into as narrow a space as possible, and this, or some similar arrangement, would be applied in many of the instruments that have been described.

Returning to Fig. 30, the vertical arm *d* is connected to the horizontal bar *u'*, whose end *t* is enlarged and padded where it rests on the piano-key. At *y* is a plunger, worked rapidly up and down by the eccentric x^1 fixed to the axis *x*, which latter is kept constantly revolving at a high speed, so that even demisemiquavers may be played when desired. The action is easily seen. When *e* leaves a perforation, *t* is pushed under *y*, and thus gets driven down on to the piano-key; or (by reversing the action) *t* may be brought under *y* when *e* enters a perforation. The former is more adapted to the use of a solid "planchette" with pins, as in the pianista previously described; but the patentee claims both arrangements as available.

He also shows how the friction-roller mechanism of Fig. 28 can be applied to act on the pedals of a piano; but the construction will be pretty clear without a special sketch of it.

The date of this specification of Ehrlich's is May, 1887; but unless I am much mistaken (I have not the means here of deciding the point), Wenham preceding him in applying the plunger arrangement, as well as in *claiming* (but not actually showing) the use of the friction roller as an alternative scheme. So far, however, as interposing and withdrawing a movable piece below a constantly working plunger, the idea is an old one, and is used in machines for punching metal. It also forms part of a machine I sketched out (and propose describing), for perforating tune-bands.

Before leaving the mechanical section of pianistas, I may as well describe the apparatus that about 1854 I was trying to work out, and which has been already referred to, more especially as the principle does not seem to have been claimed by any patentee till Mr. Wenham applied it in a different way in his pianoforte player.

Let there be a square or polygonal roller, pivoted at its ends in a swinging frame, having a regular to-and-fro movement communicated to it by the prime mover. Over this roller passes the endless tune-band, made of separate pieces (each of the size of one face of the roller) of stout cardboard linked together by strong tapes. The sides of the roller are pierced with four rows of equidistant holes, 12 in a row, assuming it to be for a 48-note instrument. Opposite each hole is a pin or stud, and to each stud is connected by arms and links a hammer, or plunger, to act on the key of the organ or harmonium—it was not intended for playing a piano. If no tune-band were hung over the roller (or if the tune-band were evenly perforated all over), the pins would enter the holes in the roller quite freely, and no key would be acted on. If, however, a blank part of the tune-band covered any hole, the pin could not enter it, but would be pushed back, and the corresponding key depressed by the plunger or hammer. The tune would thus be formed by the absence of perforations in the tune-band. At each to-and-fro swing the roller is caused to turn a fresh side, and therefore a fresh portion of the tune-band to the pins. In a still nearer approach to the Jacquard-loom principle the swinging-frame, with its roller and tune-band, was to merely push the selected plunger-studs under a reciprocating bar. The difficulty, however, of holding down the notes to obtain minims, crotchets, &c., and other objections, seemed insurmountable, and nothing further was done, so that Mr. Wenham's instrument on somewhat similar lines was the first actually constructed.

A. S. L.

MAGIC SQUARES.

[32945.]—I INCLOSE a magic square of 36 cells, thinking it may be interesting, as the square itself can be divided into nine squares, shown by thick lines Fig. 1, the sum of the numbers in each of the nine squares being 74.

FIG. 1.

36	2	34	3	4	32
6	30	8	29	28	10
26	25	13	14	15	18
11	12	23	24	22	19
27	9	17	20	7	31
5	33	16	21	35	1

I should state that this square has been constructed after reading letter 32917 of Mr. Willis in reference to oddly-even squares, and the method, if it is not (in substance) exactly that of Mr. Willis, may be a modified form of it.

FIG. 2.

+ 17½	− 16½	+ 15½	− 15½	− 14½	+ 13½
− 12½	+ 11½	− 10½	+ 10½	+ 9½	− 8½
+ 7½	+ 6½	− 5½	− 4½	− 3½	− ½
− 7½	− 6½	+ 4½	+ 5½	+ 3½	+ ½
+ 8½	− 9½	− 1½	+ 1½	− 11½	+ 12½
− 13½	+ 14½	− 2½	+ 2½	+ 16½	− 17½

Fig. 2 was first made by subtracting 18½ (the mean number) from all the numbers, and arranging the results as shown, and so as to make total of each column and of each row zero. It will be noticed that each group of four numbers, shown by thick lines, is also zero. By adding 18½ to each number, we get the magic square Fig. 1.

J. H. Truscott,

TECHNICAL EDUCATION.—TO "T. L."

[32946.]—As you call "A. M. B." in question, you would do well to be consistent, and not give yourself away so freely. Our readers will notice how in "T. L.'s" experience "good-sized, healthy boys do not require much teaching how to use hammers," &c., but use them in a way that "does not altogether suit the views of *mater*." Could not these boys be taught how to use these tools so that mater might be conciliated, and the stock of firewood increased without undue labour?

It is a fact that many boys learn principles best by practice, if only the practice is conducted by those who understand both principles and practice, and can put their explanations into such language as boys can understand. The difficulty is to get a teacher who can and will explain verbally, while he is actually performing the operation in question, and another obstacle to the desired end, so well explained in the after-part of "T. L.'s" letter, is that so few schoolmasters appreciate the value of such practical explanations. Then again many, not only boys, learn by failure. When a boy has tried to cut across a thin board with a rip saw, he is then ready to receive a lesson on why saws differ, and how each is suitable for its purpose.

But, alas, when the teacher is suitable, and his work progressing, another king arises who knows not Joseph, but believes in payment by results (so called): the school becomes a workshop, and the teacher is driven to drive his pupils to produce something to show, or to win a grant or something, and he has to cease his explanations, and secure a large but *mechanical* output.

B. A. Baxter.
A Boys' School Manual Instructor.

TELESCOPE GLASS.

[32947.]—I HAVE just noticed the communication made by Mr. Caplatzi (letter 32731) in reference to the glasses in a telescope which has fallen into his hands, and which, from its appearance, he believes the Abbe-Schott glass has been employed in its construction. There have been numerous cases where this new glass has been used in microscopic objectives of very serious alteration of their quality, especially where they have been kept at the seaside or in hot climates.

The polished surfaces have become, in less than eighteen months, milky and opalescent to such a degree as to entirely destroy their definition; on examining the surface under a microscope, they show a number of oily-looking spots, regularly disposed over the surface of the glass; these markings, if not immediately wiped off, eat into the substance of the glass, as though it had been exposed to the influence of hydrofluoric acid gas; and, what is more curious, is that the destruction appears to be almost as rapid on the interior surfaces as on those exposed to the air. Can it be that the phosphates incorporated with the silica and different alkalies is the cause of this disagreeable effect?

At all events, if the use of these new compounds has not yet resulted in obtaining permanent products as hoped for, yet we are greatly indebted to the Jena house for the application of fluorite in the construction of apochromatic object-glasses; though unfortunately that substance is not found in sufficiently large masses to permit of its being used for telescopic lenses.

Paris. No Sig.

COMMUNICATION BETWEEN SHIPS AND SHORE.

[32948.]—I SHOULD think an indiarubber tube (say about ¼in. diameter) covered with canvas, with a buoy on the end—in the shape of an air vessel—and charged with air and hermetically sealed, would be very useful for above purpose. It could be kept wound on a drum like a fire-hose reel. When the end was payed out it would have a tendency to push itself ashore, as it would be tolerably rigid because of the compressed air, and at the same time very buoyant.

Ipswich. E. C. M.

THE LANTERN MICROSCOPE.

[32949.]—I AM pleased to see Mr. Furnivel's plain and simple defence of himself on this subject. He may fairly be considered the father of the simple lantern microscope, and as I have worked with both his simple form, without alum trough, and also with Leach's, I may say that experience fully bea out his statements. That it is possible with eith form to get a large projection on the screen with good limelight is no doubt correct; but after a m careful testing of both under precisely the sa conditions, I most certainly prefer Furnivel's a less than half the price. My object in testing bo was to obtain a clear definition of the diffe yeast cells on the screen, but after repeated trial with the assistance of some experts with the lant and microscope, we failed totally with both, th best results being obtained with Furnivel's arrangement. With a Powell and Lealand ¼in. apo chromatic the results under the best conditions we most unsatisfactory, and we found with either for the highest power which could be used was a 4-1

It sounds very large indeed to talk about th proboscis of a blowfly 16ft. long; but the fact is tha the same would be far better shown if only 3ft., an would make a much more effective picture in an ordinary room. I have had no experience with th arc light in the micro. lantern, and therefore m remarks do not apply to this.

Thos. Fletcher.

NATURAL DRINKS.

[32950.]—I WISH to tender my sincerest thank to "Eos" (letter 32924) for the information give in last issue to my two queries 75845 and 758 The subject is an important one, and of gener interest, as may be seen from "999's" remark among the "Replies." As to hot drinks, my ow conviction is that they are cooling, and therefore suited to warm climates. On the other hand, cold drinks are warming, and therefore better suited to colder climates. We abuse tea and coffee in this country, both by bad making and incessant drinking. Tea and coffee should *never* be taken with regular meals. However, as in place of tea or coffee I have found (by personal experiment) that very good drinks can be made from the shell of nuts, such as cocoa-nut, Brazil nut, walnut, &c. The shell is first crushed, then roasted, and afterwards passed through a coffee-mill. An infusion is made from the powder, and taken with milk and sugar, as is done with tea and coffee. I have also made an important discovery in this connection, whereby certain fruit stones can be used, and very strong and palatable drinks obtained from them. But I fear to give details, for such would probably afford fresh impetus to food adulteration, or, rather, misrepresentation. I believe I know the "close secret" of "date coffee" making. But let us abandon hot drinks at meal time and substitute cold, which are far more wholesome.

Perhaps "Eos" could give us further particulars of the berries or bark to which he refers, or has used for making drinks therefrom.

An Old Reader.

INFLUENZA.

[32951.]—Having read the letter of "Lydney Dispenser" regarding the use of homœopathic medicines, I beg to state that, from an allopathic point of view, the course prescribed appears intricate and involved.

I should prefer to recommend to the public a remedy which is acknowledged to be of value, and is now prescribed and dispensed by the profession. Moreover, it is a good preventive; but should the disease actually attack, it would seem to lessen its force, and minimise its mischief.

I allude to "Kreas Halonia," the new substitute for quinine, which I tried, because, from the nature of the accompanying fever, I judged influenza to be of malarial origin. I say malaria is probably the cause; but, of course, atmospheric vicissitudes, or meteorological rapid changes, causing chill, are large factors in causation.

Telluric agency, resulting in malaria, is certainly more feasible than planetary influence, from which its name is derived.

G. Yeates Hunter,
Retired Brigade Surgeon, Bombay Army.
Philbeach-gardens, S.W., Nov. 25.

NEW ARRANGEMENT OF ACCUMULATORS.

[32952.]—Two or three years ago we put in a set (50 cells) of Planté accumulators. For some time they have been quite useless, owing to the difficulty of keeping the dilute S. acid from leaking. At first we tried wood cells dipped in pitch, &c., then glazed stone cells insulated on glass, coated with indiarubber solution, &c.; but all of no avail. A short time ago it occurred to me to try the effects of filling the cells with sawdust steeped in dilute acid, and so far the results have been very satisfactory; the cells so filled appear to charge quicker, and to retain the charge better, than those filled with the d.a. in the usual way.

Can any reader of the "E. M." point to a similar case, or say if the present good results are likely to be permanent—or otherwise? If no unforeseen drawbacks, would not this arrangement be a boon to cars, &c., worked by accumulators?

Bp. Auckland, Nov. 24. T. R. D.

PROJECTILES, AND THE ROTATION OF THE EARTH.

[32953.]—In last week's "E.M.," your valued correspondent, "F.R.A.S.," in letter 32925, says:—"Everyone who has ever opened a book on gunnery must be familiar with the allegation that the rotation of the earth from west to east causes a very perceptible deviation in the flight of a projectile fired from north to south, or from south to north, such deviation being, in our northern hemisphere, always to the right of the line of fire." I do not know much about gunnery; but if gunners say that, when they fire either from north to south or from south to north, the projectile always deviates to the right, that deviation surely cannot be caused by the rotation of the earth. The earth rotates from west to east—that is, when a rifleman is facing and firing south, from right to left. It is quite understandable, in this case, that the ball may, on account of the rotation, deviate to the west, or to the right; but when he turns round and faces north, the rotation is from his left to his right, so that the deviation should, in that case, be to the left, though still, of course, to the west.

Nor is it easy to see what difference it should make whether the rifleman is firing in the northern or southern hemisphere. When he is firing south in Australia, the earth still rotates from his right to his left, and the deviation of a projectile should still be to his right, and when he faces north, to his left, just as here, in Great Britain. The "N.S.W. Reserve Rifleman," quoted by your correspondent, is, therefore, probably quite correct when he affirms that the deviation is the same in both hemispheres; but surely he does not mean to say that it is always to the right of the line of fire, whether he is firing due south or due north? If so, then, it seems to me that the rotation of the earth can have nothing to do with it; but perhaps I am only an

Ignoramus.

LATHE INDEX.

[32954.]—The index on the lathe which I use has an arrangement for adjusting its length which is sometimes useful (Fig. 1). By adjusting length so that the new cut bisects any two former cuts, the 180 circle may be made to cut 360, or any other circle doubled. If the starting points of all the circles are made on the circumference of an arc whose radius is the length of index, the circles can be made to work together. I generally lift the point in shifting with my left thumbnail; a lever to lift the point by pressure could easily be put on (see Fig. 2). If the Editor wishes, I can send a description of an attachment for the eccentric cutter by which epi and hypo-cycloidal patterns of great beauty can be cut. I find 180, 100, 84, and 16 the best circles, as all numbers up to ten can be used, and many beyond.

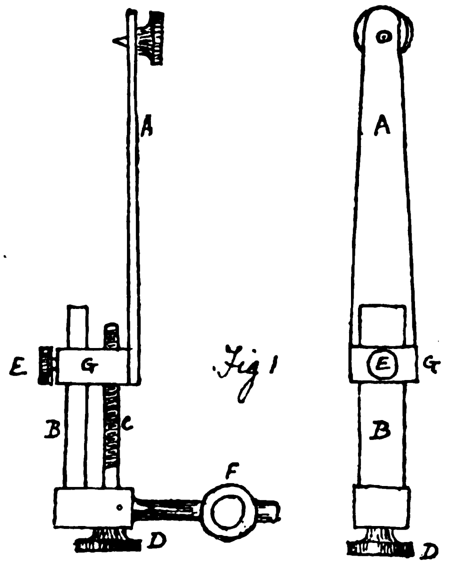


Fig. 1.—A, Index Spring; B, Bar on which G slides; C, Screw turned by milled head D; E, Clamping-screw; F, Attachment to Lathe-bed.

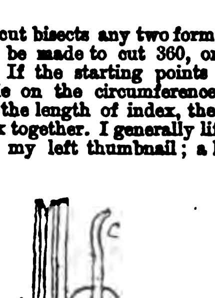


Fig. 2.—A, Dividing-plate; B, Top of Index; C, Lever; D, Roller.

Stokesay. N. D. La Touche.

[32955.]—In reply to Mr. H. L. Howell (32897) the 360 circle is essential to the production of the Etruscan border—the Vandyke and similar patterns—but it is so trying to the eyes, and the liability to make mistakes so great, that one never uses it without necessity.

A costly new lathe just finished for me by Messrs. Birch and Co., of Manchester, has a swing frame, with a set of fine-pitch change wheels, stop plate, &c., attached to the end of the screw shaft which actuates the worm-wheel on the mandrel, thus converting the lathe into a very efficient dividing engine. By this means (when the required wheels are found) 36, or almost any number, may be subdivided in the dark by one turn of the handle. At the same time the mandrel is held with the utmost rigidity; but this arrangement, admirable for most work, has, like all others, its disadvantages. It is the old story of trying to make one thing do everything. There is much more to be said about the index of an ornamental lathe, but if I had time to write, "Ours" might not have space to print.

C. C. E.

INCUBATORS.

[32956.]—I note the letter of Mr. J. Fraser (p. 309), and do not see why he should be deterred from publishing any information of which he may be possessed. The specification of a patent is a public document, and can be reproduced in substance, or in essence, anywhere. The word "patent" itself means "open," and I have yet to learn that anyone can claim copyright in a specification deposited at the Patent Office. If Mr. Fraser will supply me with the numbers and dates of the specifications he has received, I will look them up, and see what are the claims. Meantime, I would advise him not to part with his incubator, for anyone may make a patented article for experiment, even if the patent is valid. Incubans.

Novelty in Violin Construction.—In letter on p. 310, 2nd col., 8th line, omit the parentheses: three violins were used.

REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75074.] — **Street Telescope.** —"Traveller," with a good instrument, would probably pay expenses either in Sydney, Melbourne, or Adelaide. The only thing to be said against his project is the delightful opportunity he must offer to the gentry who, while "Traveller's" patron is studying the Southern Cross, or something of equal interest, are as intently pursuing their own researches in the interior of his pockets—the student's, I mean. If such a thing did come off, the gentleman who is running the circus would stand a glorious chance of getting a hiding from a crowd of larrikins, and I can assure "Traveller" they are not at all backward either with road-metal, foul language, or their feet.

Hillgrove, N.S.W. Winding Driver.

[75174.]—**Terebene Driers.**—As I notice that Mr. Stanley has not replied to the question addressed to him under the above head on p. 225, I send the following method of making terebene driers. Mix with turps about a twentieth of its weight of oil of vitriol; let stand for 24 hours, decant and distil, repeating until the product no longer acts upon polarised light. Wash with solution of soda, and dry over calcium chloride. In the commercial way these processes are modified; but as it is with varnishes, so it is with terebene driers; it is cheaper to buy than to make.

M. L.

[75287.]—**Unfermented Wine.**—I am sorry to see that "Nemo," in your issue of Sept. 18, 1891, states: "Unfermented wine is a mismomer," because "wine is a term which implies fermentation." It may do so very commonly, but surely not so commonly as to imply that the word must of necessity apply to a fermented liquor. I take it, it would rather be a mismomer to apply the word to brandies and other spirits, and yet they are the products of fermentation. Many authorities may be quoted showing that the word is applied even to grapes, as well as the unfermented liquor obtained from the grape. In the Revised Version of the Bible (Isaiah xxvii. 2) we read of "a vineyard of wine," and again, in Jeremiah xl. 12, "gathered wine and summer fruits." Plautus, also, B.C. 200, has the same idea, using the expression "Vinum cogere" to gather wine. Many other writers also affirm that in Bible lands and in Bible times both fermented and unfermented grape-juice were in common use, and to both of them the term "wine" was applied. Again, "Oriental dictionaries bear unequivocal testimony to the fact that words translated "wine" have been used both in ancient and modern times to denote varieties of unintoxicating drinks" (Dr. Nott). In former times, as in the present day, I believe wine was preserved from fermentation in three ways. 1. In the grape itself. Bunches or clusters of grapes are hung in dry, airy lofts, and used as required, till they are replaced by grapes fresh from the vineyard. 2. The juice, when expressed from the grapes, is boiled till it becomes thick and syrupy in consistence, and is known by the name of "must" or unfermented wine. 3. By passing sulphur through it, which destroys the germ of fermentation. But your readers may ask, Why this long correction? Simply to present them, as far as possible, with the truth, which is always a matter of importance, and also to disabuse the minds of those who are in the habit of getting many ideas from your columns, and then, perhaps, passing them on to others, that such an article of unfermented wine does not exist. Unfortunately, in these days when many in the race after money do not believe apparently in the very excellent proverb, "Honesty is the best policy," spurious articles, without number, will of necessity be placed on the market, but that need not trouble those who are seeking the genuine article. Undoubtedly unfermented wine can be purchased, and should therefore be obtained, especially if required for religious ordinances, even though the price be high when compared with that charged for the spurious article. FAR AWAY.

[75523.]—**Logarithms.**—I have procured a copy of Anton Steinhauser's work, and can fully endorse all that "A. D. I." says (p. 204) in its favour. It is preferable to Peter Gray's book, for the reason that it contains a table of the logarithms of all numbers up to 9999; so that if "Esne Caralita" does not require the logarithms of numbers of more than four figures, no calculation whatever will be required. When the logarithms of greater numbers are wanted, division sums will be necessary to break the numbers up into factors, as I explained in the "E. M.," Sept. 19, 1890, p. 87, when referring to Peter Gray's work. In this part of the work Steinhauser differs from Gray in that the former gives the logs. of numbers with groups of four significant figures, as 1000,3264, 1000,0000,3264, and so on, whereas Gray's are three-figured numbers, as 1,000,326, 1,000,000,326, &c. When, as in the case of "Esne Caralita," only 12 places in the logarithms are required, Gray's method of decomposition is perhaps rather shorter than that given by Steinhauser for 20 places. As "A. D. I." has not shown how to use the tables, I will explain the process. Let the logarithm of 53646432 be required to 12 places:—

```
5364)6432000(1199
     5364
     ----
     10680
      5364
     -----
      53160
      48276
      -----
       48840
       48276
       -----
536464314)564000000(1051
          536464314
          ---------
           27535686
           26823216
           --------
             712470
             536464
             ------
             176006(3280
             160939
             ------
              15067
              10729
              -----
               4338
               4288
               ----
                 50
```

Write down the number, marking off the first four figures for the divisor of the rest, annexing ciphers to the dividend, if necessary, so as to make it consist of seven figures. After four figures of quotient, the divisor must be increased by subtracting the remainder (in this case 564) from the dividend, annexing the result (6431436), shortened by two figures, to the divisor. The rest of the division may be contracted by knocking off one figure at each successive step from the right of the divisor. This will admit of a quotient of eight figures, which must be divided into two portions of four figures each. With the original divisor and the three quotients, we can easily, from the tables, find the logarithm required, for this division has decomposed our number into the factors as follows: 5364, 1000,1199, 1000,0000,1051, and 1000,0000,0000,328. Adding together the logarithms of these, we get the logarithm we want. Calling the four factors A, B, C, and D, we get—

```
Log. A = 7294  8876  9179  56....
Log. B = 0000  5206  8786  91....
Log. C = 0000  0000  4564  43....
Log. D = 0000  0000  0001  42....
         ----  ----  ----  --
         7295  4084  2532
```

which will be the logarithm true to 12 places, or to 14 if more figures are copied from the tables. The title of Anton Steinhauser's book is "Hilfstafeln zur präcisen Berechnung zwanzigstelliger Logarithmen" (Vienna: Carl Gerold's Sohn, 1880), and is sold by Dulau and Co., 37, Soho-square, for 6s. 6d.

T. S. BARRETT.

[75523.] — **Logarithms — Twenty-place Tables by Anton Steinhauser.**—The tables are arranged in four columns, lettered A, B, C, D, of which A is printed separately in two colums on each page, and the remaining three, B, C, D, are printed on each page in three columns headed by their respective letters:—

n	A	*n*	A
4300	6127 8385 6719 7354 9450 9	4150	6180 4809 6712 0927 0861 9
01	28 8976 9287 4847 1626 6	51	
02	29 9565 6032 3474 8217 0	52	&c.
03	31 0151 6966 9126 4625 7	53	
04	32 0735 2103 7598 5906 3	54	
4305	6143 1316 1455 4695 7659 0	55	6185 7102 8120 1297 9585 9
06	34 1894 5035 5730 6927 1	56	
07		57	&c.
08	&c.	58	
09		59	
4310		4160	6190 9333 0626 7427 4527 5

(3) (7) (11) 10 10 10 *n*	B	C	D
5100	2 2143 3724 9691 4379 2	2 2149 0180 1226 6	2 2149 0185 8
01			
02	&c.	&c.	&c.
03			
04			
5105	2 2165 0761 4672 2227 8	2 2170 7327 3525 3	2 2170 7333 0

Table A. requires hardly any explanation. The argument column gives the first four figures of any number, and the column A gives the corresponding logarithm to 21 places arranged in groups of four figures. Nothing more is required but the index, according to the usual rules. The Tables B, C, D require some illustration. At the head of column *n* the reader will observe three numbers in brackets (3) (7) (11), which apply in respective order to columns B, C, and D′. Thus: For column B, the number 5105 in col. *n* would read.. 1000 5105 (3)

For column C 1000 0000 5105 (7)

For column D 1000 0000 0000 5105 (11)

For column D′ 1000 0000 0000 0000 5105 (15)

the number in brackets representing the number of 0's following the initial figure 1. In the earlier part of col. A up to 2303, the first figure is 0^{4} for B, 0^{8} for C, and 0^{12} for D, and for D′ would be 0^{16}.

This means that the fully-written logarithm would be for argument *n* = 1615.

	n.	Logs. from
B	1000 1615	·0000 7013 2895 7484 6648 4
C	1000 0000 1615	·0000 0000 7031 8558 2610 1
D	1000 0000 0000 1615	·0000 0000 0000 7013 8558 8
D′	1000 0000 0000 0000 1615	·0000 0000 0000 0000 7013 9

For the remainder of the table the computer has only to consider the figures given in the tables headed by B, C, D, or D′ as the terminal figures of the 21 places, and fill up the initial places by 0000, 0000, &c. Thus, for *n* = 3325—

B *n*	1000 3325	0001 4437 8913 5683 9533 2
C *n*	1000 0000 3325	0000 0001 4440 2912 8321 3
D *n*	1000 0000 0000 3325	0000 0000 0001 4440 2915 3
D′ *n*	1000 0000 0000 0000 3325	0000 0000 0000 0001 4437 9

For the 21st figure the reader will find at the end of the book a flyleaf which opens out clear of the other pages, and gives the proportional parts for different values of *n*.

I. To find the logarithm of a given number—

```
      n = 1·371 | 2885 7423 8623 5368 7·

1.  1371 2885 7423 8623 5368 7·
    ---------------------------
               1371·
               = 1000 2104 8449 2066 7665 0 B

2.  1000 2104 8449 2066 7665 0
    --------------------------
             1000 2104
               = 1000 0000 8447 4293 3751 6 C

3.  1000 0000 8447 4293 3751 6
    --------------------------
          1000 0000 8447
               = 1000 0000 0000 4293 3748 0 D

4.  1000 0000 0000 4293 3748 0
    --------------------------
       1000 0000 0000 4293
               = 1000 0000 0000 0000 3748 5 D′
```

Then from—

A	1371	1370 3745 4789 5126 5964 9
B	1000 2104	9136 5947 6317 6806 9
C	1000 0000 8447	3 6684 8533 3698 3
D	1000 0000 0000 4293	1 8644 2621 1
D′	1000 0000 0000 0000 3748	1 6277 5

Then as the index is 0, 0·1371 2885 7423 8623 5368 7 is the required logarithm.

II. To find the number from the logarithm. Let the logarithm be—

```
                                9·5028 5012 7305 8661 4565 9
A   3183                         ·5028 3663 8621 0031 0341 8
                                       ---------------------
                                       1348 8684 8630 4224 1
B   1000 0310                          1346 2920 2648 1484 1
                                       ---------------------
                                          2 5764 5982 2740 0
C   1000 0000 5932                        2 5762 3479 0239 0
                                          ------------------
                                               2 2503 2501 0
D   1000 0000 0000 5181                        2 2500 7971 1
                                               -------------
                                                    2 4529 9
D′  1000 0000 0000 0000 5648                        2 4529 0
                                                    --------
P.P.                        2 from fly-leaf               ·9
                                                    --------
```

We have now to multiply out these factors, which can conveniently be done by short multiplication, commencing by the left-hand figure of the multiplier. This is written above the multiplicand, which is composed of D and D′. It is well to preserve the figures in groups of four, which is not done in the book for want of space.

```
Fiii ..   1000  0000  5932
          ------------------------------
Fiv & v   1000  0900  0000  5181  5648  2
Fii ..    1000  0310 | 5932  0000  0003  0·
          ------------------------------
          1000  0000  5932  5181  5651  2·
                 300  0000  1779  7554  5·
Fi....    3183 |  10  0000  0059  3251  8
          ------------------------------
          1000  0310  5932  7020  6457  4
          ------------------------------
          3000  0931  7798  1061  9372  2
           100  0031  0593  2702  0645  7
            80  0024  8474  6161  0516  6
             3  0000  9317  7981  0619  4
          ------------------------------
        0·3183  0988  6183  7906  7154  0
```

As the index of the logarithm is 9 – 10 or $\bar{1}$, we have only to put the decimal point before the first figure of the number to complete the operation. A number of examples are given in the text which should be calculated by the student to familiarise himself with the method. These divisions or multiplications are very much facilitated by the use of an arithmometer, if the computer possesses one; but that can be dispensed with at the cost of some time and trouble. These tables cost 12s., as published in Germany in paper covers.

A. D. L.

[75494.]—**Glass-Blowing.**—I frequently use a paraffin lamp in soldering, and for other purposes, but, judging from my own efforts, should hardly think that glass-blowing could be thus accomplished in place of gas. I have found it tax my utmost endeavours to blow a thermometer bulb using a large white Bunsen burner flame without the aid of mechanically-actuated blowpipe. Perhaps you would be more successful than myself. Burn the paraffin in an ordinary spirit-lamp and spread the cotton wick out so as to make a large smoky flame. A. E. B.

[75546.]—**Body Vermin.**—"Sm.," in his answer to this query, gives a very peculiar theory, which is, however, not the proper one. Oil, no matter how thick, will not kill body vermin. Mercurial ointment (50 per cent. mercury) is the best. A tincture of Cocculus indicus (fish-berries) is also good. SAN FRANCISCUS.

[75562.]—**Sounds at Sea.**—Mr. Haldane, in his book "Engineering: Popularly and Socially Considered" (page 383), quotes an interesting case which occurred some years ago in connection with the *Sydney*, bound for Calcutta. When below in his cabin, the captain heard a noise like the scraping of an iron ship, although no vessel was then in sight. Three hours afterwards an iron ship was passed, who replied that they had had "a platform rigged outside, on which men were occupied in hammering and scraping our sides." The explanation is that the marvellous transmission of sound through the sea, and over a distance of 14 miles, is due partly to the state of the air at the time, and also to the fact that the wooden sides of the Calcutta liner were good conductors of sound.

A. D. Southam.

[75604.]—**Lubricant for Rubber.**—The best lubricant for rubber is pure water.

San Franciscus.

[75612.] — **Interest.** — "Too Much for the Whistle" now allows that this very interesting though seemingly simple problem can, after all, only be solved by trial and error; his complicated formula is therefore useless, since it would more easily be found upon trial by simple arithmetic that 10 per cent. interest per quarter is too little, 11 per cent. too much, and 10½ per cent. approximately correct. There are two ways of attacking the problem algebraically—one, the first, upon which "Whistler's" equation appears to be based, arises by considering that £150 at compound interest for 5 years ought at the required rate to accumulate to exactly the same sum as an annuity of £40 for 5 years; and it will be found that at 10½ per cent. per annum, the £150 would accumulate to £247·11701489109375, and the annuity to £246·646387025. This shows that the 10½ per cent. computation is really based upon compound interest. Paying interest as soon as it becomes due is scientifically the same thing as allowing compound interest if it remains unpaid. A simpler procedure arises from the consideration that the present value of the annuity minus discount ought to be £150. Then, taking x as the sum that would, with a quarter's interest added, produce £1, there would arise the equation of $x + x^3 + x^4 + x^5 = \frac{150}{40}$, which may be simplified to $\frac{x^6 - 1}{x - 1} = \frac{19}{4}$; but this equation, though much simpler than "Whistler's," is also insoluble. At 10½ per cent. per quarter the value of x is the reciprocal of 1·105, the 4th power of which is 1·490902050625, showing the yearly interest to be not about 50·9, as "Whistler" computes it, but about 49.

S. M. C.

[75613.]—**Self-winding Clock.**—How can anyone say what dimensions this lost pendulum had? If the querist will take his clock to one of the houses in Clerkenwell no doubt he can get it fitted with a suitable pendulum; but what the "self-winding" has to do with the matter is a puzzle. I suppose it is one of the clocks fitted with a little electro-motor to keep the clock wound up; but then the clocks are of all sorts and sizes. How can a pendulum be fitted without knowing the size of clock?

R. S.

[75619.]—**Rome.**—Middleton's "Ancient Rome in 1885," A. and C. Black, may be of some use to the querist; but if he wants a history and description of St. Peter's, he should consult Gwilt's "Encyclopædia of Architecture" (Longmans), Fergusson's works, or perhaps he might find sufficient in Murray's "Handbook for Rome." Perhaps "E. L. G." can tell him where the "most complete history" can be found.

Attrius.

[75620.]—**Boiler.**—This must be one of the most peculiar boilers ever made. It is only 1ft. long, and the firebox is 8in. wide outside. The most remarkable thing, however, is that the chimney may be 2in. or 4in. and 20ft. high. Why does not the querist refer to the articles by "J. H." on the model locomotive?

X. T.

[75631.]—**Displacement.**—For methods of calculating displacement of a vessel, see Macrow's "Naval Architects and Shipbuilder's Pocket-Book," Crosby Lockwood and Son. Of course, it can be calculated from the drawings when the weights are known.

T. M. L.

[75642.]—**Metallic Compound.**—The fittings of gazogenes are usually of pewter, and they are usually spun into shape. Doubtful whether 100lb. pressure is ever reached in a gazogene. At any rate, those who make such fittings must take the responsibility.

J. L. M.

[75645.]—**No Rent.**—Interest cannot be claimed on rent which has not been asked for; but put the question with full details to Mr. Wetherfield, the Legal Editor of the *Weekly Times and Echo*. It seems to me the rent must be demanded before interest can be claimed.

S. F.

[75651.]—**Ferrotype Diaphragms.**—Use the ferrotype just as it is.

N. M.

[75648.]—**Impure Food.**—Bacon is not particularly injurious. Jews are greater sufferers from cancer that any other class of people. Fat bacon being hard to digest, it is liable to give trouble in this way.

San Franciscus.

[75655.]—**The Silver Market.**—The dealers in silver constitute the "silver market," just as those who sell potatoes make the potato market. Any of the large metal dealers forms a sort of "silver market" himself, but regulates his price according to that of others.

M. K. P.

[75661.] — **Fruit Farming.**—Prospects good. Oregon more favourable for apples, pears, and fruits not injured by cold. California is the best orange-producing state. Oranges have been raised in every country. Apply for information to the State Board of Trade, Palace Hotel, San Francisco, Cal.

San Franciscus.

[75667.]—**Lathe for Grinding Lenses.**—No special form of lathe is required for grinding lenses. Almost any lathe that runs true will do. It must be true for centring work.

L. K. C.

[75680.]—**Falling Bodies.**—In my recent answer, I took the law of variable accelerating force simply as it was given in the question. Mr. Cooper defines the law as it exists in nature; but following the general rule of writers on dynamics, he obtains certain formulæ by measuring x from the centre of the force, i.e., from the centre of the earth. It seems to me, however, that what is *here* required is an expression for t, the time taken by a particle in falling through a distance x, which is measured downwards from P, the initial position of the particle. Let a be the distance of P from the centre of force, and v the velocity of the particle at the end of t. Then we must write the equation of motion thus:—

$$\frac{d^2 x}{d t^2} = \frac{\mu}{(a - x)^2}.$$

Hence, $$\left(\frac{d x}{d t}\right)^2 = \frac{2 \mu}{a - x} + C.$$

By putting $x = o$, when $t = \frac{d x}{d t}$ must be zero, we find $C = -\frac{2 \mu}{a}$.

Hence, $$\frac{d t}{d x} = \sqrt{\frac{a}{2 \mu}} \cdot \sqrt{\frac{a - x}{x}}.$$

Let $x = z^2$, and $\therefore \frac{d x}{d z} = 2 z$.

Then $$\frac{d t}{d z} = \frac{d t}{d x} \cdot \frac{d x}{d z} = \sqrt{\frac{2 a}{\mu}} \cdot \sqrt{a - z^2}.$$

Integrate from $z = o$, and substitute $\sqrt{x}$ for z; and we have

$$t = \sqrt{\frac{2 a}{\mu}} \left(\frac{a}{2} \cdot \sin.^{-1} \sqrt{\frac{x}{a}} + \tfrac{1}{2}\sqrt{a x - x^2}\right).$$

also, $$v = \sqrt{\frac{2 \mu x}{a^2 - a x}}.$$

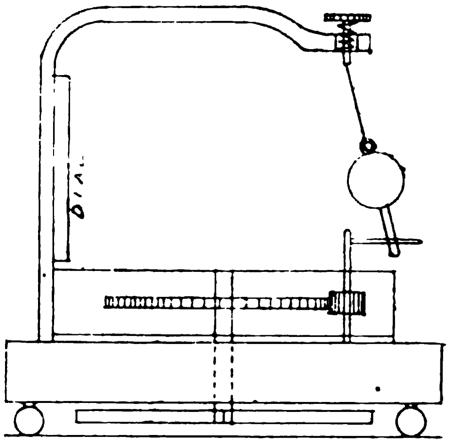
Putting $x = a$ we find the time of the particle's reaching the centre of force is $\frac{\pi}{2} \sqrt{\frac{a^3}{2 \mu}}$, a well-known formula. If R denote the earth's radius in feet, $\mu = 32{\cdot}2\ R^2 = g a^2$ – if g be the force of gravity at P.

Charing, Kent. J. R. C.

[75705.]—**Reed Voicing.**—I wish to return many thanks to "Organon" for kindly replying to my query. He has given me the exact information I was in search of. For some time past I had been trying to voice and tune reeds, and was fairly successful. I had a new set of reeds which I have added to my A.O. I tuned and voiced them. I filed them to pitch, then bent and twisted the tongues until each responded full and round like an open diapason; but my ideas all seemed upset when I read "P. O. B.'s" statement that bending is not true voicing. That led me to insert my query; but after all I find the term "true voicing" only means the true art of bending. Will "Organon" kindly inform me if the reeds are usually tested in their own cavity-board, or can they be sounded any other way to save inconvenience of drawing out and replacing in cavity during the operation of tuning; also what tools are required by a tuner. And, when tuning to equal temperament, the fifth C—G is to be tuned a beat flat. Does that mean a beat a second? The octave below one beat in two seconds, and the octave above two beats in one second; the other fifths in proportion. Any information on this will be gladly accepted by one who is anxious to learn how to properly tune.

Reeds.

[75730.]—**Motion for Equatoreal.**—Judging that the intermittent escapement, usually on all clocks, would not suit the purposes of a telescope, I beg to state that the writer had some experience with a clock with rotary escapement several years since, it being considered more of a curiosity than a timekeeper. They did not come into very general use. The particular clock referred to was of cheap construction, selling for about 8s., and worked fairly well, considering its cost, and might be made to answer the purpose of the inquiry. I have been informed that they were manufactured by the New Haven (Conn.) Clock Co., but have not made any of them recently. The clock was constructed with a train of wheels between two round plates, which were fastened to a round base of wood larger than the plates; the base had three feet, leaving a space between it and the table. The central shaft had the mainspring, to which there was attached a permanent key. The escape-wheel had its shaft extended above the upper plate some distance, to which was attached a light arm, made of fine wire. The pendulum was suspended from an arm directly over the centre of the escape-wheel. The arm was fastened to the plate of the clock, the arm had a screw-thread in which there was a milled head screw with a hole through its centre. The milled head was the regulator. The hole had a silk thread through it fastened by a pin. The silk thread continued to the pendulum ball, which had a pin on its under side which was actuated by the wire arm on the escape-wheel, which caused the pendulum to revolve.

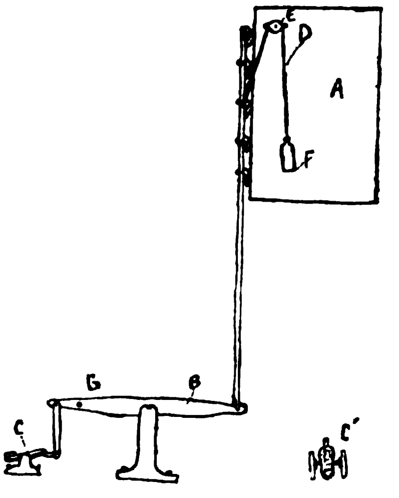


J. H. N.

[75811.]—**Motor for Model Electric Railway.**—Will Mr. Bottone kindly inform me if this motor would give voltage and current to light up two 10c.p. lamps, each 25 volts and 1½ ampère, if driven as a dynamo? Also, if a ring armature is employed, or an H girder solid? Also, will the quantity of wire be the same as stated?

Jas. Johnstone.

[75836.]—**Balanced Swell-Pedal.**—It requires very little alteration to substitute a balanced swell-pedal for the ordinary hold-down pedal. The best way is to have a pedal the shape of foot, as shown in sketch, and balanced in a small frame just in front of the heel, with a beading run round the back of heel to prevent the foot from slipping whilst resting on pedal. The pedal is connected by means of a short rod to a kind of backfall or lever, the opposite end of which is attached to the rod which connects and works the shutters. In the case of horizontal shutters, a counterbalance is required, and may be employed either in the manner shown in sketch, being a weight attached to a rope or small chain, which is brought over a pulley-wheel on side of swell-box, and fastened to

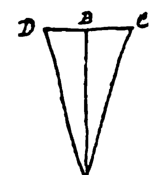


A, Swell-box; B, Backfall; C, Pedal; C', Top view of Pedal; D, Rope, or small Chain; E, Pulley Wheel; F, Balance Weight, which may instead be fixed on front of Backfall about G.

connecting rod; or, a weight might be hung on to front end of backfall about G. Of course, this is only very simple action, just to give an idea of it, and "Discere Cupio" must fix whatever action will best fit into his organ. Vertical are much better than horizontal shutters, being more free and sensitive to the movements of the foot; as they require no balance-weight, and the friction on the centre pins is reduced to a minimum; they are also more readily removed for tuning purposes. If "Discere Cupio" contemplates using vertical shutters, I shall be pleased to send him particulars as to the manner of fixing them to the swell-box with frictionless pivots. LEO.

[75813.]—**Telescope: Angle of View.—Erratum.**—For, "as ·22in. at above distance, subtend an angle of about 0′ 8″," read: as 22in. at above distance subtends an angle of about $\frac{8}{10}$ths of one second of arc. Will "F.R.A.S." kindly note above correction *in re* his own reply to above query? J. ADAMS.

[75813.]—**Telescope Angle of View.**—I make the angle subtended by the 144ft. of fencing at the distance of 4,700ft. from the spectator to be 1° 45′ 19·332″.



D C fence = 144ft. ∴ B C = 72ft.
B A = 4,700ft.

$$\text{tan. of } \angle BAC = \frac{BC}{BA} = \frac{72}{4{,}700}$$

$$\begin{array}{rl}
\text{log. } 72 = & 1\cdot8573325\\
\text{log. } 4{,}700 = & 3\cdot6720979\\ \hline
 & 8\cdot1852346\\
\text{log. tan. } 52' = & 8\cdot1797626\\ \hline
\end{array}$$

$$\frac{54720 \times 60}{82738} = 39\cdot6'$$

$$\begin{array}{rl}
\text{Angle } BAC = & 52'\ 39\cdot6''\\
 & 2\\ \hline
\text{Angle } BAC = & 1^\circ\ 45'\ 19\cdot2''
\end{array}$$

Working out by the formula for small arcs—

$$\begin{array}{rrr}
\text{Given log.} = & 8.1852346 & \\
\text{Constant number} = & \bar{5}\cdot3144251 & \\ \hline
 & 3\cdot4996597 & \\
\tfrac{2}{3}\text{ log. sec} - 10752\cdot39 = & \cdot0000169 & \\ \hline
 & 3\cdot4996428 & \\
 & 4996321 = & \text{log. } 3159\cdot6\\
 & & 07\\ \hline
 & 107 & 007\\
07 & 97 & \\ \hline
 & & 3159\cdot677\\
 & 100 & \\
07 & 97 &
\end{array}$$

That is, angle B A C = 3159·677 seconds

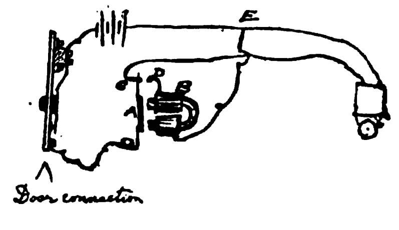
$$\begin{array}{rr}
 & 2\\ \hline
\text{Number of seconds in } DAC & 60)6319\cdot354\\ \hline
 & 60)105\cdot3225\\ \hline
 & 1\cdot75537^\circ\\
 & 60\\ \hline
 & 45\cdot32220\\
 & 60\\ \hline
 & 19\cdot33200
\end{array}$$

∴ D A C = 1° 45′ 19·332″. G. G. B.

[75844.]—**Four-lobed Clover Leaves.**—Many thanks for the dried specimens and sketches safely to hand. This is a true clover of an evolutionary type, probably induced by some circumstances of stimulation. What can be more marvellous than the fact of the hundreds of superb roses in cultivation taking their origin from half a dozen ignoble species!—the hedge sloe and the crab, too, developing into the luscious fruits of our orchards! EOS.

[75863.]—**Electric Shop-Bell.**—It can be done. You will need two independent battery-circuits, with a Leclanché in each. No. 1 must lead to the shop-door, which in course of opening completes one circuit; this must actuate an electro-magnet under your counter with a balanced armature like a telegraphic relay. No. 2 circuit must include the bell on the second story, and must be completed by the drawing down of the balanced armature of the relay. Although the relay should be balanced, it should remain down when attracted by the electro-magnet, even when the current round the magnet ceases. This may be brought about by making it work "cloggy" by the application to the pivot of a little lard; to stop the bell you will need to remove the armature with its contact by hand, as you suggest. A. E. B.

[75863.]—**Electric Shop-Bell.**—As drawn, the bell will ring on the door being opened. Now suppose the bell is ringing and you press the armature A against the magnet B, you break the connection at G and make it again at D. The current will now flow from the door connection through the armature and the magnet coils on to E battery and door, the magnet holding the armature until the door is closed, when, the current being cut off, the armature will fly back to first position. R. J. JACKSON.

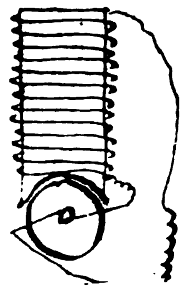


[75866.]—**Copal Varnish.**—Fuse 1lb. of African gum copal, add 2 pints clarified oil; boil gently for five hours until quite stringy and mix with 3½ pints of turps. A. D. SOUTHAM.

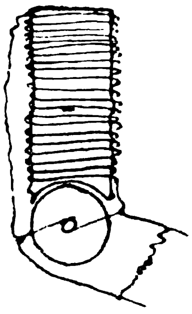
[75873.]—**St. Martin's Eve.**—I quote the following from Dyer's "British Popular Customs" on the observance of Martinmas in Ireland:—"At St. Peter's, Athlone, every family of a village (says Mason in his 'Stat. Acc. of Ireland'—1819, Vol. III. p. 75) kills an animal of some kind or other. Those who are rich kill a cow or a sheep, others a goose or a turkey; while those who are poor and cannot procure an animal of greater value kill a hen or a cock, and sprinkle the threshold with the blood, and do the same in the four corners of the house, and this ceremonious performance is done to exclude every kind of evil spirit from the dwelling where this sacrifice is made till the return of the same day in the following year. W. C. PLANT.

[75876.]—**Faulty Cable.**—"H. S. P." will find all the tests he requires, with diagrams and full information, in Munro and Jamieson's "Pocket-book of Electrical Rules and Tables." The price is, I think, 7s. 6d. cash. A. D. SOUTHAM.

[75884.]—**Electrical Nomenclature.**—1. By Ohm's law $C = \frac{E}{R}$ where C = current in ampères, E = PD (potential difference) in volts, and R = resistance in ohms. These are the three elementary units. Electrical energy is amps. × volts = watts. 746 watts = 1H.P., which in your case is 10 amps. at 100 volts = 1,000 watts = 1·3H.P.—i.e., assuming there is no loss in friction, &c. 2. (*a*) In a series-wound machine, the field-magnet coils are in the same circuit as the armature, consequently the same current passes through both (Fig. 1).; (*b*) In a shunt machine part of the current is shunted round the field-magnets, the remainder passing through the armature, as shown in Fig. 2; (*c*) A compound-wound machine is a combination of shunt and series windings on the field-magnets. 3. The commutator is that part of the dynamo (or motor) which reverses the current at the proper period. It is built up of copper strips, separated by some non-conducting material such as mica. A "brush" pressing on the commutator leads the current from the dynamo to the lamps, &c., the current returning by the other brush. 4. A continuous current is one which flows in the same direction, as opposed to alternating currents which flow alternately in opposite directions, generally 100 or more times a second. Last, but not least, buy a good book on the subject, say, Prof. Ayrton's "Practical Electricity," which is based on the practical definitions of the electrical units (5s. 8d. cash). A. D. SOUTHAM.



I.—Series Wound.



II.—Shunt Dynamo.

[75889.]—**Formula Wanted.**—I fail to see what other formula you want under the given circumstance, than simple rule-of-three. By the bye, water being unity, a substance of ·9s.g. will be lighter, and the hydrometer will sink further in it than in water, and not stand further out. I think this is what you want, ·9 : ·95 :: 5 : 5·28 nearly. A. E. B.

[75895.]—**Shrunk Woollens.**—To "J. L. D."—None of "ours," nor any other readers can tell you this. By immersing the articles in a fairly strong and boiling-hot lather, with plenty of it, and gently stirring them in it for some (say 4 to 8) minutes, then give them a warm blue rinse, not wringing them nor mangling them, but gently squeeze out the big wet, then hang to drip in a breezy open place, and while still warm, gently and evenly stretch them; you may enlarge them a little. When the goods are three-fourths dry, lay out each one flat as possible upon your ironing-table, and stretch them again gently and rather strongly, but not so much as to fray them. Next fold each one quite evenly into a convenient size for putting under heavy pressure over night, being tightly wrapped up in a suitable cloth. Lastly, use a rather heavy iron, moderately hot, not too hot, always remembering that flannel scorches sooner than anything else, except paper, and pull the article whilst you are ironing, all hems and seams getting extra pressure. In future avoid the shrinking process. Let the washing be done without rubbing or wringing, or rough shaking. Flannel is allowed to be apt to shrink a little in the first wash, but should not any more. Above every other mischief-maker, shun the use of the hydro-extractor so usually found in laundry use. It is a splendid drier for cotton and linen clothes; but it never should be used for woollens, because the rapid motion tangles together the fibres of wool threads, thus matting them in a thick felt. A blanket will thus be shrunk 6in. both ways. H. O'B.

[75896.]—**Hysteria.**—Amongst homœopathy's voluminous literature is the veteran author's (Dr. Dudgeon's) contribution, "The Pathogenetic [disease-producing] Cyclopædia of the Homœopathic Materia Medica," the second chapter being devoted to the symptoms relating to the mind—i.e., a record of (some of) the peculiar changed features caused on the imagination by drug action. Section 4 relates to delirium and to delusions (I have seen a blow on the head completely alter the disposition pro temp., both of a dog and of a woman). Amongst those medicines of the vegetable kingdom likely to influence the present case are—*aconite, Agaricus amanita, *belladonna, hyoscyamus, *pulsatilla, stramonium, opium, *bryonia, and cannabis. Those from the mineral kingdom are less prompt in their action, but yet possess more permanent constitution energy; for it is an axiom in chemistry that each of its elementary bodies is indestructible. Under the headings "General Symptoms," "Moral Symptoms," and "Head," a brief description of those marked with an asterisk, as well as several others, will be found in "The Uses of the Sixteen Principal Medicines of Homœopathy," but that of menstruation would probably afford the most important indication for the selection of the drugs and their course. Heath, 5, St. Paul's Churchyard, London, E.C., publishes for 5s. "Laurie's Epitome," which also contains most of the modern (American) drugs. Standing at my front door, Severn's full flood, two miles wide, lies at my feet some 300ft. below. On the opposite bank is the delightfully sylvan prospect afforded by Earl Ducie's beautiful estate; beyond that is the ancient market town of Wickwar, its former vicar, Rev. Everest, an intimate friend and pupil of the illustrious Hahnemann, was one of homœopathy's first pioneers in England, not by preaching and writing only, but by the cures he brought about gratis to those who desired his assistance in many so-called incurable diseases. Then, recorded in the

Homœopathic Times of 1849-53, instances of similar cures teem from the pen of the wife of Rev. Chepinel, vicar of St. Sampson's, Guernsey. Mrs. Chepinel learnt, chiefly through her own personal experiences of drug-action, and by hard study of the best French and German authors of homœopathic works, how to treat curatively numberless cases of disease, declared by allopathy to be hopeless. Now, why should not her example be followed by many of the educated (?) women of Great Britain to many of whom occupation would really be a blessing, for idle women's hands, especially, are—well, best kept out of mischief. I often question whether the healing art's legitimate place is not even now really in the hands of the Church, and as it was up to, say, the 15th century. As things are in 1891, medicine has a purely commercial aspect, and consequently, rather *à la* the Quaker's counsel: "Friend, if thee *can* get money honestly, do it: but mind, thee must get money," and reckless of the patient's ultimate condition.

Lydney Dispenser.

[75899.]—**Compressed Air.**—As air has weight, the more you compress in a vessel the less buoyant will it, of course, become. Within certain limits you could sink any vessel (for steel it must necessarily be) by compressing air into it, for air can even be liquefied by sufficient pressure and coldness.

A. E. B.

[75899.]—**Compressed Air.**—"999" makes a curious mistake in giving the weight of cube foot of air 12¾oz. "Molesworth," 12th edition, gives 527 grains; another authority gives 565·4. Perhaps "999" can, in correction, give the weight from the most recent authority naming it? B. F.

[75904.]—**Telephone.**—If your circuit is not too long, and your magnets are good, you should not require a battery. I should think your diaphragms are loosely mounted; they should be rigidly fixed round the edges, and drum-like in their vibrations, otherwise the movements will be "shuffling," and will not be transmitted through the circuit.

A. E. B.

[75914.]—**Magneto Machine.**—A Gramme machine with ring armature would be most efficient, but a dynamo would be far preferable and cheaper.

F. Askew.

[75915.]—**Wimshurst Machine.**—Probably in connecting the Leyden jars you present points for leakage. Work your machine in the dark, and any leakage will most likely manifest itself by a faint light. Perhaps your Leyden jar arrangement short-circuits the machine. Warm the jars and varnish above the foil on both sides with sealing-wax varnish. I do not think that the *fact* of the tinfoil being in more than one piece would affect the efficacy, providing each is joined and stuck close to the glass. Your connection appears to be correct.

A. E. B.

[75916.]—**Cleaning Old Coins.**—Before rubbing them with any cleanser, gritty or rough, try Sapolio. It was recommended to me a few days ago. H. O'B.

[75916.]—**Cleaning Old Coins.**—If the dirt consists of organic matter, soda and water will cleanse them; but if of metallic oxidation, I think you might safely try dilute sulphuric acid, for this will dissolve the oxides of silver and copper, but not the metals themselves. A. E. B.

[75919.]—**Stoneware Pots.**—You will get the best cells that could be made for your purpose in salt-jars of stoneware—stout, cylindrical vessels, ¼lb. to 1lb. capacity. I used no other in my experiments for many years. Nowadays I do not see table-salt so packed, but there must be thousands of these receptables in miscellaneous goods shops and marine stores. Eos.

[75919.]—**Stoneware Pots.**—The necks of stoneware bottles can be cut off by means of an iron disc running in sand and water, the sand lifted occasionally to the cut; or by a copper disc fed with oil and emery; but—and what a "but"!—would it not be much cheaper to buy pots of the size required (say salt-jars) than to expend so much labour in cutting off the upper parts of ink-bottles to make battery jars? The "chipping" will never do. I doubt whether the querist would succeed with one in a hundred. These would-be economical dodges often turn out very dear in the result.

Nun. Dor.

[75923.]—**Problem.**—I make $x = 220372·5104238$. Are you sure you have not mistaken any of the signs, say × for +? A. D. Southam.

[75923.]—**Problem.** — To "Puzzled."—Your figures are all right. I make it 220399, having put down ·8762 instead of ·876188 as the last multiplier, which would just about account for our very trifling discrepancy. J. K. P.

[75923.]—**Problem.**—The result given (viz., 18301) is unquestionably incorrect. "Puzzled" himself is much nearer the mark, the correct result to twelve decimal places being

220393·076792556194, &c.

Autolycus.

[75923.]—**Problem.**—I make the value of x to be 220,393·1255596, which agrees pretty closely with that obtained by the inquirer. The inference is that if 18301 is the correct answer, there is some mistake in the book from which the example is taken, or that some error in the signs or numbers has been made in copying it out. Probably the latter. G. G. B.

[75926.]—**Harmonium: Manual Coupler.**—If "Hampton" will send me a sketch showing position of keyboards, pallets, &c., I will try to help him; but it is scarcely advisable to go to the trouble of fitting manual coupler when there is only one row of reeds in swell.

Stubbins, near Manchester. J. Schofield.

[75926.]—**Harmonium: Manual Coupler.**—I think it will be necessary to see this instrument before much useful advice can be given. The lower set of keys is said to be 21in., and "fixed at their ends," while the upper set is 14in., "worked on a pin at centre," and carrying the action to back of instrument. A manual coupler to connect the upper to the lower bank of keys would be of the ordinary tumbler pattern — that is, little "stickers," or plungers, working through a rod, which can be so turned as to place them perpendicularly when the coupler is "on," and turn them clear of the key fall when the action is "off." Devices of the kind have been illustrated in back volumes; but the querist should really call in an expert to see the instrument. Organon.

[75928.]—**Crystallisation.**—H. Harbord treats of two things, p. 315. 1. The curiosity of crystallisation of iron sulphate in a square but not in a round bottle; all other circumstances such as strength of solution, &c., being equal. 2. The formation of ice. Now, as to No. 1, when dabbling with chemicals, I have often been puzzled with the fact that I was able to get crystals at one time and not at another, though I tried to produce the same solutions each time. I noticed this more than once with chloride of calcium, which I used to make so as to get a higher temperature in a water-bath. Question: Has H. Harbord noticed the peculiarity he mentions when treating other solutions besides that of sulphate of iron? 2. As to formation of ice, this treads on the question I have often pondered over—viz., whether crystals were in all cases of sudden formation or of quick growth, or some the one and some the other? Take, for instance, a crystal of SiO_2. Was it formed simultaneously or by slow growth? If the latter, one would expect on breaking it to find evidence of the growth. But it breaks with a conchoidal fracture. X. Y. Z.

[75930.]—**Gas-Engine.**—A gas-engine, of course, has, for the supply of gas to the cylinder, two stop-cocks—one on the engine itself, and the other on the gas-bag—so as, if necessary, to shut off the supply of gas from the gas-bag. If, in stopping the engine, the stop-cock on the gas-bag is turned off first, the gas will escape from the gas-bag out at the exhaust until the gas-bag is empty, or nearly so, and has to be filled on starting the engine—that is to say, provided that the engine has been stopped long enough for the gas to escape. Turn off the engine stop-cock first; there is not much need to turn off the other at all.

R. L. M.

[75932.]—**Fairy Cave.**—I have seen some good designs in books on ornamental horticulture, and the construction of grottoes, &c. Try a concealed concave mirror (it could be placed in a clump of hardy ferns). I have seen a huge block of ice added to the waterfall greatly increase the illuminative effects. The floating figure of a fairy on wings could be projected on the apparent distance. Rough masses of cork, with minerals, shells, mosses, grasses, &c., artistically placed, I have greatly admired in a grotto, intersected by a natural spring.

Eos.

[75933.]—**Dynamo.**—Wind the armature with 18lb. No. 12, in 30 sections. Wind the field magnets with 60lb. No. 20. Connect up in shunt. The rule for calculating the sizes of wire to be used is simple enough, and is given in extenso in my book, "The Dynamo: How Made and How Used." Briefly, bearing in mind that in a shunt-wound dynamo the resistance of the F. M. wires must bear to that of the armature wire (when running between the brushes) the proportion of 400 to 1, you begin by seeing in a wire table what gauge of wire you must use on the armature to carry the current you desire without injurious heating; then, for the field magnets, use wire of such a gauge that it can carry 1-20th of the said current without heating.

S. Bottone.

[75939.]—**Bleaching Guttapercha.**—It is not, I think, sufficiently well known that Dr. Gore, when experimenting with liquid carbon dioxide confined in glass tubes with guttapercha stoppers, observed that the stoppers were bleached when in contact with the liquid. C. J. Woodward.

[75939.]—**Bleaching Guttapercha.**—Guttapercha is bleached by dissolving it in bisulphide of carbon, allowing the solution to settle, pouring off the clear part, and allowing this to evaporate. In dealing with large quantities it is more economical to filter the solution, but if it is allowed to settle for a week the loss is very small in pouring off. Great care must be exercised in the use of the bisulphide of carbon, as it is exceedingly volatile, inflammable, and poisonous, and the vapour mixed with air is very explosive; the work should be done entirely out of doors, and no lights must be used near the vapour. 999.

[75945.]—**Defective Dynamo.**—As you say the insulation is perfect, from your description of results with galvanometer, I should imagine you have coupled up the machine wrong way about. Try what results you get by uncoupling the field-magnet wires, and taking the wire (which formerly went to terminal to the brush pillar, from which you have just uncoupled the other wire, and taking this latter wire to outer circuit terminal.

S. Bottone.

[75946.]—**Vacuum Tubes.**—In answer to "H. G. D.," I shall have pleasure in contributing a letter or two on vacuum-tube construction, in fulfilment of my former promise. I have not done so hitherto, because apparently the readers of the "E.M." are not much interested in glass-blowing.

Leicester. E. E. B.

[75947.]—**Dynamo for Small Accumulator.**—The armature should be either ring or drum type, not shuttle. Field-magnet core, wrought iron, 1¼in. diam. 4in. long; armature 3⅜in. diam., to run in 3½in. tunnel, 2in. deep. Wind field magnets with 4lb. No. 20, armature with 1lb. No. 18. Connect up in shunt. S. Bottone.

[75948.]—**Skeleton Leaves.**—They should be macerated in water (rainwater) in a warm place. I found a broad, glazed milk-pan a suitable vessel. Let them remain till putrefactive fermentation takes place, when the soft parts are easily separated from the fibrous by washing in fresh water, blowing on them with a pair of bellows, and then gently pouring a small stream of water from a narrow spout upon them. Care must be taken to remove every particle of the soft parts with a fine needle or a camel-hair pencil, after which wash the skeletons in fresh water, then with a weak solution of chloride of lime, and expose on stout paper, under a wire cover, in the air to bleach. When white enough, they must be washed with dilute hydrochloric acid (1 acid to 60 water), dried, and mounted. Leaves can also be skeletonised by burying in a box of damp sand or very light soil. In India I frequently obtained perfect specimens of the great teak leaves and those of the graceful Ficus religiosa, the large water-lily, and many others, in the decomposing heaps of forests and marshes, which only required to be washed and bleached after they had undergone the natural process of fermentation during the tropical rains. Capsules, barks, and fruits are made into skeletons in a different manner. The calyx of the winter cherry and the fruit of the thorn-apple I have often obtained in hot climates from rubbish heaps, only requiring cleansing and bleaching. These are both elegant structures. Any of the hard objects enumerated should be quite ripe. Boil them very slowly till they become quite soft; occasionally remove them on the point of a long needle; patiently extract all pulp from stem to crown, throwing away the coloured water every time before immersion and filling up with fresh, so as to see how the operation advances. The interior pulp can be gently removed by a long, narrow penknife. When the skeleton is perfectly clean it should be immersed in a glass jar of alcohol and kept there, if of any great size, for some time. I have often found many barks of trees naturally prepared till they resembled lace. According to the toughness of their outer rind will be the length of artificial preparation required, some in one month, others two months, or longer. Of course the decomposing leaves yield a most offensive odour. Eos.

[75950.]—**Greenhouse.**—I have before replied to a similar query in the pages of "E. M.," and refer you to two little sixpenny books in the Manuals for the Many Series, published at 162, Fleet-street—No. IV. "Greenhouses," No. XIII. "Heating." These are profusely illustrated, and contain the fullest instruction on those subjects.

Eos.

[75950.]—**Greenhouse.**—I never heard of hot-air pipes for heating a greenhouse; but hot-water pipes are common enough. I think the querist should look through his back numbers and see if there is not something to suit him, or refer to the catalogues of makers of heating apparatus. He gives only two dimensions of the greenhouse (12ft. by 6ft.), forgetting apparently that it has a third dimension, and omits the most important point of all—the area of exposed glass. Such queries are little short of ridiculous. Those who want information might surely put their queries in a definite form. I daresay Mr. Fletcher could give the querist a useful hint or two. Nun. Dor.

[75951.]—**Heating Power of Gas.**—In an ordinary Bunsen burner, coal-gas is mixed with four to five times its bulk of air, and the surface of the flame takes up the remainder of the air necessary for perfect combustion, the total quantity required being about 11 parts of air to 1 of coal-gas. Dowson gas is not water-gas, but a mixture of this and producer gas, and it is usually considered that 1c.ft. of coal-gas 16c.p. will do as much work in practice as 3½c.ft. of Dowson gas.

THOS. FLETCHER.

[75954.]—**Blueing Small Steel Articles.**—Polish the steel articles, and lay them upon a piece of hot iron until they attain the desired colour, which will be at 600° Fahr.; then slake in water or oil. WALTER STRAFFORD.

[75954.]—**Blueing Small Steel Articles.**—The best way is to support a plate of iron, or preferably copper, over an atmospheric gas-burner; place the articles to be coloured on this, and as soon as the proper colour appears, push them off on to a cold plate. THOS. FLETCHER.

[75955.]—**"Greater Britain."**—This compound loco. is fully described, with pictorial illustrations, in the *Engineer* of Nov. 20. I have not been able to find any illustrations of that wonderful loco. on the Midland which was said in these columns (May 15) to be the largest single-wheel, inside, cylinder, on the narrow gauge. "Loco.," after making the statement, seems to have retired, and that 7ft. 10in. loco. is like Mrs. Harris. However, in the *Engineer* there is a wood engraving of the "Greater Britain," and a phototype block of the engine and tender, with all dimensions, in the text. Is there a better locomotive out? NUN. DOR.

[75957.]—**Water-Gas.**—The formation of water-gas by the action of incandescent carbon has a cooling effect, because the amount of heat rendered latent by the reduction of steam is greatly in excess of that produced by burning carbon to carbonic oxide. Thus, $H_2O + C = CO + H_2$.

	Calories.
Heat rendered latent by dissociation of steam is equivalent to that produced by the combustion of 2 units of hydrogen (2 × 34,200)	= 68,400
Heat produced by combustion of 12 units of carbon burnt to carbonic oxide (12 × 2,400)	= 28,000
Making a loss of	40,400

In the manufacture of producer gas, the latter, a heat-forming reaction, alone takes place. In making on a small scale, a considerable thickness of fuel—say 2 to 3ft.—is desirable, and the vessel should preferably be in the shape of an inverted cone, with angles, say, of 75°. Even then probably a large amount of unreduced steam will pass over with the gas. Superheating the steam will be an advantage.

F. SCARF.

[75958.]—**Pianofortes.**—There is the new patent pianino, which I think might suit the requirements of querist. This instrument is mounted on a kind of rackwork, and can be raised or lowered to suit performer, and is four octaves compass.

Stubbins, near Manchester. J. SCHOFIELD.

[75958.]—**Pianofortes.**—There are no four-octave pianos made by any makers. You might pick up an old square of five octaves for about 30s. But you can get a very good portable instrument of four octaves, known as the Bell Pianette, from Messrs. Cramer. This consists of a series of tuning forks struck by hammers. The effect is very harp-like. The instrument stands well in tune—in fact, it bears an enormous amount of hard wear.

S. BOTTONE.

[75958.]—**Pianofortes.**—The smallest pianoforte I ever saw was Percival's patented portable pianoforte, which had the keyboard arranged on each side, and was played with the instrument practically between the performer's knees. It was made at Whiteley's, and I think Mr. Ward, the organist, who was at the time organist of Quebec-street Chapel, knows something of it. It was described in a back volume—almost as a matter of course (see p. 190, Nov. 1, 1878.) As to what the querist says about doing away with (cutting off) the lowest and the highest octave—well, such a thing would not be much of a pianoforte—that is all. See p. 239, Nov. 11, 1881. ORGANON.

[75958.]—**Pianofortes.**—So far as I know, there are no manufacturers in London making pianofortes with a compass of four octaves, but there are some which are imported from Germany containing five octaves. Perhaps "S." will not object to the extra octave above his ideal. He does not seem, however, to understand human nature, for it is quite certain that after he has managed to play the "Blue Bells of Scotland," &c., on his four-octave piano, he will, in course of time, become more and more ambitious; or should any friend of his, who is really a musician, try to perform on it, what then? I see "S." has misunderstood me. I do not call a piano 4ft. in height or more "a toy piano," whatever its compass may be. I referred merely to instruments of about 3ft. high, even though they may contain a compass of seven octaves. J. H. SCHUCHT.

[75961.]—**Electric Lighting.**—It would be better to use the 30c.p. machine, as in all probability the 60c.p. would not work at all at half speed. The power expended would be the same in either case. It will be better to use three lights of 10c.p. each. S. BOTTONE.

[75962.]—**Regulating Damper.**—The spindle on which your material is wound must be arranged so that it takes up the slack from the spindle that gives the desired speed, the winding spindle being driven by a loose belt having just sufficient grip to take up the slack.

Ipswich. E. C. M.

[75962.]—**Regulating Damper.**—I do not see what this title has to do with the subject-matter of the query. "Puzzled" can easily regulate the speed at which his material is drawn through the solution by regulating the speed of the engine. A well-made engine can be made to go fast or slow as desired; but it is doubtful whether any automatic arrangement can be adopted in the case in question. All that the querist has to do is to regulate the speed of his engine, which is easy enough, and not much of a subject for a query in the ENGLISH MECHANIC. He must simply have some one to attend to the work. S. R.

[75963.]—**Power of Engine.**—For so small an affair, treat it as a simple high-pressure engine. The calculation will not be far out. The proper way is, of course, to test what power it gives by the brake. NUN. DOR.

[75965.]—**Precipitating Gold.**—"Protochloride of gold is formed by exposing the perchloride to a heat of 600°. It is a yellow, insoluble powder, which, by boiling, is changed into metallic gold and perchloride. The perchloride of gold is formed when gold is acted on by aqua regia or by chlorine. It forms, when evaporated sufficiently, ruby-red crystals, which are deliquescent."—(Gregory's "Outlines of Chemistry.") The writer of the above would be obliged if "J. H. F. A." would give the *silver*-plating recipe to which he refers in his question as to precipitating gold. The silver-plating process, he states, does not need a battery. SUBSCRIBER AND READER.

[75967.]—**Strength of Electro-Magnets.**—You must give me some data as to battery power you intend to employ before I can answer this satisfactorily. Roughly, using horse-shoe shaped electro-magnets, the following sizes of cones, wound with No. 20 wire, would do: ½in. diam. 6in. long, ⅝in. diam. 9in. long, ¾in. diam. 12in. long, 1in. diam. 15in. long. In all cases let the wound diameter be three times that of the bare core.

S. BOTTONE.

[75968.]—**Softening Bladder.**—Try glycerine, after wetting the bladder. But what is the object? A bladder kept moist will surely go rotten.

NUN. DOR.

[75971.]—**Arc Lights.**—Yes; a Crompton compound-wound will serve for arc lights. An arc lamp of 1,000 candle-power takes 8 to 10 ampères, at 50 to 55 volts, to feed it; hence requires as much current as ten incandescent lamps of 16c.p. each. A 1,000c.p. arc lamp will illuminate well 750 square yards. S. BOTTONE.

[75972.]—**Accumulators.**—A = 2 ampère-hours, B, C, and D about ½ ampère-hour at most. Reckon 6 ampère-hours for each square foot of surface. S. BOTTONE.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75359.	Windmill, p. 118.
75374.	Calculating Power, 119.
75385.	L. & N. W. Locos, 119.
75395.	Vaucanson's Endless Chain, 119.
75396.	Stereographs of Non-Planar Vibrations, 119.

75608.	Biunial Lantern, p. 206.
75626.	Shunt Formula, 206.
75633.	Sledges, 206.
75652.	Gramme Dynamo, 207.
75660.	Fan Blast, 207.
75661.	Fruit Farming, 207.

RESIDENTS in India are appealing to entomologists to discover some means of circumventing the white ant. This insect would appear to have a peculiar appetite for wills, a recent law suit having hinged upon the loss of such a document in this manner. An advertisement in the *Gazette of India* also reveals the fact that no less than seven Government promissory notes, of the aggregate value of 3,500 rupees, have been devoured by white ants.

QUERIES.

[75973.]—**Telephones.**—I have a pair of telephone bar magnets, ¾in. diameter 6in. long, also cases for same, but want to know the size and amount of wire for soft-iron core?—W. C.

[75974.]—**Band-Saws.**—Would some reader kindly tell me the best way to braze band-saws? I have one of Fletzer's gas blowpipes and bellows, but I cannot produce heat enough. They are recommended for brazing.—J. W.

[75975.]—**To Mr. Bottone.**—Will you please tell me what amount and size of wire to put on a dynamo to give 8 ampères at 40 volts, or as near as possible, and to charge 20 4 ampère-hour accumulators? Length of armature, 5½in.; diameter without wire, 2in.; 10 sections, drum type. The yokes of the magnets are 5in. long by 5in. by ⅝in., and will bore out to 2⅞in. or so.—NORTHWARDS.

[75976.]—**Explosion.**—I have a receiver belonging to a coil boiler, and wish to add an electric appliance to tell me when the water rises. I have tried putting a brass wire down the centre of the water-gauge, insulated from the tap, and fastening the other wire to the tap, but there is not the slightest connection. Why is this? I thought water a good conductor.—PRESSURE.

[75977.]—**Dial Cutter.**—Could any of "ours" give me advice as to the best way of cutting out tin dials for steam gauges? I have constantly a great number to make, and I find it very slow cutting them out with the shears. —W. JONES.

[75978.]—**Locomotive Queries.**—Would some kind reader give me some information about the following? 1. Is there, or has there been, running a locomotive with a 10ft. driving-wheel? I have been informed that there was one running on the broad gauge, with the boiler below the axles, and the steam-chest, with valve gear, &c., above, boxed in. If such an engine is, or was running, I should like to have her dimensions, with a sketch if possible. What is the largest driving-wheel now in use? 2. Dimensions, with sketch if possible, of one of the broad gauge engines of the present day. 3. I should like also to have details, with drawing, of the "Bryce Douglas" gear which Mr. Drummond, Loco. Superintendent of the Caledonian Railway, had for a time in his four-coupled bogie-engine No. 124, but subsequently discarded for the ordinary link motion. 4. What is the difference between Mr. Gooch's stationary box-link motion and the link motion generally adopted? 5. Is it possible to obtain a copy of a complete set of working drawings of a locomotive as drawn up for the builders?—LEO.

[75979.]—**Rarefaction of Air by Fan Motion.**—Would any of the readers of this paper be so kind as to answer the following question? An ordinary fan air-propeller, say 8in. diam., four blades, revolving freely (without any casing) on a shaft, if driven at a very high speed, would it not tend to force the air out of it and produce a vacuum within the area beaten by the blades? If so, what number of revolutions and what power to drive it would be necessary?—FAN.

[75980.]—**Soldering.**—I got a job lately to solder a piece of cast iron to a piece of tin, but was unable to get the cast iron tinned, though I tried every possible way. Can any of "ours" give me any information on the subject?—AMATEUR.

[75981.]—**Edison Dynamo.**—I want to build an Edison-type dynamo, to work at 60 volts, 22 ampères, at about 1,200 revs. 1. Will a drum armature, 3¾ by 8¼, wound with 146 yards No. 18 B.W.G. in two layers, make a good armature, and the right voltage? 2. The field-magnets, 12in. wrought-iron cores, 3½in. dia., with cast poles, which I want to wind compound. How, and what quantity, also sizes of wire, shall I require to balance the armature? 3. For a shunt machine, should I be right if I wound 16½lb. No. 17 B.W.G. on fields? 4. Would a weldless steel tube, 1 11-32in. bare out, 1in. bore, be stout enough for the shaft? How do you work out the size and quantity of wire to put on the fields for a compound machine?—BARON.

[75982.]—**Interest.**—On January 24, 1888, a friend lent me £200 at the rate of 6 per cent. per annum interest, and since then I have paid him £71 10s. on account, as follows:—

April 24, 1888	£26	10	0
November 6, 1888	25	0	0
April 23, 1889	10	0	0
December 23, 1889	10	0	0
	£71	10	0

Will someone kindly inform me total amount due to him June 24, 1891, including interest?—T. V.

[75983.]—**Kiln.**—Will some friend tell me what is the smallest size kiln made of bricks that can be erected to burn bricks and tiles in to use as a test? Inside measurement, height, and how many fire-holes?—EXPERIMENT.

[75984.]—**Cylinder Rings.**—I have an escape of steam in cylinder. Can the rings be set out or tightened? Have tried the steam by taking out one end of cylinder and putting steam to the other. Will any reader assist me?—S. J.

[75985.]—**Clock-Making.**—Will the writer of the recent articles on this subject, or anyone who is a practical hand, kindly answer the following questions for me? 1. Is there any rule by which to find diameter of fusee in proportion to the size of the barrel? 2. What is the diameter of small end of fusee in proportion to the large end, and should the fusee be curved or a straight line from large to small end? I have a chiming clock, nearly finished, nearly on the lines of the one described in the "E.M." 3. Pendulum, 10in. to centre of ball; diameter of ball, 3in.; vibration of pendulum, 1in.; teeth in 'scape-wheel, 30. Is this swing sufficient?—CLOCK.

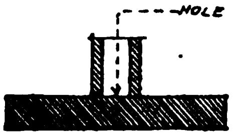
[75986.]—**Medical Coil.**—I have a medical coil, by Halse, with three handles. I cannot get the middle handle to work. I am told that the middle one should be the strongest. All the wires are firmly soldered at the bottom, and I work it with a dry battery. Can any reader help me out of the—DIFFICULTY?

[75987.]—**To Mr. Bottone.**—I have a small engine, 1½in. bore by 2½in. stroke. What size of dynamo is it capable of driving?—Apprentice.

[75988.]—**Phosphor-Bronze.**—Will some readers give me the best methods of melting phosphorus bronze, and moulding the same in small lots?—W. B.

[75989.]—**Air-Vessel.**—What is the rule with regard to the size of air-vessels fitted on the main columns of pumps? Would any gentleman advise me in the following case? In the pit I am in connection with there is a compound engine working a double-action pump; size of rams 6in. dia., and 1ft. 6in. strokes, main pipes 6in. dia., and 270yds. long. There are four rams—two on each side—and the pressure is about 350lb. per sq.in. What size of air vessel would suit, and must there be a valve between it and the main column? Also would a water-gauge, to show position of water and air, be an advantage?—Alltyab.

[75990.]—**To "J. H." or "J. K. P."**—Would you inform me how to tap or screw a hole with a full thread to the bottom of a blank hole ¾in. or an ½in. deep, as per sketch, section?—An Eight Years Reader, Brierfield.



[75991.]—**Hand-Shaking Battery.**—There is a battery which gives a powerful shock to anyone shaking hands with the person using it, though nothing can be seen. Could any of your readers tell me how it is done?—W. B. M.

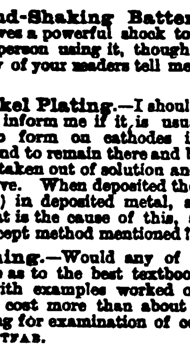
[75992.]—**Nickel Plating.**—I should be very glad if some reader will inform me if it is usual for bubbles of hydrogen gas to form on cathodes in nickel-plating depositing vat, and to remain there and become deposited unless instantly taken out of solution and exposed to air, when they dissolve. When deposited they look like small holes (not lumps) in deposited metal, and appear very unsightly. What is the cause of this, and is there any remedy for it except method mentioned?—Aston.

[75993.]—**Mining.**—Would any of "E.M." readers kindly advise me as to the best textbook on ventilation, &c., of mines, with examples worked out in it, and one that would not cost more than about 6s.? I want it towards preparing for examination of colliery manager's certificate.—Alltyab.

[75994.]—**Transparent Varnish.**—Will any of our readers inform me of a transparant varnish that is unaffected by acids, moisture, and heat up to 212° Fahr., also having a slight degree of elasticity?—Kensington.

[75995.]—**Blackening Zinc.**—What is the best way of making zinc a dull black for experiments with the magic-lantern?—A. T.

[75996.]—**Triangle.**—If the two sides of triangle, G and C rest detached from, and on, side D, side D being balanced on point D, length of arm, A to C, being one-third of from F to C, a tension being drawn from A to D, how much would B outweigh E—i.e., independent of weight of structure?—H. C. B.



[75997.]—**Leclanche.**—Looking through back nos. of "ours," I was struck with the frequent occurrence of the word "Leclanché." I suppose most of them contain it, at least, a dozen times, which is plain indication of the general utility of this battery. What other man could boast of such an honour? For this was primarily, I suppose, a man's name, and not merely an arrangement of glass jars, porous pots, &c. When we reflect upon the universality of the battery arising from its utility for telegraphic, telephonic, and bell-ringing purposes, to the almost complete exclusion of all other batteries (than all of which put together it is probably more useful), we must recognise in the Leclanche battery one of the greatest inventions of the age. Who was, or is, Leclanché? I have searched for some biographical notice of him, and have, so far, been unsuccessful in my search. I think, Mr. Editor, there are thousands of your readers beside myself who would be gratified with a sketch of the life and career of the man to whose ingenuity, business despatch, home comfort, and all matters of urgency, we owe so much. Can any reader oblige?—A. E. B.

[75998.]—**Electric Lighting.**—Would any reader say if I could light a 5 or 10c.p. lamp by a small dynamo run by the lathe. I only require the light while doing light work, such as drilling. Could I drive a 10c.p. dynamo by the lathe, or is it too much?—C. F. M.

[75999.]—**Alternating Circuit.**—I want to construct an apparatus to work in an alternating circuit. The alternations are 12,000 per minute, and I want the moving part of this apparatus to vibrate with a speed corresponding with the current alternations. If this is not impossible, I should be glad to know how to set about it? All information will be much esteemed. A polarised armature has been tried, and failed, though every part was laminated.—N.

[76000.]—**American Glass-Cutter.**—What is the principle of the cutting power of the little wheel? Why should it not trundle along the surface without cutting? Naturally it would be thought that if a steel edge would cut glass at all, it would do so used as a knife; whereas, if the wheel sticks it ceases to cut. Why are the wheels always so very small, since larger ones would, if the principle holds good, be more convenient to use? Will some one who knows, if such there be, explain the above, which is as mysterious as the electric Mrs. Abbot to—O. J. L.

[76001.]—**Egg Tester.**—Should be much obliged if any reader could give me directions how to make an egg tester, for testing the fertility of eggs after they have been in incubator for a few days.—Wet.

[76002.]—**Fireirons.**—Could anyone tell me if the cheap sets of fireirons are made of cast iron—that is, made in a mould, or are they forged? If someone in the trade will answer they will much oblige.—Smith.

[76003.]—**Aluminium.**—I have some very thin sheet aluminium, which I find to be hard and springy. Can the same be annealed or rendered soft without any springiness—something of the nature of copper—and, if so, how?—Metal.

[76004.]—**Blower for Organ.**—Can anyone suggest any cheap motive power for blowing a small chamber organ of 10 stops? Hydraulic or gas engines are no good, as I have neither water pressure nor gas. I fancy I remember having seen an arrangement consisting of a series of weights at the back of the organ, described in this paper some time ago. I should be much obliged for any information respecting this apparatus, or any other which might be applicable? I should not object to a machine working intermittently, say for an hour at a time.—Nig.

[76005.]—**Killing Rabbits by Electricity.**—I am thinking of trying to catch rabbits (which are plentiful here) by means of a fine wire about 200yds. long stretched between insulators, and carried about 4in. above the ground, in connection with one pole of an induction coil, the other pole being put to earth. My idea is that they would walk against the wire in the night and get killed. What size coil and battery would be necessary to insure success? Would the leakage on damp foggy nights be very great? Would there be any particular advantage for this purpose in having a very large coil with a certain battery power? I intend making coil myself, as I have made one before. I suppose a coil is the only thing that would do?—Gas.

[76006.]—**Small Hooks.**—I want to make a few S hooks out of ¼in. steel. How can I get them right shape and good finish? Have tried, but get them bruised in hammering. Must hold 50lb. weight.—G.

[76007.]—**Charging Accumulators.**—How long does it take to charge an accumulator of say 3 cells from a 4-cell bichromate battery?—and how do I know when it is full? Can harm be done by overcharging?—P.

[76008.]—**Charging Leyden Jar.**—How do I ascertain whether a Leyden jar is fully charged from a Wimshurst machine? Do I burst the jar by continuing it, or when must I stop?—P.

[76009.]—**Deviation of Compass.**—What was the magnetic declination in Calcutta 30 years ago, and what is it now?—Antares.

[76010.]—**Wire Spinning for Pianofortes.**—Would Mr. Schucht, Mr. Davies, or some other able correspondent kindly help me by giving me some instruction in wire spinning required in making single and double-covered strings for pianofortes? Having lately got possession of a string machine for making them, I have tried making a few strings, which are not up to the standard, as we can slide the copper wire about when strung on pianoforte, and on that account cannot get a good quality of tone. I think the fault must be in the ends not being fast. I have been given to understand that there is a liquid composition or solder used for fastening them. I shall be glad of any information that will get me over any difficulties in making them, especially on making the double-covered strings.—Anxious One.

[76011.]—**Lighting Fairy Lamp.**—To Mr. Bottone.—With reference to your reply to query 75867 re above, please say what candle-power this lamp will give when used with two chromic-acid cells, as you state? Is there any rule to determine the candle-power of lamps by the number of volts used? For example, if 4 volts give 2½c.p., will it take 8 volts to give 5c.p., and 16 volts to give 10c.p., and so on? Do the volts and candle-power run proportionately together in this way? A little information will much oblige.—Incandescent.

[76012.]—**Transformer.**—To Mr. Bottone.—I have made an induction coil as described in your book, and intend doing this the same way if it will suit. I should like to know what length and diameter I had better make the core, and what difference in its (the coil) construction would make a difference of 1 volt in the transferred current? I should want this current to be steady. Would not the contact-breaker spoil this? I intend joining the secondary coil to the supply, and then, of course, I shall obtain the transferred current from the primary coil. Am I right?—Motor.

[76013.—**Stove Draught.**—Will someone please tell me how to increase the draught of an ordinary heating stove, burning coal, without lengthening the pipe, which is impossible? By adopting one of the methods given in Williams's "Combustion," I have succeeded in consuming the smoke, but the draught is not nearly so good as it should be. The pipe is 5in. diameter and 10ft. long. Would reducing the diameter of it be any advantage?—An Old M.S.E.

[76014.]—**To Mr. Bottone.**—Will you kindly give me sizes and weight of wire, also sizes and build of field-magnets and armature for 30c.p. dynamo of the Siemens type, fields wound compound, short shunt? Also, whether armature would be better on spiders or wood core. What number of revs. required, and what H.P.? Would it be better for all ironwork to be wrought? I have your book on dynamo.—Etincelle.

[76015.]—**Silvering Specula: Mr. Common's Method.**—In the February number of the *Monthly Notices* of the R.A.S., at page 227, the report from Mr. Common's observatory mentions that as the result of a number of trials a new silvering process has been adopted by means of which "a perfect film of any required thickness can be formed with absolute certainty, and mirrors of any size can be silvered with ease and rapidity." Can any of your readers describe the new process?—or perhaps Mr. Common will himself kindly favour us with a description.—G. S. F.

[76016.]—**Silvering Specula: Chemical Rationale of.**—Will some of your able chemical readers explain the chemical reactions which take place in the preparation of the reducing solution used in Brashear's process? That solution is made by dissolving 840gr. of loaf-sugar in 800gr. of distilled water, then adding 39gr. of nitric acid and 25dr. of alcohol, the mixture being finally made up to 25oz. by the addition of water. I should be glad if the formulæ of the reactions are given. Is it important (1) that the water in which the sugar is first dissolved should be restricted to 800gr. for the quantities mentioned? (2) Does an excess of nitric acid do harm?—in making up a solution about six times the specified quantity of acid was inadvertently added. Will this react on the alcohol and alter the constitution of the resulting solution, so as to make it useless for the purpose in view? How is caustic potash made pure by alcohol? Any water present in the latter will take up carbonate, which must, therefore, remain on evaporation. Can the alcohol be recovered? How is the evaporation best conducted, or should the potash be used in the alcoholic solution?—T.

[76017.]—**Generator for Gas Furnace.**—I have got a Fletcher's injector gas furnace and blower, No. 1 size. I want to make a generator so that I can burn the vapour of benzoline or gasoline. A sketch of inside of generator, with sizes, will greatly help me. Have no back numbers.—J. Preston.

[76018.]—**Mechanical Telephone.**—Diaphragm of telephone is broken. What can I make a new one of?—J. P.

[76019.]—**Fixing Wimshurst Plates.**—Will Mr. Bottone please advise the best method for fixing Wimshurst plates to wood bosses, also cement to use? I have tried shellac and elastic glue; they seem too brittle and come off.—Wimshurst Machines

[76020.]—**Phonograph.**—To Mr. Gillett.—In the last article on the phonograph you say the cylinder must revolve about 60 times per minute. Taking this in consideration, and looking through the relative sizes of the driving pulleys, the speed of the motor must be between 8,000 and 9,000 revs. per minute. Is this correct?—T. Rexsat.

[76021.]—**Spiral Steel Springs.**—Would one of your numerous correspondents kindly give me the rules for the proportions of spiral springs for direct-loaded safety-valves? I have a set, but I am afraid they are not correct, as they give such peculiar results, and in the books that I have access to I can find no other.—G. P. S.

[76022.]—**Dynamo.**—Will any reader kindly state if it is possible to stop or impede the waste of magnetism between the pole-pieces (which approach at the edges ½in.) without altering machine? (2) What loss of power would take place in a dynamo the "H" armature of which is ½in. distant from the pole-pieces?—G. M. S.

[76023.]—**Batteries.**—Is it possible to charge bichromate and other primary batteries like accumulators? If so, what percentage of the charging current would you get?—G. M. S.

[76024.]—**Clicking Noise in Telephone Receivers.**—We have had our shop fitted up with telephones, and we are greatly annoyed at the clicking noise heard in the receivers. Can Mr. Bottone tell us the probable remedy of same?—Click.

[76025.]—**Electric Lighting on Small Scale.**—Will anyone kindly tell me the cheapest motive power for a 60c.p. dynamo? Also size and shape of castings for a motor to drive same, and would wrought iron do better than cast? Diagrams would greatly oblige.—Midhurst.

[76026.]—**Electric Launch.**—To Mr. Bottone.—I have a boat 4ft. long which I wish to fit up with a motor and bichromate battery. Kindly tell me probable cost of motor (reversing), number and capacity of cells to drive at four miles an hour in still water? I should of course remove the zincs from solution.—J. J. B., Twickenham.

[76027.]—**Isinglass.**—Will a draughtsman kindly give full directions for preparing isinglass as a size for drawings?—Blackwater.

[76028.]—**Ellipse.**—Find the length (true to four places of decimals) of the whole circumference of the ellipse whose major and minor axes are 12in. and 5in. respectively.—Libra.

[76029.]—**To Mr. Bottone.**—I have recently had charge of an electric light installation for a cotton mill of 700 lights. There are two continuous-current machines, running 711 revolutions per minute. After running a short time the armature registers about 140 degrees of heat. Should this be so? If not, what is cause of heating? Also, all the switches on switch board get so hot that you dare not touch them. Please say whether this should be so or not. The lights are mostly used for weaving, and we have a loss of 20 volts from machines to furthest part of sheds. It is proposed to put 90-volt lamps in furthest shed and 95 volts in middle shed, and 100-volt lamps in shed near to dynamos. Is this the proper thing to do? Of course, we get a very poor light in furthest shed. I may say that the machines give out 108 volts, and we have 100-volt lamps all through at present.—B. L.

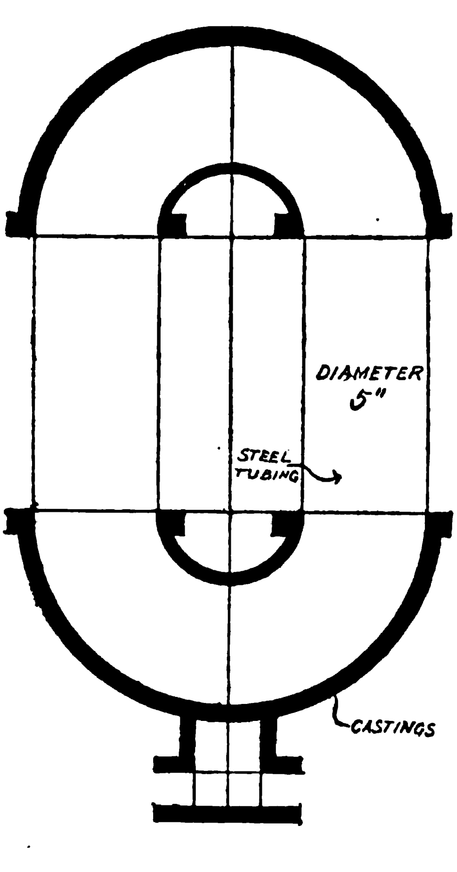
[76030.]—**Dwelling Houses.**—I want to ascertain the approximate number of dwelling houses built annually in the United Kingdom, and the number of these above and below a rental of £18; also the estimated number of existing houses. Can any reader give me these particulars or say the best source of information on the subject?—R. A.

[76031.]—**Chamber-Pipe Organ.**—To Mr. Thos. Elliston, Sudbury.—I have a chamber organ, pneumatic action, 18 speaking stops, two manuals, Great and Swell, and I have been greatly troubled for some little time with a loud hissing noise in the Swell box, especially noticeable when the Soft Swell stops are used and the

Swell opened. The noise very much resembles air escaping from the Swell soundboard. Can you tell me the cause of the noise, and the best course to adopt to remedy the same? The front of the organ (open diapason speaking) is decorated with several colours, in which blue and gold are the most prominent, and I want it redecorated to match the room, the case being walnut and maple. I want the pipes painted chocolate and gold. Can this be done by an ordinary decorator, and does it necessitate the removal of the first colours? I may also mention the organ was built in Rome, and was purchased by myself at the Inventions Exhibition, where it was exhibited by the builders.—T. A. L.

[66082.]—**Lamp Resistance.**—How can I find the cold resistance of incandescent lamps, the working pressure and current being given—110 volts and ·75 ampere. This question was given at the City and Guilds examination this past year. It is easy to compute the hot resistance, but I do not know how to find the cold.—J. T. B.

[76083.]—**Steel Tube and Casting.**—What thickness should the seamless steel tube be to safely withstand pressure of 500lb on the square inch of the following diameter 5in., 3in. 2in., to be as light as possible, to be used as boiler tube, the 3in. to be flue, the other as steam-pipe. What would be the best metal to make the casting of, as per sketch, so as to be as light as possible, and the best way of fitting tube to the same—the weight per foot of steel tubing?—E. F.



[76084.]—**Dynamo Hard to Drive.**—I have put together a small dynamo as follows: Fields upright, wound with No. 16 wire, 3lb. on each limb; armature, Siemens I-pattern, wound with ½lb. No. 20 wire, the whole connected shunt. I cannot drive it from a lathe over a V-pulley on armature shaft, the pull of magnets being so great that the cord slips round and the armature goes backwards. At the same time intense flashes are given off from the brushes. Will some kind friend just point out where the fault probably lies? I have been told to connect it in series; but I want it for accumulator charging, and so am obliged to have it shunt.—Jimcrack.

[76085.]—**Telephone Construction.**—Will Mr. Bottone or Mr. Allsop tell me how to fit a carbon transmitter on to an existing set of Stanhope telephones? There are bells and two telephones at each end of line, automatic switch in box, with the bells on the covers. Am I obliged to have two carbon transmitters, or could I manage with only one at one end, and use the two telephones at the other? A sketch of the connections would be gratefully received by—A Regular Amateur.

[76086.]—**Galvanising Small Castings.** — I wish to galvanise small castings, 2in. to 4in. long and about 4oz. weight. I find the process explained in back numbers, except that, with reference to the sal-ammoniac which covers the zinc, the only direction is to have a thick layer. How thick?—¼in., or 6in., or more.—S. B.

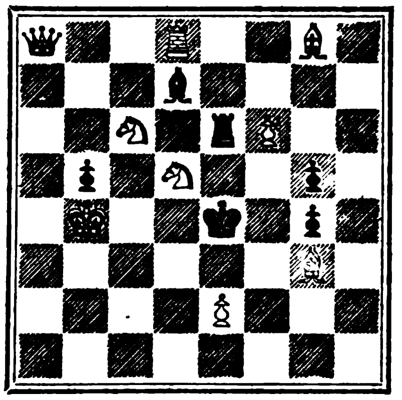
[76087.]—**Galvanometer.**—To Mr. Allsop.—I am making a lineman's galvanometer in an upright wood case, and I want to wind it to 0, ·10, 100, and 500 ohms. I intend to use 1ft. of No. 12 s.c. copper wire for the 0, 50ft. of No. 36 for the 10, and 500ft. of 36 for the 100-ohm coil. Would you kindly tell me what number and length of wire for the ·500-ohm coil, and how the coils are arranged, and what is the best way of fixing the spindle on centres or bearings? I intend to use a brass frame and ivory bobbins, as I want it good and as sensitive and reliable as possible. A drawing of bobbins and size would oblige—A Fitter.

CHESS.

All communications for this column to be sent to the Chess Editor, at the office, 332, Strand.

PROBLEM MCCLXXXIII.—By W. T. Hurley.

Black.



White. [9 + 6.

White to play and mate in two moves.

Solution to 1281.

White.	*Black.*
1. Q to Q sq.	1. K to Q 4.
2. Kt to Kt 3.	2. K moves.
3. Kt mates.	

NOTICES TO CORRESPONDENTS.

Correct solutions to 1280 by K. Fellows and A. Fellows, Pegasus; to 1279 and 1277 by C. S. Bright.

W. Jay.—We have replied by letter.

C. S. Bright.—Glad to hear you will compete in new solution tourney which commenced with Problem 1282. Your card, dated 30th October, has only just come to hand. You omitted to put England on it, so it has been travelling about America.

The Boden-Kieseritzky Gambit.—The opening moves are :—1. P-K 4, P-K 4; 2. B-B 4, Kt-K B 3; 3. Kt-K B 3, Kt takes P; 4. Kt-B 3, Kt takes Kt; 5. Q P takes Kt, P K B 3; 6. castles, Q-K 2 (!); 7. R-K sq., P Q 3; 8. Kt.-R 4. "W. W.," in the *British Chess Magazine* for November, suggests that black shall now play B-K 3 or P-K Kt 3, instead of the book move Kt-B 3. Our readers are invited to discuss the following continuation after 8—, B-K 3, viz :—9. B-Q 3 (!), P-K Kt 3; 10. P-K B 4, Kt-Q 2; 11. B takes P ch, P takes B; 12. Kt takes P, Q-R 2; 13. Kt takes R, Q takes Kt; 14. P B 5, B-B 2 (if B takes B P; 15. Q-B 3, &c.); 15. R K 3 and the Q is likely to be harassed. Any correspondent who is interested in this opening is requested to communicate his views :—We propose giving from time to time some fresh analysis—as as space will allow.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, December 2, and unacknowledged elsewhere :—

R. Gibbard.—Acide.—D. Packer.—Daramona.—Lever.—W. Leadbetter.—C. Morrell.—Novice.—A. Gardener.—Anxious.—Amateur.—Plumber.—Fredos.—Motor.—Iron and Steel.—David Walsh, B.Sc.—Cycla.—Dextrine.—C. H. Fridy.—One that Does Not Know.—J. H.—A Fellow of the Royal Astronomical Society.—S. S.—Hyern Brewset.—J. H. Evans.

D. McNaly. (We do not remember the advertisement of drawing-paper ruled to scale in lead-pencil; but if any one can inform you, it is the very firm whose "watermark" is in the paper on which you write. Apply to Waterlow and Sons, London, and if such paper is prepared, you will probably get the information required. We cannot look back "about ten years ago" to hunt up an advertisement.)—Hugh L. Aldis. (You must mean Proctor's work on Saturn. That ought to be known in Cambridge. Apply to Messrs. Longmans, Paternoster-row, E.C.)—J. A. Graham. (You can no doubt obtain all particulars of the new lead galvanising process from Mr. Binet, 6, Great Winchester-street, E.C., or see it in operation at the works of Messrs. Westwood, Napier Works, Millwall, E.)—M. P. (All particulars as to the rules and regulations of scientific societies can be obtained from the respective secretaries.)—Chelt. (Please see the indices of back volumes. "Tone to the system" is not, we suspect, to be obtained from any form of electrical apparatus; but you can try. Faith has great healing power.)—A Young Beginner. (Do not understand your reference to "hydrometer." Is it galvanometer or voltmeter you mean? At any rate, you can find the information required in back volumes, even in recent numbers; but primary batteries are very costly for electric-lighting work. Why not apply to the makers?)—Battery. (Chromic acid has been mentioned about a thousand times in these pages. If you cannot get it at your druggist's, no doubt Mr. Bottone can supply it.)—Refrigerator. (We have given illustrations of many of the most useful ice-making machines; but naturally they are mostly patents, and can be used only for experiment without infringing the rights of the patentees.)—An Enquirer. (What can you mean? The zinc is melted in anything suitable—an iron pot, for instance; but you can use a crucible if you like. You must mean something more than appears on the face of your query: so repeat with more detail as to the difficulty. You don't want a "hearth" for melting zinc.)—Novice. (Certainly a lantern of the kind can be used in a small room. The makers will give all particulars. The distance from the sheet can be regulated. Any of our advertisers who sell magic-lanterns will supply all the information needed, and a textbook as a guide.)—Egroeg. (Better consult a dentist if the information given in back numbers is not satisfactory. The tooth can be stopped with guttapercha; but whether that is the best remedy no one can say without seeing the tooth.)—Orpailleur. (Better send the gloves to the dyer's, as he has conveniences, and can do them cheaply; but you can dye them by dipping into a decoction of logwood and afterwards into a solution of sulphate of iron. Perhaps the aniline black would suit, but it is not permanent. 2. How can you gild without gold? Please see many replies in back numbers or any textbook on electro-metallurgy. Carbon will not deposit gold unless the gold is in the solution. Some one has been "poking fun" at you.)—Electra. (There is no way of finding out what has been patented except searching, either by yourself or by an agent.)—Richard Dixon. (We do not know the publisher's address, but you can probably see the paper at the Patent Office Library. Probably also, it is filed by some of the large advertising agents.)—F. W. R. (See answer to "Gamma" last week, p. 317. Cottam's is generally preferred by observers.)—Thos. Casson. (The luminous fountain was fully described soon after it was shown at the exhibitions. The latest development was illustrated in the number for July 19, 1889. 2. Water can be decomposed by the electrical method or by converting it into steam, and passing it over incandescent coke or through a tube filled with red-hot fragments of iron. See indices of back volumes.)—Amateur. (Perhaps it is one of the red sorts, that do not bleach readily. Has it been earthed up well?—that ought to do all the bleaching possible.)—A. H. R. (Why not follow the directions given in connection with such motors in back volumes? See recent back numbers.)—Carbon. (It has been frequently stated that the best carbon plates for batteries are cut out of retort scurf; but they can be made much in the same way as the rods for arc lamps. Plant is required in the latter case; but see indices for references to many hints on the subject.)—E. W. Butler, Fulham. (There is no particular form for outside use. Are the connections, perhaps, defective?)—J. A. B. (They can be obtained at such shops as sell die-sinkers' and engravers' tools.)—W. G. Chalton. (The best plan is to undergo a course of training in the laboratory of a public analyst. There is no examination the passing of which makes an "analytical chemist.")—Pro Bono Publico. (If you want to really "patent" the pills, it would be advisable to consult an agent. What are known as patent medicines do not necessarily come under the Patents Act.)—Girder. (We do not think the time has expired; but it is to be ascertained by applying direct to the Postmaster-General.)—J. B. (A recipe for silicate of soda on p. 255, May 15, 1891.)—Chemicus. (Many of them are mentioned in the English journals; but probably Mr. David Nutt, Strand, W.C., could give a list and prices.)—T. C. Smith, Brighton. (Most gratefully; kindly begin as soon as you like. We can always make room for papers on really practical subjects.)—W. Leach. (We do not insert adapted copies of letters sent to other papers, and we have no taste for controversy of the kind you seem anxious to commence, and for the personally bitter tone of your letter.)—S. Inos. (Estimates of cost must be advertised for, or obtained of advertisers in an ordinary way. They are not subject-matter for queries.)—C. G. M. Bennett. (Thanks; but we cannot reproduce pencil sketches, and we have, moreover, already given it.)—E. M. Richards. (Enough has been said, we think. Readers do not care an atom for such controversy.)—Z. Y. X., F. Scarf. (In type.)

"Rejuvenation."—An Eminent Physician (M.D., R.N.), &c., writes:—"I have twice visited Mr. C. B. Harness' Electropathic Establishment, at 52, Oxford-street (London). I had long been a believer in the efficacy of electropathy scientifically carried out, but was not prepared for the perfection of appliances there displayed. I was quite as much pleased as surprised. Thousands of ailing ones may here seek for and find what I may term rejuvenation, in contradistinction to premature old age. I recommend electropathy in many ailments, especially the following:—Nervous exhaustion, chronic debility, ennui or melancholy, amenorrhea, dysmenorrhea, rheumatic gout, chronic rheumatism in any form, functional heart complaints, neuralgia, and chronic ailments of the digestive canal." Every man and woman in search of health should wear one of Harness' Electropathic Belts. Those who are unable to call and avail themselves of a free personal consultation are invited to write at once for descriptive pamphlet and book of testimonials. Note only address, 52, Oxford-street, London, W.

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Subscribers receiving their copies direct from the Office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a Pink Wrapper, as an intimation that a fresh remittance is necessary if it is desired to continue the subscription.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, DECEMBER 11, 1891.

MOULDERS' EXO-SKELETONS.

SINCE moulders work in sand, and build up structures more or less heavy in that material, and since these have to stand liquid pressure—often enormous in amount —the structures require to be supported with rigid framings akin in function to the skeletons of organic beings. We may pursue the analogy, and point out that these framings fulfil the functions both of exo- and endo-skeletons. There is the outer framework or skeleton of a mould—the moulding-boxes or flasks—and the inner skeleton—the grids and drawback plates; Then, besides the major portions of the anatomy, there are the minor, embracing the lifters, rods, and nails, which support small and local portions of sand. Let us take a survey of these and their functions.

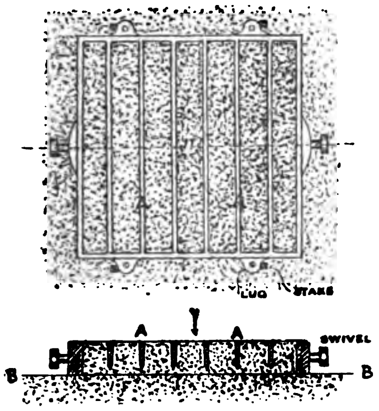


Fig. 1.

It is, however, scarcely possible to separate the outer and inner skeletons absolutely without causing much confusion of illustrations. I shall, therefore, take the exo-skeleton as referring to the framework of *moulds*, and the endo-skeleton as referring to the framework of *cores*. This distinction, though not strictly correct,. will simplify the method of treatment.

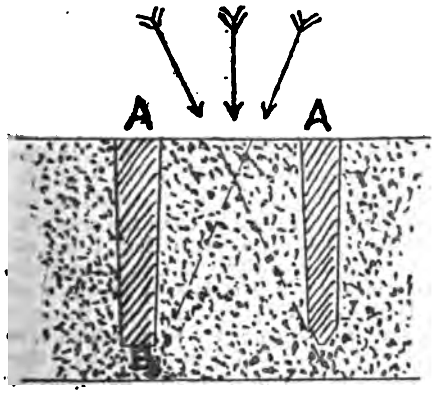


Fig. 2.

As I am going to consider the subject of these skeleton frameworks from one point of view only, that of affording support to the moulds, I need not make special allusion to subsidary parts, as handles, swivels, pockets, and so forth.

For convenience we may divide moulds into two great classes—those in which the work is mainly or entirely imbedded in the *floor*, and those in which it is inclosed entirely in *flasks*. In the first case, the sand surrounding the mould being that of the foundry floor in which the mould is formed, no inclosing framework of metal is necessary, the walls of the mould affording ample support. And this method, of course, would be suitable for nearly all moulds, but for one practical matter—namely, that the under faces of moulds made in this way are not, and cannot be, rammed so well as those of moulds made is flasks that are turned over. That is, in a mould made in the foundry floor the sand has to be tucked under the pattern and rammed at such a disadvantage that it will not be of uniform consistence or homogeneity, and the consequence will be that the under surface of the casting will not be quite true and uniform. But when a mould is inclosed entirely in flasks, then the portion that is to be lowermost at the time of casting is rammed up first of all while it is facing uppermost, and the flask, with the inclosed pattern, is afterwards turned over bodily for the ramming of the top part. Consequently each surface of the mould, bottom as well as top, is rammed directly against the pattern face, and the sand will be of equal consistence, which cannot be the case when it is tucked underneath a bottom surface.

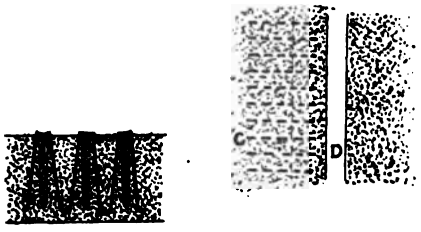


FIG 3

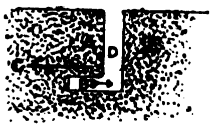


FIG 4

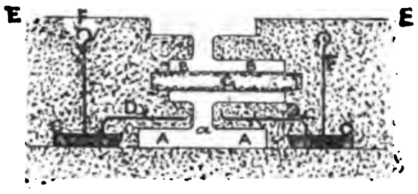


Fig. 5.

In practice, when a pattern having a large surface has to be moulded by bedding in, the pattern is laid on and removed from a temporary loosely-rammed bedding, once, twice, or even three times, and the moulder goes over the whole surface of the bed in detail with his hands, ramming soft places harder, and loosening the sand in hard spots. In this way very good results are obtained; but not so good as those secured by ramming direct upon the face, and turning over.

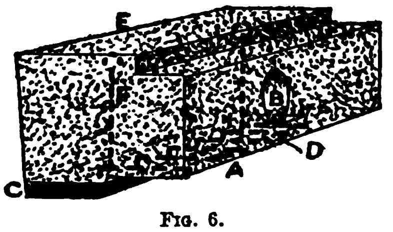


Fig. 6.

But moulds made in the foundry floor are never, unless in exceptionally rough classes of work, ever cast open on the top. They are covered with a single flask of sand. This, therefore, is the simplest type of skeleton or frame used by moulders, and it is termed a "top part," or "cope." It holds and retains the sand that forms the upper part of the mould. The face of this portion of the mould, being of the same contour as the top part of the pattern, may either be level or of diversified outline, and hence the form of a cope will be modified very materially.

Fig. 1 is a plan view and section respectively of what may be termed the standard type of top flask, or cope. It consists of a stout outer frame of cast iron, usually square, oblong, or circular in outline, and crossed with bars or stays, A, made somewhat thinner and shallower than the outsides. The stays must be shallower than the outer frame, else there would be no thickness of sand intervening between them and the face, B, of the mould. But they are brought rather near that face (¾in. usually) in order to give all the support possible to the face sand. Observe their bevelled bottom edges. The reason why these are bevelled is this: The sand is always rammed from above, in the direction of the arrows. If the edges were not bevelled the sand would remain very loosely and insufficiently rammed, as at B, Fig. 2, just underneath the bars; but, being bevelled, the sand is rammed as uniformly underneath the bars as elsewhere.

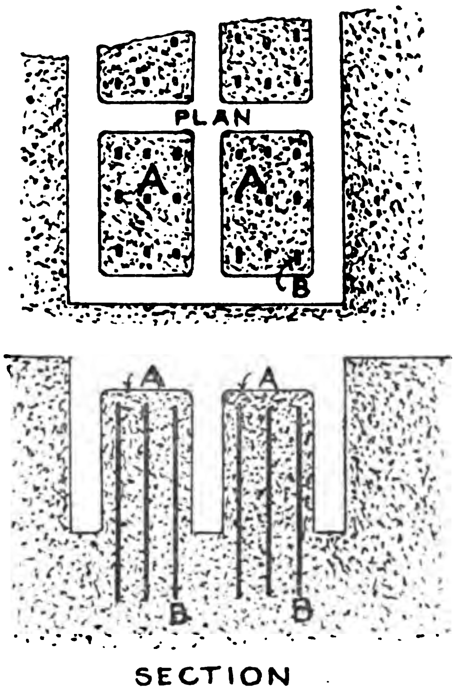


FIG 7

From this typical plain top, to tops whose bars are cut to all outlines to suit all classes of patterns is a natural transition. When castings of any single type are made in considerable quantities, then the bars of the top flask are always shaped to the precise outline of the upper portion of the pattern, but always at a distance of about ¾in. away from it. So that, however irregular the surface of the pattern, there is nowhere more than about ¾in. of sand quite unsupported with bars.

Still, a flask with bars alone would not safely sustain a mass of sand weighing, in many cases, several hundredweights, sometimes even, two or three tons. The bars are necessarily tapered, as seen in the figures, to facilitate the making of the flask, in the first place, and the natural tendency of the sand to fall downwards is increased by the presence of this taper. Then there is the elasticity of the flask itself, and the shocks

VOL. LIV.—No. 1394.

and accidents to which it is subject. All available precautions are taken to minimise these risks of a fall out of the sand happening. The flasks are made very stout and rigid; the faces of the bars are cast very rough, being often purposely scored or hatched over with narrow ridges. They are always splashed with clay-water before the sand is rammed in, and the sand is rammed while damp, and with considerable force. But, in addition, *lifters* are hung in all the bar interspaces, to assist in supporting the masses of sand.

These lifters are a very vital element in the skeleton of a mould. Fig. 3 shows, in a rough fashion, how they are used. They are mostly suspended from the upper edges of the bars, and they reach down a little below the bevelled edges of the bars. It is easy to see that they must afford great sustenance to the sand, which is rammed around and among them, and that, with a mould adequately "liftered," a fall out of the sand is well-nigh impossible.

There is thus ample guarantee in a top part for the security of the sand. But what of the lower portion of the mould made in the foundry-floor? Does the inclosing wall of sand afford sufficient support to the mould? In some cases it does, in others it does not. It does when a mould is plain, without overhanging portions, or semi-detached portions or partitions between isolated masses, or "cods" of sand. But when these occur, then skeleton-like frameworks of various kinds have to be introduced for the purpose of affording enough support to those portions of sand to enable them to withstand the pressure of the liquid metal.

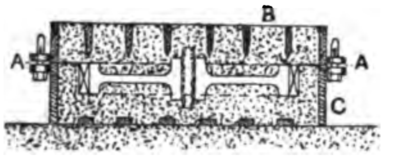


Fig. 8.

Take first the case of a mould (Fig. 4) having a mass of sand, A, overhanging a recess, B, that is to form a flange in the casting. Obviously such a mass of sand must tumble down unless some support is afforded it. A common way of effecting this is by means of rods, C. These are rammed down in the sand above the flange of the pattern, and being carried well back into the body of the mould they act something like cantilevers, the mass of sand to the left hand far more than counter-balancing the tendency of the sand at A to bear down and displace the rods.

In some cases such a mass of sand would be supported by quite a different method. It would be carried by means of a drawback plate. It is easy to see that there is a limit to the use of rods rammed up in the mould in the way shown in Fig. 4, if the amount of overhang over B is very much, for, in withdrawing the pattern flange from B, in the direction of the arrow, it is very likely to tear some portion of the overlying sand A down. Owing to the awkwardness of its position, this sand cannot readily be made good by mending up, neither can the mould be blackened properly. This, however, is a relatively simple case:—Supposing instead of a fairly open space, D, like that in Fig. 4, into which a loose flange can be drawn in two pieces, and in which the moulder's hands can find room to work, or instead of a mass of sand, E, that might be lifted out on a plate previous to the withdrawal of the flange B, suppose there is a mould like Fig. 5 also made entirely in the floor. It is clear that there is now no possibility of withdrawing the flanges A and bosses B of the pattern from the sand, either bodily or in detail, unless some portions of the mould itself are first removed. This removal is effected upon drawback plates, C C, a very essential and extensively used type of moulders' skeletons. These plates C C carry the whole of those portions of the mould which extend from their own upper faces to the joint, E, formed by the cope.

These drawback plates C C are laid upon a bed roughly levelled for them in the bottom of the mould, before any ramming up is done. There is no essential difference in the details of the actual ramming and venting done upon a drawback-plate, or in a mould. These points, however, have to be attended to:—The plate must be so stout that it will not spring at all when lifted with its weight of sand. Stout rods, D, are cast in it to overhang the flange, and rods, F, with eyes to lift it by. The rods D must be placed close enough together to sustain the overlying sand, and must be stout enough to remain rigid under its pressure. The drawback plate and the sand upon it is jointed into the sand of the mould around, both at ends and back, with long sloping faces, which are strewn with parting sand. When the mould is made, therefore, the appearance of the drawback removed from its position will be that shown in Fig. 6.

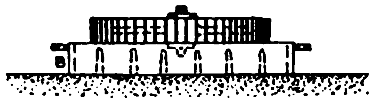


Fig. 9.

The sequence of moulding here is very briefly this:—A suitable hole is dug out and its bottom levelled. The pattern is placed thereon, the ends rammed, and the drawback plates C C laid in position against each side. The sand is then rammed to the top E, the cope put on and rammed, and removed; the pattern drawn down to *a*, the drawbacks lifted away, the bosses B B taken from them, and, lastly, the flange A A taken out. The parts of the mould are mended, cleaned, and blacked, and put back—the drawbacks first, with the round core, G, and the cope (not shown) afterwards.

There is also the case of "cods" of sand—for that is the term used—standing up from the base of a mould, as in Fig. 7, A. If these cods were simply rammed with no support save the coherence of the sand itself, the pressure of the liquid metal would swill them away. They are, therefore, sustained by means of iron rods, B, driven firmly down into the bed of the mould, while the ramming up is proceeding. Slender cods of considerable height can be safely sustained by this means.

I will now consider the skeletons of moulds made entirely in flasks.

Almost all flasks are made in two or more parts. Two parted boxes are used for work in which only one jointing is necessary. Fig. 8 shows a box of this type, inclosing the mould of a plated spur-wheel. The joint is at A along the upper edge of the wheel-rim; and the upper dished portion with its boss is carried in the sand of the cope or top part, B; and the rim and the lower face and boss are in the drag or bottom part, C.

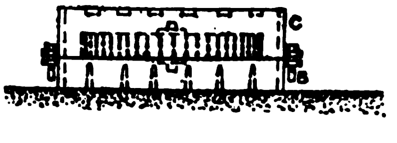


FIG 10

In moulding all work done in such boxes, both faces, as just now mentioned, are rammed direct, no tucking under at all being done.

In the first place the wheel is laid upon a mass of sand loosely shovelled into the turned-over top box B (Fig. 9), is beaten down into it, and is levelled into its intended position. Then the bottom part C is put over it (Fig. 10), and the sand in that is rammed permanently above and around the pattern, the rammer passing between the flat bars. Afterwards, the pair of boxes, securely cottared or bolted together, are turned over upon a level bed of sand, the cope taken off, as in Fig. 11, the sand smoothed off upon the face A, parting sand strewn over it, and the cope put on, as in Fig. 8, and rammed permanently. Then it is lifted, the pattern withdrawn, the mould mended and blacked, and put together for casting, Fig. 9, and the "pouring basin" runner and riser made.

Note the difference in the shape of the bars or stays in the top and bottom portions of the flask, Fig. 8. The first are arranged vertically, the second flatwise. The latter would possess no power to sustain a mass of sand, if placed in the top of the mould, as the vertical bars do. But in the bottom they will hold up any load of sand when the mould is being turned over, which is all they are required to do. They are cast flat, as being more convenient for general work, leaving as they do the whole of the bottom flask open to receive patterns of various outlines. When, however, special flasks are made for standard patterns, it is common to make the top and bottom bars alike, that is, vertical, and cut to clear the pattern outlines at the distance of ¾in. away; Fig. 12 shows a section through a symmetrical flask of this type inclosing its pattern.

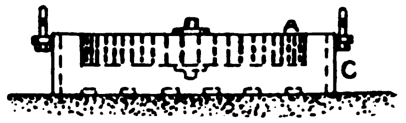


Fig. 11.

When, however, more than one jointing of the sand is necessary to allow of withdrawal of the pattern taking place, then, usually, though not invariably, boxes parted in more than one joint are used. These are termed three-parted, four-parted, boxes, and the portions other than the top and bottom are termed "middle parts." Fig. 13 shows a three-parted box, A being the "middle." Note that this is entirely destitute of bars, which, of course, would be in the way of any pattern. But the sand in that, being self-contained, has, nevertheless, to be carried by some means. This is done by means of rods and lifters. Note the internal flange, *a*, cast around the middle part, which is not cast in the top and bottom flasks. Upon this flange square rods of wrought iron (Fig. 14, B) are laid previous to ramming up the sand around the pattern. They are arranged in relation to the pattern, denoted by the dotted outline in the figure, being laid in as close contiguity to it as practicable. To assist further in sustaining the sand, lifters like those in Fig. 3 are *laid* up upon these, *leaning in a sloping position* from the rods B to the inside of the flask. This is the best support that is possible in a middle part; and although the rods and lifters are brought very close to the pattern, the falling out of the sand from a middle is much more common than its falling out from a top part.

These are typical boxes; but they are capable of very extensive modifications to suit many kinds of work. To notice them in detail would occupy too much space, and would be quite uncalled for in this particular article. I will, instead, hasten on to mention some fundamental modifications.

Frequently there are skeletons within skeletons. Thus drawbacks are often used within flasks, just as well as in the foundry floor. They are employed in cases where it would be impossible, or very difficult, to to make use of a separate middle part, and where, if practicable, it would not be so convenient for getting at the mould for mending up and blacking.

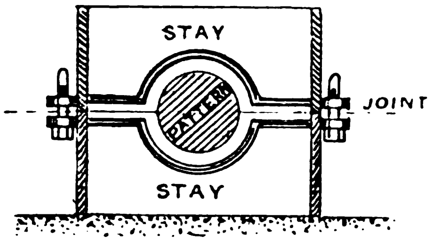


Fig. 12.

Thus, the spaces underneath the feet of some cylinders are better removed and mended up while upon drawback plates than they could be if carried in a separate box part.

Again, in the case of work moulded in large flasks, the labour of making a large joint and ramming up a whole box full of sand is often saved by using a kind of plate, not exactly a drawback, but one that fulfils a similar purpose. It often happens that one flange stands in such a position as to necessitate a joint. Thus in a bevel wheel cast with a half shroud, the trouble and risk of using a middle part to carry the zone of sand formed by the overhanging shrouding is avoided by carrying that narrow zone upon a cast-iron ring, rammed upon the joint-face, and parted off with parting sand.

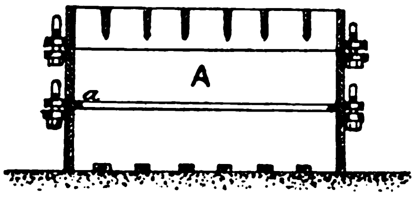


Fig. 13.

Again, when a circular flange and branch, A, stands out from the side of a pattern, as in Fig. 15, and with a foot, B, above, it is necessary that the upper sand at C be lifted away after the removal of the loose flange B before the branch A can be taken from the mould. Then a skeleton lift, or "grid," is made, consisting of two cast-iron plates, D, connected with the curved rod or rods, E, arching over the branch. The plates are also supplied with eyes, F, for lifting them by. Sloping joint faces are made and strewn with parting sand, as explained in connection with Fig. 5. The sand is rammed upon the grid and against the sloping joint-faces and up to the top joint-face. The remainder of the mould is finished and the grid lifted, and the branch withdrawn.

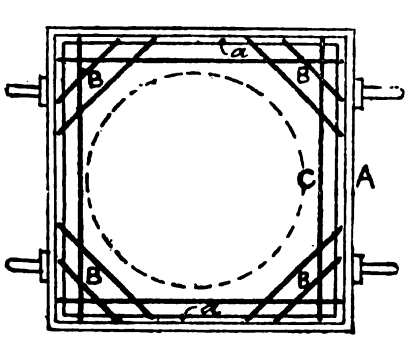


Fig. 14.

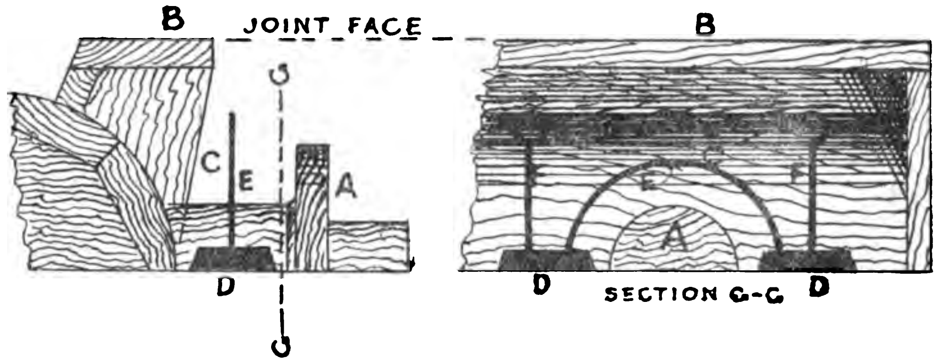


Fig. 15.

This form of lift, variously modified, is largely used in many kinds of work. Thus it is no uncommon thing to use it in a middle or bottom part, or open top, in place of fixed bars. In jobbing work it often happens that a large pattern in wood or loam has to be moulded for which a suitable flask with suitable bars cannot be found, and for which it would not pay to make a special flask. Then a suitable top part is improvised by making a rough skeleton of plates and ribs, to arch over the top of the pattern. Fig. 16 shows such a device suitable to a large pipe, air vessel, or similar casting. There are two large plates, A, cast to lay upon the joint-face of the mould and alongside the pattern, and these are connected with arched ribs, B, of wrought iron, cast into the plates, and they are lifted with the eyes C. These eyes are secured with rods or screws to the flat bars of the top flask, so that for the time they form an integral portion of it, and they are lifted with it.

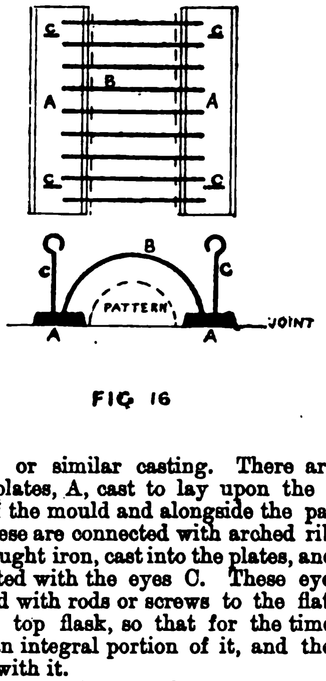


FIG 16

These types bring us by an easy transition to the grids proper that are wholly inclosed by the sand—our endo-skeletons. The consideration of these will occupy a future paper.

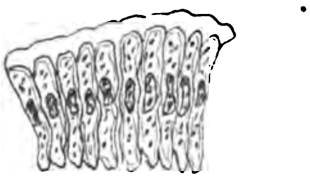
J. H.

PRACTICAL MICROSCOPY FOR STUDENTS.—X.

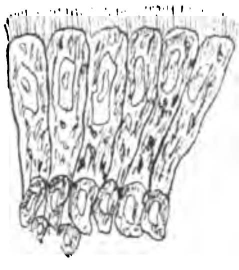
By Frederick Davis, B.Sc.

In our last chapter we dwelt principally upon the Amœba and the microscopical character of the blood. We will now examine some of the simpler forms and modifications of the cells found in the human body, and the tissues which they go to form.

The human body may be considered to be one immense mass of simple cells, modified in some cases to such an extent that the cellular character becomes extinct; whilst in other cases, even in advanced life, the cellular structure is retained. The simplest form of animal tissue is epithelium. It exists in several forms—namely, squamous, columnar or cylindrical, ciliated, and spheroidal. Epithelium, then, consists of a number of cells placed one upon another and side by side in such a manner that the under layers are constantly and persistently increasing and growing, with the natural consequence that the upper layer, which does not grow and increase, is, as it were, pushed off. We have a proof of this in our daily life, and occasional rough skin, which in reality is nothing more than Nature throwing off the cells which have become valueless to her. Epithelial cells are nucleated. It will be observed in studying the epithelial cells that there appears to be a little skin between them. This during life is semi-fluid, but after death coagulates and forms a thin, skinny layer; it is termed "interstitial substance," and acts as a cement for holding the cells together to form tissue. The squamous variety are those which become flattened, and as they become pushed to the surface form scales, and are shed in the ordinary manner. If we take a bone or paper knife, and scrape the inside of the lip or back part of the tongue, we shall remove from the mucous membrane a number of these cells, which, if placed upon a slip and examined under the 1in. power with a drop of water, we shall observe the formation of the squamous cells to advantage. We can, however, if preferred, stain the nuclei of the cells by permitting a little magenta solution to run under the cover glass. Columnar epithelium is that in which each cell takes the form of a column, and arranging themselves side by side have the appearance of a series of columns. This form may be seen by cutting a very thin section from the intestine, the parts known physiologically as "villi" showing the formation well. These cells may also be found in the lungs—i.e., small bronchi and in the tubules of the kidneys.



Columnar Epithelium.

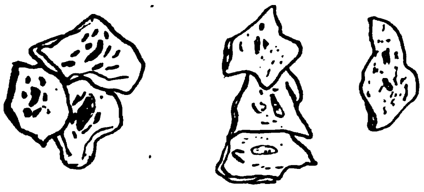


Ciliated Epithelium.

Ciliated epithelium is really very wonderful. It would appear as if every cell were provided with a large number of hair-like processes, termed cilia, in certain parts of the body—to wit, the trachea, the inside of the nose, and other parts—this form is very plentiful. During life these little hairs are constantly vibrating; or, rather, bending first one way, then the other, at a most rapid rate; so much so, that when placed upon a slip, and examined in a solution of salt, the current produced by the cilia is apparent; but the cilia themselves cannot be seen after a time; however, as the cells die the cilia gradually become less and less active, until their motion can be distinctly observed. The ¼in. objective should be used for the purpose.

Any student desiring a little research work would do well to ascertain the actual cause of motion in these cilia, whether muscular or not. If the student cannot obtain ciliated epithelium from the human subject, he can always obtain a frog, from which, by scraping the roof of its mouth, he will get plenty of ciliated epithelium. Many of the mollusca are also provided with ciliated epithelium—for instance, the pallium and lamella of the oyster or mussel, and from the gills of the crayfish or lobster. These cilia are of great interest, and should be thoroughly studied.

Spheroidal epithelium is that in which the cells have neither become compressed, as in the squamous, nor elongated, as the columnal, but retain their globular form. This variety may be found in the gastric glands of the stomach. The method is to cut a portion, and, after having hardened it by soaking in spirits or solution of chromic acid, imbed it in wax, as described for the botanical student, and cut by means of a razor a very thin section perpendicularly to the substance itself. The razor should be kept moist with spirit whilst cutting the section, as it renders the motion smoother, and a better and thinner section results. The section may be then floated from the razor by dipping the blade into a vessel containing water—a very shallow dish is the best, similar to an evaporating dish. The water may then be poured off, leaving the section in the vessel. Then pour upon it some carmine solution, and after covering with a watch-glass or other covering permit to remain for about 36 hours. When the section appears to be sufficiently stained pour off the excess of solution. Wash the section in water, then in glycerine and water, and finally place the section in pure glycerine for about twelve hours, and mount in the ordinary manner.



Squamous Epithelium.

A portion of the stomach treated in this way forms a most instructive slide, the gastric glands exhibiting upon the inside the globular epithelium, and the cylindrical formations of their tubes.

The solution of chromic acid suitable for the purpose described above may be made by dissolving one part by weight of chromic acid to three hundred and ninety-nine parts by weight of distilled water. Another chromic solution, used principally for nerve tissues, is composed of chromic acid, bichromate of potash, and water; to every five hundred and ninety-seven parts of the water add two parts of the second and one part of the first ingredients. In hardening tissues, however, spirit of wine is very largely employed, and acts satisfactorily in most cases; it has the advantage of being more penetrating than the chromic solutions, and consequently occupies less time in operating.

For the carmine or Beale's solution, dissolve five grains of carmine in about twenty drops of solution of ammonia; add about one fluid ounce of distilled water, filter through ordinary filtering paper, and add one fluid ounce of pure glycerine and two fluid drachms of spirit of wine; leave the stopper out of the bottle which contains this solution until the odour of ammonia is absent.

Carmine solution for nerve tissue is prepared in a little different manner—in fact, it is much stronger; it consists of five grains of pure carmine dissolved in three hundred grains of strong solution of ammonia (sp.gr. ·880), to which may be added fifty grains of pure glycerine.

These solutions are much employed in microscopy, the latter chiefly for staining sections of the brain or spinal cord, medulla oblongata, &c.

CHEMISTRY FOR STUDENTS.—IV.

By JOHN MILLS.

Author of "Alternative Elementary Chemistry," &c.

IN our last article we dealt with a series of graphic experiments, from which we were enabled to draw certain inferences relating to the atmosphere that should be kept in view by the reader in pursuing the study of chemistry still further; and it would, therefore, be an advantage if the student took a retrospective view of what has already been said about "The air we breathe" before perusing what follows. Assuming that due attention has been paid to the hint just given, we will proceed to investigate the nature of the atmospheric envelope more minutely.

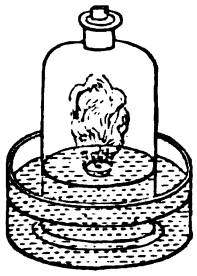


FIG. 25.

Composition of the Air.

The word "analysis" is of frequent occurrence in chemical literature, and it is used to denote the separation, or splitting up, of a complex body into its component parts. It is by the process of analysis that we shall indicate to the reader how a knowledge of the chemical nature of the air has been acquired. Until the early part of the 17th century air was regarded as a simple substance, akin in character to fire, and the philosophers of that period imagined that it was capable of entering into combination with other bodies. For example, it was known that metals, such as lead, copper, and iron, became *calcined* or oxidised, and, at the same time, increased in weight, when heated in air. This augmentation of the weight of the substance treated was considered to be due to the air having united bodily with the metal. A simple experiment will do a great deal towards convincing us that these notions were unsound, and will serve to show that science is always plain and easy if if we proceed carefully step by step, and patiently grapple with each knotty point as occasion requires.

Phosphorus, which is a substance obtained from bones, readily takes fire in air, and during the combustion it becomes oxidised, just as iron or copper does on being heated to redness. Each experiment that we perform is a sort of question put to the body under examination, and the answer is given by means of the phenomenon or change observed. Place a small piece of phosphorus in an evaporating dish, and float the latter in a basin of water; heat a glass rod in a spirit flame, touch the phosphorus with the glass rod, and then cover the dish with a bell-jar, Fig. 25. After the combustion is complete, the water will rise in the jar to the extent of one-fifth its volume.

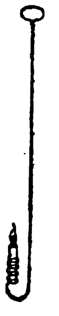


FIG. 26.

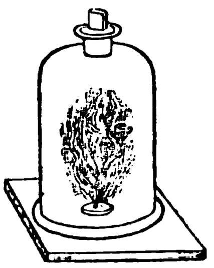


FIG. 27.

Air Consists mainly of Two Gases, Oxygen and Nitrogen.

We may repeat the above experiment as often as we like, and still the result will always be the same—viz., a shrinking of the confined air to four-fifths of what it was originally. Why is this? Does the gas remaining in the bell-jar differ in any way from atmospheric air? These are questions which will readily suggest themselves. Now light a short piece of candle, twist a bit of wire around it to serve as a holder, Fig. 26, take out the stopper from the bell-jar, and lower the burning candle into the residual gas: the flame is at once extinguished. A lighted match, ignited sulphur, or a jet of burning coal-gas all refuse to burn when similarly lowered into the bell-jar.

Plainly, we have obtained a gas from the air which, unlike air itself, is what is termed a *non-supporter of combustion*. This gas is *nitrogen*, a very *inert* body—that is, remarkably inactive; thus, it does not easily combine chemically with any other substance; it is without colour, taste, or smell, and will not burn; the combustion of the phosphorus, therefore, must have been sustained by something else than nitrogen. In reality, the flame was due to the combination of the phosphorus with another gas, *oxygen*, which exists in the air, a white cloud of *oxide of phosphorus* being the result, and this oxide, having a powerful affinity for water, rapidly dissolves.

Oxide of phosphorus may be made, and its *deliquescent* (tendency to melt or liquefy) nature shown as follows:—Put a chip of phosphorus in a dish as before, place the dish on a dry plate or tile, touch the phosphorus with a hot glass rod, and then cover the dish with a bell-jar, Fig. 27, taking care to tilt one side of the jar from time to time as the combustion proceeds, so that the access of oxygen may be free and uninterrupted. A white snow-like powder will form, which is the oxide in question, but it soon disappears and forms with the moisture of the air *phosphoric* acid.

Oxygen.

We have already stated that *oxygen* is contained in the air, and it will, therefore, serve our purpose best at this point to learn something about the gas, because we shall then be better able to appreciate what will have to be advanced later on. Grind some *potassic* chlorate to powder with a pestle and mortar, Fig. 28, and afterwards mix a little *black oxide of manganese* with the chlorate; put the mixture in a test-tube provided with a cork and delivery tube, and supported by the clamp of a retort stand, as shown in Fig. 29. After heating some time by means of a spirit lamp, as indicated, a gas will be freely evolved, and may be collected in a gas jar previously filled with water, and placed mouth downwards over one of the apertures in the shelf; the gas is oxygen. Oxygen may be obtained by heating the potassic chlorate alone, but the gas is liberated at a much lower temperature when the oxide of manganese is used, although the latter suffers no change. Several gas jars or bottles may be filled with oxygen in the way explained, and these should then be sealed by means of greased plates until wanted for use.

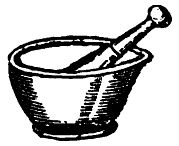


FIG. 28.

Fasten a bit of charcoal to one end of a piece of wire, and fix the other end of the wire in a cork of a suitable size to admit of its being adapted to the neck of one of the bottles filled with oxygen, Fig. 30; kindle the charcoal in the flame of a spirit lamp, and then introduce it into the gas. A vivid combustion takes place and *carbon dioxide* is formed, which will turn lime-water milky, when the latter is poured into the bottle and shaken up vigorously.

Put a piece of sulphur (*Brimstone*) in a deflagrating spoon, heat the latter in a spirit flame till the sulphur takes fire, and then lower into a jar of oxygen, Fig. 31. The sulphur will be found to burn with a beautiful blue flame, and a gas is formed which has a very irritating odour, and it likewise turns blue litmus paper red; the new gas is *sulphur dioxide*.

It will be seen that by the combustion of charcoal and sulphur in oxygen we have obtained two very different bodies. Both are colourless gases, one being without smell, while the other has a pungent odour, and yet they are both entirely unlike either air or oxygen, and possess properties which are characteristic—that is, such as enable us to distinguish them from every other substance. If some solution of blue litmus be poured into the vessels containing the new bodies it will be changed to a red colour. On the other hand, if sodium be burnt in a jar of oxygen, it is converted into a white mass, which readily dissolves in water, and the solution so obtained turns red test-paper *blue*.

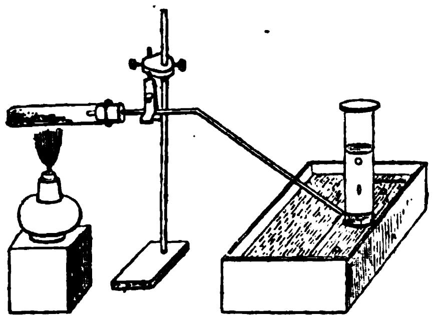


Fig. 29.

Oxygen itself is colourless and invisible, possessing neither taste nor smell. Unlike nitrogen, however, it supports the burning of a lighted match, taper, or other combustible body, the flame being far more fierce than in air. A glowing splinter of wood, when introduced into the gas, at once re-ignites, because the inert gas, nitrogen, contained in air, is not present to dilute the flame-feeding action of oxygen. Phosphorus burns with a dazzling light in oxygen, and the same is the case with shreds of zinc-foil tipped with sulphur, while iron wire may be made to burn so as to give off pretty little sparks or scintillations. In fact, all bodies which burn in air burn with increased brilliancy in oxygen.

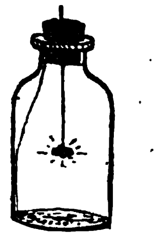


Fig. 30.

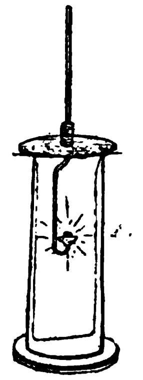


Fig. 31.

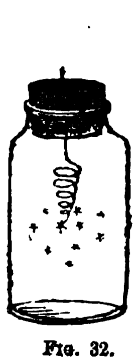


Fig. 32.

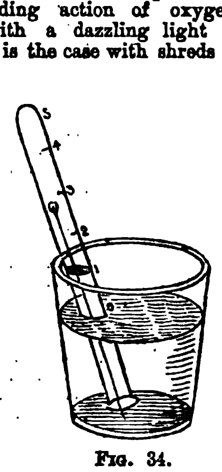


Fig. 34.

Wind a piece of fine iron wire round a glass rod or a pencil, so as to give the wire a spiral form; fix the upper end of the wire into a cork, and attach a bit of matchwood, or a piece of tinder, to the lower end. Kindle the wood or tinder, and then adjust the cork into the neck of a bottle filled with oxygen, Fig. 32. The burning material heats the iron to redness, so that the latter is enabled to combine with the oxygen and burns brilliantly, throwing out sparks. The oxidised iron melts and falls in globules to the bottom of the bottle, which should contain a little water.

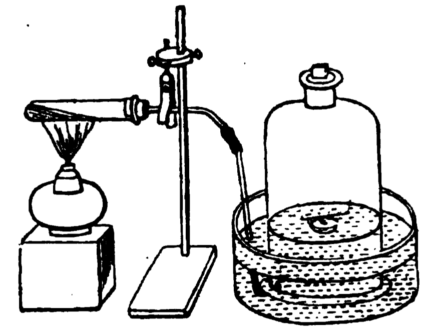


Fig. 33.

We have now acquired sufficient knowledge of the character of oxygen to enable us to return with advantage to a further consideration of the confined portion of air we were experimenting upon at the commencement of this lesson. Let us try, then, what the effect will be if we mix some oxygen with the nitrogen obtained by burning phosphorus under the bell-jar. The arrangement shown in Fig. 33 will do for this purpose. The delivery tube of our oxygen apparatus dips into the water in the glass dish, and the end is bent so that the evolved gas may pass into the bell-jar until all the water in the latter is expelled, and the confined air brought up to its original volume. Care should be taken to withdraw the delivery tube as soon as the bell-jar is filled, so as to prevent the water from rushing up the tube in case the evolution of gas ceases.

Now take out the stopper from the bell-jar, introduce a burning match or a lighted taper, and see what happens; the flame is kept up just as in ordinary air. The confined air is thus seen to have recovered its original power of supporting combustion. There can be no doubt, therefore, that oxygen was removed from the air, in the first instance, by the burning phosphorus, that oxygen is the *flame-feeding* substance, and that nitrogen serves merely to modify the otherwise too violent action of oxygen.

Rough Analysis of Air.

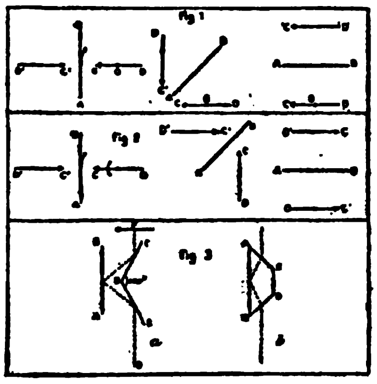
Phosphorus burns slowly in air, even at ordinary temperatures, and we may make use of this fact to effect a ready, though rough or approximate, analysis of air. Fasten a small piece of phosphorus on the end of a wire, and introduce the wire into a test-tube graduated into five equal parts, Fig. 34. Invert the test-tube in a tumbler of water, so that the water in the tube and tumbler is level with the zero on the graduated scale. In about half an hour the liquid will have risen through one of the divisions of the scale, due to the absorption of oxygen. The experiment leads us to the conclusion that one-fifth of the air consists of oxygen, and that the remaining four-fifths are due to nitrogen. By experiments such as we have here described, the chemist has been enabled to determine the composition of the air we breathe.

(*To be continued.*)

THE CYCLOSTAT.

THE various processes commonly employed for the observation of bodies in motion (intermittent light or vision) greatly fatigue the observer, and, as a general thing, give only images that are difficult to examine. We are going to show how Prof. Marc Thury, upon making researches in a new direction, has succeeded in constructing an apparatus that permits of the continuous observation of a body having a rapid rotary motion. The principle of the method is of extreme simplicity. Let us consider (Fig. 1) a mirror, A B, reflecting an object, C D, and revolving around it: when the mirror will have made a half-revolution, the image, C′ D′, of the object will have made an entire one. The figure represents three successive positions of the mirror, distant by an eighth of a revolution. The structure of the image shows that it has made a quarter-revolution in an opposite direction in each of its positions. But if (Fig. 2) the body itself has revolved in the same direction with an angular velocity double that of the mirror, its image will have described a circle in remaining constantly parallel with itself. The image will be just as insensible as the object itself; but it is very easy to bring it back to a state of rest. Let us suppose (Fig. 3 *a*) the observer placed at O, the revolving object at T, the axis of rotation being this time the line O F. Let us place a mirror at A B, and cause it to revolve around the same axis; but, instead of looking at the image directly in the mirror, let us receive it, before and after its reflection upon A B, upon two mirrors, C D and D E, inclined 30° upon the axis of rotation of the system; the image, instead of being observed directly in the mirror A B, will always be seen in the axis O F, and will consequently appear immovable. The same result may be obtained (Fig. 3 *b*) with a rectangular isosceles prism whose face, A B, serves as a mirror, while the faces A C and B D break the ray—the first deflecting it from the axis to throw it on the mirror, and the second throwing it back to the axis of rotation, which is at the same time the line of direction of the sight.

The principle of the instrument, then, consists in causing the revolution, around the axis of rotation of the object to be observed, of a mirror parallel with such axis, and in observing it in the axis itself after sending the image to it by two reflections or two refractions. In reality, the entire instrument is contained in the small prism above, properly mounted upon a wheel that may be revolved at will, and, in this form, it may serve, for example, to determine the rotary velocity of an inaccessible axis. For this it will suffice to modify its velocity until the axis appears to be at rest, and to apply the revolution counter to the wheel upon which the prism is mounted, or to another wheel controlling the mechanism.



Figs. 1, 2, and 3.—Diagrams Explanatory of the Principle of the Cyclostat.

But M. Thury has constructed a completer apparatus, the "cyclostat" (Fig. 4), which, opposite the prism, has a second plate, whose actuating wheel is mounted upon the same axis as the first, the gearing being so calculated that the prism shall revolve with twice less velocity than the second plate. This latter, observed through the prism, will be always seen at rest, and be able to serve as a support for the object that it is desired to examine.

The applications are multitudinous. In the first place, in certain difficult cases, it may serve for the observation of a swinging thermometer, which is then read during its motion. Then it may be employed for the continuous observation of a body submitted to centrifugal force. Apropos of this, we desire to add a few words. Most of the forces at our disposal, applied to a body, are transmitted from molecule to molecule, and produce tension, crushing, &c. Gravity and magnetic attraction form an exception; their point of application is found in all molecules of the body, and they produce pressures and slidings of a peculiar kind. But these forces are of a very limited magnitude; but it might nevertheless be of great interest to amplify them in a strong measure. Let us, for example, suppose that a magician has found a means of increasing the intensity of gravity tenfold in his laboratory. All the conditions of life would be modified to the extent of being unrecognisable. A living being born in this space would remain small and squat. All objects would be stocky, and be spread out in width or else be shattered. Viscid or semi-solid bodies, such as pitch, would rapidly spread out and take on a surface as plane and smooth as water under the conditions of gravity upon the earth. On still further increasing the gravity, we would see the soft metals behaving in the same way, and lead, copper, and silver would in turn flow away. These metals, in fact, are perfectly moulded under a strong pressure, just like liquids, through the simple effect of the attraction of the earth applied to all their molecules. Upon causing an adequate attractive force to act upon the molecules of metals they will be placed under conditions analogous to those to which they are submitted in strong presses, or in the mills that serve for coining money. The sole difference consists in the fact that the action of gravity is infinitely more regular, and purer, from a physical standpoint, than that of the press or coining mill. Through very simple considerations, we thus reach the principle which was enunciated, we believe, by the illustrious Stokes, that our idea of solid and liquid bodies is a necessary consequence of the intensity of gravity upon the earth. Upon a larger or smaller planet, a certain number of solid bodies would pass to a liquid state, or inversely. Let us return to the cyclostat. In default of gravity, centrifugal force gives us a means of realising certain conditions that we would find in the laboratory of our magician. The cyclostat permits us to observe what is going on in that laboratory without submitting ourselves to forces that might cause us great annoyance. We have hitherto been content to put poor frogs therein and study upon them the effect of the central anæmia and peripheral congestion produced on their organism by the unrestrained motion of the liquids carried along by centrifugal force. The results, it seems, have proved very curious.—*La Nature.*

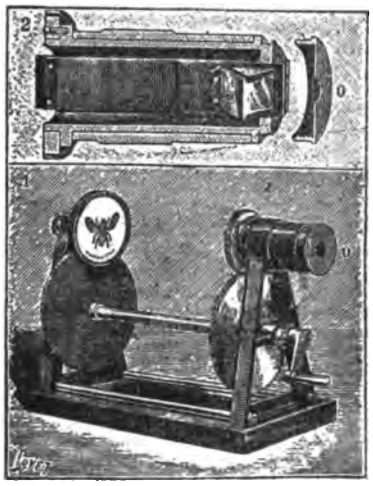


FIG. 4.—The Cyclostat.

1. General view of the apparatus. 2. Section of the ocular O.

THE SWELL IN THE ORGAN.—III.*

I HAVE now to enter upon the consideration of the Swell as applied to each separate department of the organ. In doing so I shall be touching upon all the offices of the swell and pointing out its practical conditions and requirements at the same time. By way of a brief introduction to this very important branch of my subject, I may just remark, although I have no intention of touching, in the present Paper, on the tonal structure of the organ and the proper arrangement of the tonal forces in the several departments of the instrument, that I have very decided personal views upon these matters, as perhaps some of you may know from my past writings. I entirely disagree with the present type of arrangement—I may say stereotyped arrangement—and feel convinced upon one subject—namely, that until we agree on a more logical and commonsense disposition of the speaking stops of the organ, very little genuine progress can be hoped for in the art of organ construction. I shall not, therefore, after this unreserved statement of my disagreement with the present and popular system of stop appointment, further allude to the matter; so, in my following remarks, I shall speak of the application of the swell-box, without special allusion to its contents or what its contents should, in my opinion, be in each department of the organ I pass under review. Accordingly, when I speak of the Great Organ, Choir Organ, Swell Organ, Solo Organ, and Pedal Organ, you will understand that I speak of them, so far as their stop appointment is concerned, just as we now find them in the best types of European organs.

Whilst I do not anticipate a storm of opposition to the proposal to extend the swell-box to such departments of the organ as the Choir and Solo, I feel certain of a perfect whirlwind of objections against the proposal I have to make to apply the swell-box to both the Great and Pedal departments. But this whirlwind will not blow me away from the firm stand I have been induced to take in this matter; and I do not fear that I shall long remain unsupported by thinking musicians. I shall start with the Great Organ; and my remarks shall be as brief as possible. To the European organist, the idea of enclosing any portion of the Great Organ in a swell-box smacks of musical heresy, if it does not seem an absurd one. We shall see how far the charge of absurdity can stand under the light of sound reasoning and common sense. Here I make a simple statement, which may be new to you, but which I ask you to bear in mind and think out logically for yourselves. It is this: *There is no more reason in making any department of the organ inexpressive and invariably uniform in its tones, than there would be in destining any division of the instruments of the Grand Orchestra to deliver its sounds at one unvarying strength and without any expression whatever.*

To my mind this statement contains a perfectly logical proposition; and surely every true musician must recognise it the instant its true bearing enters his mind. In the course of a short conversation I had with your amiable and distinguished Honorary Secretary, after his recent admirable discourse on the Instruments of the Modern Orchestra, he made a most thoughtful and apt remark which I have much pleasure in passing on to you. He said the Grand Orchestra might be considered as the Sun in the musical universe, whilst the Organ might be looked upon as the Moon, shining with *borrowed light.* How I wish both organ-builders and organists would realise what this terse remark really means; and how much its acceptance and its logical teaching would benefit the art of organ-building.

I remember Dr. Turpin saying to me, a few years ago, that it was greatly to be regretted that the organ, as a musical instrument, was so deficient in powers of expression. I agreed with him of course; but replied that the organ, as he knew it, was a very inexpressive instrument because no exertions were made by our conservative and groove-loving organ-builders to improve it in this direction; and because organists, as a rule, were so ignorant of the art of organ-building and the internal economy of the instrument, that they could not dictate with authority to those engaged in the construction of organs, or point out improvements in any important direction. As members of the College of Organists, even you must pardon my speaking plainly. No one will rejoice more heartily than myself when organists are seen to take sufficient interest in the grand instrument on which they perform to completely master its scientific and practical construction; and to feel themselves no longer at the mercy of organ-builders. I really think the College of Organists should institute a series of lectures, and so conduct a proper course of study in the Art of Organ-building; and a knowledge therein should be one condition of Fellowship.

In applying the swell to the Great Organ, it is with the view of making it what I venture to call flexible rather than for the purpose of imparting powers of expression to it. Only a very few stops suitable for the Great department call for expressive powers. I have used both the terms *flexible* and *expressive*, and it is perhaps advisable that I should clearly define what I mean by them. When I speak of an organ being *flexible*, I mean that it is capable of easy and immediate control, so far as the strength of tone of any department or portion of any department is concerned, at the will of the player. Under the present crude system of English organ building, and tonal apportionment, numerous stops are inserted which have a sharply defined and a very restricted use. Take all the "harmonic-corroborating stops," as Dr. Hopkins aptly calls them, and it will be found, under the present stereotyped system, that they are only usable in full effects, or when all the foundation-work is drawn. For instance a Great Organ Mixture—you would only draw it when or after all the stops of the department below it are drawn. This is what is meant by the direction "full to Mixtures." Now, I maintain that this mode of proceeding—perhaps the only one under the old-world system of organ building—is a most undesirable and inartistic narrowing of the utility of all the harmonic-corroborating stops. The same remarks apply to the Octave, Super-Octave, and Mutation stops. I should never think of applying the term, *flexible*, to a department in which there are stops whose use is laid down and fixed, and which cannot be drawn unless everything related to them is also drawn. When a department is made *flexible*, the general utility of its stops is greatly increased, and both the Mutation and Compound stops can be drawn with even a single Unison.

When I speak of an Organ being *expressive*, I mean that each and every one of its departments are partially or wholly capable of *crescendo* and *diminuendo* effects, and, under certain conditions, of good *sforzando* effects also. I hope I have made myself clear as regards the distinction I make between the terms *flexible* and *expressive*.

I said that in applying the swell to the Great Organ, it is with the view of making it flexible rather than expressive. Such being the case, I advocate the enclosure in the swell-box of only such stops as call for control and modification of strength of tone. The Double stop, whatever it may be, the diapasons, probably all the Unisons, with the exception of reeds, and the chief Octave, should not be inclosed; but the other Octaves, Super-Octaves, all the Mutation stops and Mixtures, and the Reed stops, should most certainly be placed in a swell-box. This box should immediately adjoin the exposed stops, and be made with the largest possible area of shutters or louvres. When fully open, there should be a refining effect only, without any practical loss of tone. I need hardly point out to you how *flexible* such a Great Organ would be; for you must see at a glance that its complete harmonic structure, under the control of its swell, commanded by a balanced lever, is no longer confined to the full effect, but can be used with the softest Unison exposed stop in the department, or with any combination of stops in its own or any other department coupled with it. To give you, in a very humble way, a notion of what I mean, I may just say that I have inserted in my own Chamber Organ a Mixture of five ranks, which, whilst it is designed to be amply sufficient for the full organ, it is, under the control system I am advocating, equally useful with any single unison stop in the instrument down to the softest toned: indeed, when drawn with the *Principale Dolce* (a very quiet Dulciana) alone, it produces one of the most beautiful and uncommon effects possible in my Organ.

In addition to the tonal results obtained by the simple adjustment of strength by means of the swell, striking and singularly rich effects are produced by either a gradual or by an instantaneous entry of the full chorus into the full volume of the unison and double tone yielded by the exposed; foundation-work. This being done by simply opening the swell-box. Of course, the chorus has been heard all the time, but only as a mysterious background of refined harmonic tones so long as the swell-box remained shut.

In the ordinary expressive direction, the use of the Great swell may be said to be very limited; indeed, it may be said to be practically confined to such stops as the Reeds, when they are used for solo passages, or when used to reinforce the Diapason or non-expressive foundation-work. In the latter case, the effect is that of a crescendo on the Trumpet, or whatever the chief Reed may be, within a rich and steady volume of pure Organ tone. Such an effect is not to be heard in any Great Organ, or, in fact, in any uncoupled department in European Organs at the present time.

I might considerably enlarge on what I have said; but, as time is limited, I must conclude my remarks on the Great department by enumerating the stops in the Great of Mr. Roosevelt's Sydney Organ scheme, pointing out the unenclosed and the enclosed divisions.

The eleven exposed or unenclosed stops are:—

Contra Bourdon	32	feet
Double Open Diapason	16	,,
Double Melodia	16	,,
Open Diapason	8	,,
Bell Diapason	8	,,
Violin Diapason	8	,,
Flute Harmonique	8	,,
Principal Flute	8	,,
Doppel Flöte	8	,,
Octave	4	,,
Flute Harmonique	4	,,

The seventeen enclosed stops, forming the flexible and expressive division, are:—

Gemshorn		fee
Viola di Gamba		,,
Rohr Flöte	8	,
Quint	5⅓	,,
Gambette	4	,,
Rohr Flöte	4	,,
Tierce	3⅕	,,
Octave Quint	2⅔	,,
Super Octave	2	,,
Piccolo Harmonique	2	,,
Mixture	V.	Ranks
Furniture	V.	Ranks
Scharff	IV.	Ranks
Double Trumpet	16	feet
Trumpet	8	,,
Baritone	8	,,
Clarion	4	,,

I could occupy you half an hour with a brief digest of the tonal capabilities of this one department, but I must leave all to your imaginations, and pass on to the consideration of the Choir Organ. I keep to the old-fashioned and time-honoured terminology, so as not to run any risk of confusing you; but I do not approve of that terminology. For instance, it is almost absurd to call any one department the *Swell Organ*, in an instrument where every department may be wholly or partially enclosed in a special swell-box, and I do not think it is highly logical to speak of the *Choir Organ*, when that department is not in any direct way related to an architectural or to a vocal choir, or specially adapted to choir purposes. But this question may stand over for the present.

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* Paper read before the College of Organists by GEORGE ASHDOWN AUDSLEY, F.R.I.B.A.

Whatever the tonal constitution of the Choir department may be, and whether it is looked upon as an accompanimental, or simply a softly-toned division of the Organ, there can be no valid objection raised to its being endowed with flexibility and powers of expression. The only question is, shall *all* its tonal forces be enclosed in a swell-box, or shall they be divided, as suggested in the case of the Great Organ? I am of opinion that, as the department is seldom a large one, it should be wholly enclosed. Mr. Roosevelt commonly follows this practice; and places all the Choir stops in the swell-box which also contains the Great Organ stops. There is no objection to this, as there is little chance of these two departments interfering with each other; or being used independently at the same time, in any manner calculated to interfere with the expressive treatment of the Choir stops. When used as an accompanimental Organ, it is obvious that the Choir cannot be made too flexible and expressive. It has always offended my musical sense to hear a highly trained choir of voices, expected to sing with true and refined expression, accompanied on departments of an organ which are totally devoid of expressive powers. In this direction I may be hypercritical; and if I am asking too much in desiring the instrumental accompaniment to be expressive, perhaps some musical authority present will put me right. I am a man easily convinced by logical and common-sense arguments.

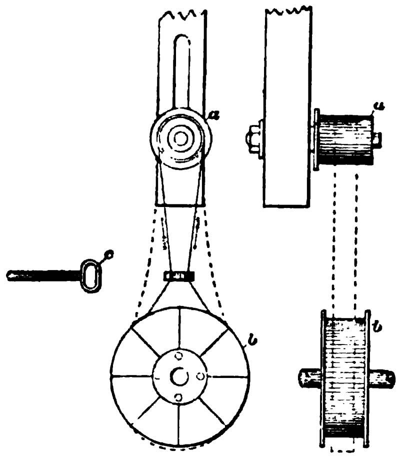
I have very carefully considered the matter in all its bearings, and have come to the conclusion, that whatever use the so-called Choir department may be put to, that use is increased or improved tenfold by its possessing powers of expression and being under complete control. Time will not permit me to go into details; but there is one stop, which is commonly placed in the Choir department in the works of our greatest English organ builder, and, downwards, in those of his imitators, that I really must direct your attention to. This stop is the *Clarinet*, probably the most perfect imitation of an orchestral instrument the organ can present. Now, in nine cases out of ten, this important and characteristic stop is found in English organs in the Choir department, and, accordingly, entirely devoid of light and shade or powers of expression, and in no way under control. Such an inartistic, unmusical, and thoughtless blunder as this, is, to my mind, a disgrace to the modern English school of organ building, and how it has so long been winked at or tolerated by English organists, not to say calmly specified by them, is a musical mystery I cannot fathom. If there is one stop in the organ which more than another calls with imperative voice for flexibility and full expression, it is the Clarinet. It would be just as unseemly and absurd to insist that the clarinets of the orchestra be played at all times at their full strength of tone and without a particle of expression, as it is unseemly and absurd to insert the Clarinet in an unexpressive department of the organ. I trust you will bear in mind that the organ, in several important directions, shines with a borrowed light from the grand orchestra; and remember, whilst preparing specifications for your future organs, what has been said respecting the Clarinet. My remarks, although specially true of the Clarinet, are applicable to other stops which are frequently inserted in the Choir Organ.

Allowing that the Choir stops are enclosed in the same swell-box that contains the expressive part of the Great Organ, it follows that one balanced lever only is required for controlling both departments.

(*To be continued.*)

POLISHING AND GRINDING.[*]

A LEATHER or canvas strap coated with emery and running on two pulleys usually of the same diameter furnishes us with the means for polishing many things which could not be done very well, if at all, on the ordinary wheels. When a strap is used the wheels are generally so placed that the belt travels in a horizontal line; the driven pulley being adjustable to and from the driver, a proper tension can be maintained on the strap at all times. Now, although this arrangement permits of a wide and extended use of the strap, there is one class of work which requires a slightly different arrangement of parts, to the end that the operator may be enabled to use the strap to better advantage—I refer to the polishing of the inside portion of handles, like *c* (see sketch), or like forms. Such work may, of course, be polished by means of a round stick coated with emery, and small enough to pass through the piece, the stick being revolved at a high rate of speed. This method, however, will be found slow and unsatisfactory when compared with the strap when properly handled. In the *American Machinist* of December 4, 1890, the writer gave a description of a polishing frame, which, with a few additions, may be used to good advantage in connection with the strap. By referring to the sketch, it will be seen that the arbor upon which the small pulley *a* runs is fastened to a timber, through which a slot is cut in order to permit of a vertical adjustment of the pulley *a*, which should be directly over the pulley *b* and in line with it. The timber itself should be firmly secured to the ceiling above, and made rigid by means of guy-rods or braces. The pulley *a* is shown with a flange, to prevent the strap from running off against the timber. The flanged pulley *b* may be constructed on the same general plan as given for the emery wheels; but in addition *b* should have a flange on each side, as shown. The strap being quite loose when on *a* and *b*, as shown in the dotted lines, it will not be driven by the pulley *b*; but if we remove it from *a*, and pass it through the handle *c*, and on to *a* again, we can then tighten the strap on the pulleys *a* and *b* by simply moving the piece *c* down toward *b* until there is sufficient friction on *b* to cause the strap to travel around the pulley *a*. Then by moving the piece around in different directions we are able to polish over half of the desired surface before reversing the piece *c*. The speed in feet per minute at which the strap should travel should not be less than that used for wheels. It will be found more profitable as a rule to purchase the straps from a dealer, as they will give better satisfaction than the home-made article, unless the maker has had experience in that line. When a strap shows any sign of giving out, do not wait for it to end its career while running, for a broken strap stingeth like an adder and biteth like a serpent. As the grindstone often plays an important part in connection with the polishing business, it may be well to give some idea of the speed at which they are run in places where the users are supposed so get as much as possible out of them. Mr. James Halligan, superintendent of the Lamson and Goodnow Cutlery Co., informs me that they use stones of 62in. to 66in. diameter, and 7in. to 8in. face. The Lake Huron stones are run 4,337ft. per minute, and the soft stones 3,650ft. per minute. In the case of Lake Huron stones I have often found the above figure exceeded—in a number of cases the rate was slightly over 5,000ft. per minute. It would be a difficult matter to determine the highest rate of speed at which a stone could be run with safety on account of the difference often found between stones from the same quarry; also the liability of hidden defects. A great many grinders test new stones by running them after they have been trued up at a higher speed than the normal one used, taking care, however, to keep well out of the line of fire in case the stone should decide to dissolve partnership with the arbor. If no defects, however, are shown by this test, the speed is reduced to the regular rate, and the stone put into service after being hacked. The hack somewhat resembles an adze, the blade, however, being much longer and the handle shorter. The face should be a little more than half the width of the stone. Holding the hack at a slight angle to the stone we cut around on one half of the face of the stone, then, changing the angle of the hack, finish the other half, the cuts being made about 1¼in. apart. As the stone wears away this operation must be repeated as often as needed, and if it is out of true the high spots should be hacked deeper and closer. By a little practice and judgment the stone can be kept true by means of the hack alone. The question as to how often a stone should be hacked will be answered best by the stone itself, especially if the operator is on piece-work; for a smooth stone seems to have no cutting qualities at all scarcely in comparison with one freshly hacked. Although our solid emery wheel friends are making rapid strides, the hacked grindstone running in the neighbourhood of 5,000ft. per minute is not quite out of the race yet.



SCIENTIFIC NEWS.

NO fewer than 24 new minor planets have been discovered during the past 14 months, M. Borrelly, of Marseilles, having detected No. 322 on November 27. It is equal in brightness to a star of the twelfth magnitude. Of the 24 additions to the list, twelve are discoveries by M. Charlois of Nice, eight by Dr. Palisa of Vienna, while two each are credited to M. Millseovich, Rome, and M. Borrelly, Marseilles.

Wolf's comet is now decreasing so much in brightness that it can only be an object of interest in powerful telescopes. At the beginning of the New Year its brightness will be only 3·5 as compared with unity at time of rediscovery.

It may be mentioned that with reference to Sir W. Thomson's remarks in his address as president of the Royal Society on the variation of latitude detected by the observations at Berlin and Honolulu, that Mr. S. C. Chandler gives in the *Astronomical Journal* an examination of the values obtained at Harvard College, Cambridge, Mass., in 1884-85. He finds the minimum latitude to have been on Sept. 1, 1884, and the maximum on May 1, 1885, with a range of about 0·7".

At a recent meeting of the Paris Academy of Sciences, M. G. Rayet, of the Bordeaux Observatory, presented a paper in connection with four photographs of eclipse phenomena taken by M. F. Courty, of that Observatory, on the occasion of the recent lunar eclipse. The disc of the moon could be traced on the negatives and on some positives. M. Janssen suggested that photographs of the eclipsed and the full moon might be useful in determining the intensity of the light. There is, however, some doubt as to the possibility of photographing the eclipsed moon.

The death is announced of Mr. George T. Bettany, M.A., at the early age of 41. Mr. Bettany lectured for some years at Girton and Newnham Colleges, Cambridge, on biology, and was lecturer on botany at Guy's for about ten years. He was conjoint author with Prof. Parker of a work on the "Morphology of the Skull," and was also author or editor of many works of a scientific character.

The Rev. William Gundry, M.A., head master of Malvern College, and the author of several philosophical works, died rather suddenly on Saturday last.

From Sydney, N.S.W., news has arrived of the death of Sir W. Macleay, in his 71st year. Sir William emigrated to Australia more than half a century ago, and devoted much attention to scientific pursuits, especially to entomology. In 1874 he conducted, at his own expense, a successful mission to New Guinea. He was the first president of the Australian Linnean Society, was president of the Entomological Society, and had been a member of the Legislative Council since 1874.

Sir Victor Brooke, Bart., who died recently at Pau, where he had resided for some time, did some excellent work as a naturalist, and contributed many papers to the *Proceedings* of the Zoological Society of London. The most valuable was entitled "On the Classification of the Cervidæ, with a Synopsis of the existing Species," and is understood to be only an instalment of a monograph on the subject which he did not live to complete. Sir Victor was only forty-eight.

It is stated that there is much doubt whether the proposed Antarctic expedition from Australia will start next year. It will be remembered that the offer of Baron Oscar Dickson, of Gothenburg, to supply £5,000 was made conditionally on Australia subscribing the rest of the funds considered necessary. Baron Nordenskjöld is prepared to take command of the expedition, and Baron Dickson has selected two vessels he considers suitable for the work; but there does not appear to be much public interest taken in the matter by the Australians.

What is described by a provincial paper as a "remarkable invention" consists of an electrical clock, devised by Messrs. Smith (father and son), of Leeds. "A neat brass cylinder encompasses the lower end of the pendulum, containing a coil of copper wire over two miles in length. This cylinder, moving with the pendulum, glides gracefully backward and forward over a magnetic bar." The automatic regulator is said to be an interesting feature, and is the invention of Mr. Smith, jun. It is "a kind of miniature electric railway, over which two tiny cars are propelled with surprising precision, operating on positive and negative currents so slight in their nature as to be almost imperceptible to the touch. The maker says he has tested the clock in all weathers, and finds that atmospheric conditions have absolutely no effect on its working."

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[*] By F. H. Treacy, in the *American Machinist*.

Many Parisians have protested against the posts used for the arc lights in the Place du Carrousel, which have been termed "gibbets," and offend the artistic taste of the Parisians. The posts are to be painted and gilded.

In connection with the Electrical Exhibition which is to open at the Crystal Palace with the New Year, a strong committee of experts has been appointed, consisting of Profs. Grylls Adams, W. E. Ayrton, J. Perry, D. E. Hughes, A. B. W. Kennedy, and S. P. Thompson, Major Cardew, Sir J. N. Douglass, Messrs. W. B. Esson, Gisbert Kapp, and W. H. Preece. The space available was scarcely equal to the demand. and it is stated that every branch of the electrical industry will be fully represented.

The new system of freight transportation is having a practical demonstration in Maryland, where an electric railway, 18 miles long, is being run through a first-class farming country that the steam railroads have not touched. This road will not only be used for passenger traffic, but will be equipped with freight cars that will have a capacity of five tons. These cars will be used for the special handling of all farm and mill products of the surrounding country.

As an instance of what can be done in telephony, it is asserted that recently, between Tewkesbury and Cheltenham, 700 words of an ordinary newspaper report were spoken and received in the allotted time of "three minutes."

The application for a patent for a "new and useful improvement in transmitters for electrically transmitting sound of any kind," deposited by Mr. Emile Berliner in the U.S. Patent Office, June 4, 1877, was granted on Nov. 17, 1891, an interval of more than fourteen years. The invention is really a combined telephone and telegraph, and was assigned to the American Bell Telephone Company, of Boston.

In a paper read recently before the Vienna Society of Engineers, Herr Koestler shows that from an examination of several lines in Austria and Hungary, the relative cost of working street-cars by horses and by electricity is as 75 to 50.

The following is said to be the system which Mr. Edison proposes to adopt for his electrical railway:—Current is transmitted at a potential of 1,000 volts to a number of motor transformers situated below the roadway, which transform it to a current at 20 volts and, say, 1,000 ampères. These motor transformers are connected to the rails, from which the current is picked by the car as it passes over them. The principal difficulty is said to have been the discovery of an efficient contact between the rails and the car. It was considered that such a contact should be able to pick up the 1,000 ampères of current through 2in. of mud, and this is said to have been successfully accomplished. At the low potential used in the rails the loss on a wet and salted track is stated to be only 5H.P. per mile, whilst in very wet weather, which cleans the rails and roadway, the loss is only half that amount. The cost of a double line of track completely equipped is estimated to vary between £6,000 and £20,000 per mile.

According to statistics there are at present in the United States 1,700 electric central stations, employing a nominal capital of 155,202,850dols. These stations supply current to a total of 183,509 arc lamps and 2,436,374 16-candle glow lamps, and develop a force of 459,575H.P.

It is stated that a factory for working the Holland electrolytic process of manufacturing caustic soda and chloride of lime is to be established at Snodland, Kent.

The publication of the works of the distinguished mathematician, C. G. J. Jacobi, commenced about ten years ago under the auspices of the Berlin Academy of Sciences, has just been completed. The complete works occupy seven volumes.

A trial of a new method of ballasting railways was made on the G. and S. W. near Kilmarnock, the other day. The ballast is laid by means of self-emptying hopper waggons passing at a moderate speed along the line, and followed immediately by a plough fixed underneath an ordinary waggon, which spreads the ballast evenly, and, at the same time, throws it clear of the rails. The system was invented by Mr. T. Rodger, and is in use in the United States, Australia, and New Zealand.

Dr. Leo Pribyl states that the Germans and Swedes are utilising their peat bogs in the manufacture of naphtha, tar, solar oil, paraffin, acetic acid, and gas, and the peat yields an elastic fibre which, freed from dust, is employed for weaving into carpets. Good peat also furnishes a cellulose which is valuable to paper makers. Besides serving as a wholesome litter for live stock, it is also used to preserve perishable goods. Meat and fish are now packed in peat litter for transport between Trieste and Copenhagen.

USEFUL AND SCIENTIFIC NOTES.

It is stated that a Philadelphia concern has recently brought out a new machine for manufacturing fine-figured silk goods. In the ordinary Jacquard attachment there are 600 holes in each card, and this attachment is necessary in order to produce figured goods. In the new machine there are 1,100 holes, and the natural result is that the figures in the silk will be a great deal smaller, and a great deal finer goods are made.

Several rain-making experiments on a small scale have been recently tried in various parts of the Madras Presidency by private agency. They have been partially successful, and it is possible that further systematic trials may be instituted by the Government. Explosions of dynamite on the summits of hills of an altitude of from 500ft. to 600ft. above the plains affected an area of about four or five miles radius, inducing smart showers. The experiments are of especial interest in regard to the question of the practicability of arresting clouds which in the dry season pass over the coastal districts and discharge their contents a few miles out at sea.

A gigantic projection-microscope is at present being "built" for the approaching exhibition at Chicago, by Messrs. Poeller, of Munich. The light employed is to be of 11,000c.p., and a parabolic aluminium reflector will be used. The peculiarity of the apparatus is that there is attached to it a regulator, worked by a shunt current, which serves to keep the lower carbon always in focus. A special arrangement is also to be employed for lowering the temperature of the interior of the lanterns, which, with the amount of heat given off (1·43 calories per second), would be dangerously high. This consists of a Helmholtz centrifugal regulator, which supplies all the lenses of both condenser and polariscope with a fine spray of liquid carbonic acid, the efficiency of which arrangement is so perfect that a consumption of ·0007grm. of carbonic acid suffices to keep the apparatus perfectly cool.

Muscæ Volitantes.—People are often almost frightened out of their wits by the sudden appearance of flying specks before their eyes; sometimes they are only one or two, but often thousands of them can be seen, particularly when a person looks toward a white surface, as white clouds, white houses, white pavements, or towards water surface. These flying specks are mostly small points, connected one with another by fine lines, and the points often present a beaded appearance. At first, persons are likely to try to knock them away, thinking it is something before their eyes. They come usually in both eyes at the same time. They may diminish or increase in number at times, but rarely ever disappear entirely. They usually have a fixed position in the field, but occasionally they move or float about to a limited extent. They never interfere with vision by settling over objects looked at. They are invisible with the ophthalmoscope. Their nature is not well understood. The explanation usually given is that they are opaque points in the vitreous humour, which throw shadows upon the retina and thus become visible. Badly focused eyes are most likely to be troubled with muscæ volitantes. They signify nothing serious so long as they are mere points connected by fine lines, and do not interfere with the acuteness of vision. Treatment is more than useless. If the eyes are out of focus, proper glasses should be selected. It is important that the patient should ignore their presence entirely; should avoid seeing them as much as possible and let them alone. Large floating masses before the eyes, which swim round and often obscure vision, are the result of serious disease, and should be promptly looked after.—A. D. Williams, M.D., *St. Louis Medical and Surgical Journal.*

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor *of the* English Mechanic, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

THE LATE BISHOP OF CARLISLE—AGE AND EVOLUTION OF THE STARS—DARK STRUCTURES IN THE MILKY WAY—LOGARITHM OF THE EARTH'S RADIUS VECTOR; AND LOG. SIN. OF 8·848" — TELESCOPE — "SATURDAY MOONS" AND THE WEATHER—RAIN-MAKING BY DYNAMITE EXPLOSIONS—THE "COMPANION TO THE OBSERVATORY"—PROJECTILES AND THE ROTATION OF THE EARTH.

[32957.]—The death of the Bishop of Carlisle removes from among us a man who has, in a quiet and unobtrusive way, done a good deal in his day for English Science. He came out second wrangler and Smith's Prizeman at Cambridge 51 years ago, and as fellow and mathematical lecturer of his college (Caius) published several mathematical text-books. One little book of his, "Elementary Chapters on Astronomy," a translation of the first five chapters of Biot's "Traité Elémentaire d'Astronomie Physique," ought to be in the library of every student of the science. As, however, it was published in 1850, I fear that it must now be out of print. Latterly, Bishop Goodwin appeared in the reviews in the *rôle* of a controversialist on the orthodox side; and certainly his articles were very admirable. In short, to me he appeared to be the only man who ever *answered* Prof. Huxley. Anyone who will contrast the weakness and ineptitude of Dr. Wace's reply to the professor on the subject of the Gadarene miracle, with Dr. Goodwin's trenchant rejoinder on Dr. Huxley's own special subject, the crayfish, will understand what I mean at once.

Should this meet the eye of any student of astronomy so blind to his own interest as not to have become a member of the British Astronomical Association, I would strongly urge that student to expend 1s. 6d. in the purchase of the *Journal* of the Association for October 1891, for the sake of an admirable and most suggestive article by its editor on "Stars of the First and Second Types of Spectrum," forming, as it does, a very valuable contribution to our rapidly increasing knowledge of the structure and growth of the sidereal universe.

And, to the same end, the December number of your contemporary, *Knowledge*, should be consulted for another of the editor's remarkable articles on "Dark Structures in the Milky Way," illustrated by reproductions of two photographs of regions in Cygnus, by Dr. Max Wolf, of Heidelberg; and one of a part of the Galaxy in Sagittarius by Mr. Barnard, besides wood-cut diagrams. A comparison of the tree-like forms of the solar prominences with similar structures in the great nebula in Orion points (*inter alia*) to the conclusion that the latter are gaseous, and suggests the very remarkable query with which Mr. Ranyard concludes his essay: "Have we, in the Milky Way, gaseous phenomena on a still more colossal scale?" Should future investigations and discoveries enable us to answer this question in the affirmative, our ideas of the wonderful zone of light which surrounds our system will undergo strange changes indeed.

"Alcyone" (query 75952, p. 316) can get the sun's distance from the logarithms on p. III. of each month in the *Nautical Almanac* by adding them to the log. of his mean distance, which, with a solar parallax of 8·848' is 7·9656365. For example, opening the book at random, I find, under July 1st, 0·0072293, and adding this to 7·9656365, thus—

7 9656365
0·0072293

we get 7·9728658, the log. of 93,913,300 miles, the sun's distance on that day. Or, take October 1st—

7·9656365
0·0002931

92,454,800 log. 7·9659296.

The characteristic of the logarithm changes because the sun's distance passes through unity to a decimal fraction. Take October 11th, for instance. Here the sun's distance is less than unity, and the log. is really $\bar{1}$·9990272. The characteristic is made 9, and 10 is suppressed in the sum—that is all. In this case, we should say—

7·9656365
$\bar{1}$·9990272

92,185,700 log. 7·9646637

The log. sin. of 8·848″ is obtained by simply adding the log. of the seconds of arc to 4·6855749.

Thus— 0·9468451
4·6855749

8·848″ sin. 5·6324200

Such an arc has no measurable secant, and as $\frac{0}{3}$ = 0, there is nothing to subtract.

From the description given by "Cornwall" in query 75959 (p. 316), it is almost certainly his eyepiece which is in fault. Cookes, of York, are always regarded as first-class makers. If your correspondent will get their little book (reviewed by you on p. 167), he can test his telescope exhaustively for himself.

I do not think that any of my brother correspondents can fairly accuse me of indisposition to take trouble when by doing so I can help a beginner, or further the interests of science; but upon my word, query 75960 (p. 316) is almost arctic in its coolness. What "Bob" (of Torquay) in effect asks me to do is to hunt through the almanacs for the last 40 years (!), which he can assuredly do himself quite as well as I can. But even had I some hours to devote to this mechanical kind of job, the time would be utterly wasted: *Imprimis*, because the idea of a Saturday's moon influencing the weather at all is (*pace* that elegant-minded person "Wega") "idiotic nonsense," and in the next place because the phases of the moon may occur on Saturday in one part of the United Kingdom and on Sunday in another. The full moon in the early morning of January 25th of the present year will illustrate what I mean. It was full at 0h. 25·3m. a.m. Greenwich mean time on that day; but the time at Armagh is 26·6 minutes behind that at Greenwich, so that the moon was full there at 11h.58·7m. p.m. on January 24th, being then a Saturday moon in Ireland and a Sunday one in London. Does any human being, not actually under restraint, believe that this can affect, proximately or remotely, any meteorological conditions whatever?

In the penultimate paragraph of your "Scientific News," on p. 14, I find that "it is stated that the experiments carried out in Texas with the view of bringing rain down by exploding dynamite attached to little balloons have proved 'satisfactory in all cases.'" It would, however, seem that similar experiments just tried in Madras, where the drought is causing such grave apprehension, have failed entirely. Now, it is impossible to conceive that atmospheric conditions differ in America and in India to an extent which will suffice to explain this discrepancy. When I was somewhat younger than I am now, there used to be a widely-spread belief that copious downpours of rain always followed big battles; but, like many another popular superstition, this would seem to have been founded on an imperfect induction.

The close of another year once more brings with it Messrs. Turner and Common's admirable little "Companion to the Observatory," which, as of old, is replete with information of the greatest use to the observer. In days to come, when the present shortcomings of the *Nautical Almanac* shall have become things of the past, and our national ephemeris supply data now only to be gathered from those of other countries, this "Companion" may cease to have any *raison d'être*; but, pending that time, no possessor of an observatory—or even of a single telescope—can afford to dispense with it.

Will "Ignoramus" (letter 32953, p. 333) forgive me for pointing out that the rate of rotation of a point on the earth's surface varies with the latitude from 1036·4 miles an hour at the equator to 0 miles an hour at the poles? Now the motion of a projectile at any given spot is compounded of this motion of rotation of its starting point with that of its motion in the line of fire. Suppose now that he is firing from south to north, in the northern hemisphere. The ball starts with the same amount of motion towards the east as the spot on which the breech of the gun is placed, the movement of which towards the east (the right hand) is more rapid than that of the point towards which the shot is fired. Hence the shot will apparently deviate to the right when it reaches the more slowly rotating portion of the earth's surface. On the other hand, if we are firing from north to south, the ball will start with a slower motion towards the east than that of the point at which it is aimed; will, as it were, lag behind, and will again strike to the right (this time the west) of the mark aimed at. If "Ignoramus" will try this out on a terrestrial globe he will at once grasp the idea, and further see how and why all this should be reversed in the southern hemisphere.

A Fellow of the Royal Astronomical Society.

STAR TESTS AND SMALL TELESCOPES.

[32958.]—In reply to letters 32893 and 32929, it may interest the writers to have my own experiences with small apertures. Some five years ago, being away from my observatory, I took with me a French tourist glass (by Chevalier) of 1⅜in. o.g., 24½in. focus, for ordinary seaside work, putting into its case three astro. eyepieces belonging to my 5⅜in. Grubb refractor, giving powers of 62, 91, and 98 on this o.g., which was mounted in the ordinary draw-tube and supported on a brass stand. The eyepiece 98 was a single-crossed lens. My observations were made on four different nights, and I append some of the results, as they may interest owners of small telescopes. More can be seen, and that better, with a *good* 1⅜in. o.g. than with a *bad* 3in., and here let me give a word of advice to young beginners—Go to a well-known maker, and buy the "best" o.g. and eyepieces that your purse will allow. Much interesting and instructive work may be done with a small instrument intelligently used.

σ Orionis. Both *comes* quite easy, also the *f* triple; power 62; fancied I could divide 9 and 8 with 91. On the whole, 62 showed the group the best.

ι Orionis. Saw 8½ easy with a little attention; difficult at first on account of glare of primary; quite easy with 98 single lens.

λ Orionis. *Comes* quite easy with 91; could not pick up 10½ *f*, but glimpsed at with 62; 9½ steady with both powers.

θ Orionis. Saw three stars in the Trapezium with both 62 and 91, but failed to pick up the fourth with either Huyghenian; but with the single lens saw all four quite easily.

γ Andromedæ. Beautiful contrast; both colours well defined.

Polaris. Glimpsed *comes* with single lens 98; have seen it with 1½ of centre of my 5⅜in. Grubb o.g. with power 170 in moonlight.

ε^1 ε^2 Lyræ. Divided both pairs; saw 9½ plainly in moonlight, power 91. ε^2 difficult at first, but easy with 98 single lens.

Saturn. Ring well seen; could just make out Cassini's division with power 91; saw shadow of ring on planet, the bright equatorial band a marked feature; glimpsed the darker belts on globe; tried 62 and 91; 62 gave the best results.

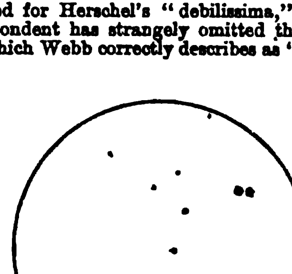
Moon. Some of the views of the larger craters when on the terminator were very well shown; the serrated shadows of the walls cast on to the bottom of Copernicus being plainly seen.

From my own twelve years of telescopic work, I have rarely been able to use a higher magnifier than 50 to the inch of aperture. My single lens is not quite 60 to the inch, and gives splendid definition in good air. **T. R. Clapham, F.R.A.S.**

Austwick Hall, near Lancaster.

ε^1 AND ε^2 LYRÆ.

[32959.]—Mr. Geo. Whittle in his sketch of this group (letter 39893), shows ε^1 and ε^2 with two small stars between them. If the latter are intended for Herschel's "debilissima," then your correspondent has strangely omitted the 9·5 mag. star, which Webb correctly describes as "obvious."



As Mr. Whittle asks for other observations, I send a sketch of this group as seen in my 15in. With reflector, power used 240, and taken Sept. 8, 1891. But I think it probable that a higher power eyepiece on a very fine night would show me some additional stars. **T. A. Skelton.**

THE COLOUR OF THE ECLIPSED MOON.

[32960.]—By dovetailing two remarks made by me (with a considerable interval between them) at the last meeting of the British Astronomical Association, your reporter has (on p. 329) conveyed a curiously erroneous idea of my perception of the colour of the earth's shadow on the moon during the recent lunar eclipse. The shadow and penumbra, during the intervals when I could observe them, were of a brownish-grey; but a short time before totality, and just prior to the hopeless clouding-up of the sky, two members of my household—one with the naked eye and the other with a terrestrial telescope—noticed that the shadow was of the familiar copper-red. I had, unfortunately, left the telescope during the short time that this was visible. **William Noble,**

President of the British Astronomical Association.

LUNAR ECLIPSE, NOVEMBER 15, 1891.

[32961.]—This eclipse proved very largely a failure in this district, but in some respects its early features were very satisfactorily witnessed considering the bad atmospheric condition at the time. The clouds, fortunately, cleared a little before the earliest phase, and the sky continued fairly clear until about 11.15, when dense vapoury masses sprang up and overspread the whole scene, rendering any further observation impossible. The penumbral feature (or partial shadow) crept in upon the moon at the predicted hour, perceptibly lessening her light as the gloom spread over her disc, preceding the entry of the true shadow at 10.35. The earliest appearances indicated the probability that the face of the moon instead of being, during totality, its usual coppery colour, would have been of a dark leaden tint; but when the shadow had advanced about one-fourth there were seen, by aid of the telescope, strong indications that the ruddy hue would prevail, and this colour became very decided as time went along. The ruddy tinge was brightest, and looked very translucent at the edge of the moon's eclipsed limb, but faded gently to nil before the eye reached the margin of the shadow travelling over her disc. The colour generally of the obscured part was bluey-grey, and very hazy in character throughout. The details of the illuminated part were very clear and distinct, although at times a little subdued by the passing over of filmy pieces of stray cloud. No star was visible at any time around the edge of the moon, and the sky surrounding corresponded somewhat to the bluey-grey of the eclipsed tint. About 10.50 a very pretty atmospheric effect was witnessed, for around the moon there formed a most pleasing disc-like halo, about four of her diameters across, which was fringed with a margin of beautiful colour, mainly of an orange shade, and this lasted some little time. At this stage a brilliant meteor darted across the sky, apparently, as our observer said, out of the moon.

It was suggested by a Belgian astronomer that the earth was on this occasion in such a position as to cast in shadow the outline of the Andes upon the face of the moon, and advised observers to look out for this appearance; but the best telescopes would have failed here to detect this, as the edge of the earth's shadow seemed less defined than on former occasions, which might have arisen from the air in our locality being so overcharged with moisture. With all respect to this distinguished authority, it is very questionable whether the outline of any terrestrial mountains could ever thus be detected, as the highest are not more perceptible in proportion to the earth than the roughness of an orange is to its diameter; and, further, at the distance the moon is from the earth, the edge of the shadow there falling would be less decided than nearer; consequently the outline of these proportionately small elevations would have merged into the general outline of the earth's shadow and be lost.

The observer at the telescope witnessed the mountains in the moon, one by one, obliterated as the shadow travelled over them; but the crater Aristarchus, the brightest point on the surface of the moon, stood conspicuously visible about 11.0, in the midst of the already-darkened region. During visibility the circular outline of the moon remained perfectly distinct, and was never lost to view once. This, combined with the red tint, unmistakably indicated the clear meteorological state of our atmosphere around the margin of our globe immediately facing the moon—a conclusion based upon the accepted theory regarding this phenomenon during lunar eclipses. Great preparations had been made at many of the Continental observatories, and at Greenwich, for astronomical investigations relating to the moon; but it is feared, from telegrams received, that disappointment was experienced at many stations, although at Madrid, Bermuda, and Canada they were specially favoured with fine weather. At Edinburgh, during occasional breaks in the clouds, all the stages of the eclipse were witnessed. There, it is stated, the colour was dark red, and the stars shone brightly all around her. It might be incidentally remarked that this last spectacle to the eye at the telescope is the most impressive of all, for the moon, then mantled in a weirdlike garb, appears engirdled with a coronet of stellar gems, and this beautiful aspect is only possible during the phase of totality. This appearance was remarkably conspicuous during the total eclipse of 1888.

Southampton. **S. S.**

THE EARTH'S SHADOW ON THE MOON.

[32962.]—Though prevented by cloudy weather from obtaining even a momentary glimpse of the recent lunar eclipse, I would ask permission for space in your columns to call attention to the suggestion put forward by Mr. Neville Holden (letter 32927) respecting the cause of irregularities in the contour of the earth's shadow as thrown on the moon. Like many others, I was anxious to observe the eclipse of the 15th ult. for the purpose of verifying the observation made by M. Boë at a previous eclipse, during which he noticed an irregularity in the outline of the earth's shadow, which he supposed to be caused by a mountain range on the earth's surface. Capt. W. Noble, at the annual meeting of the British Astronomical Association, pointed out that the late eclipse offered a favourable opportunity of confirming it, as the Andes would be so placed as to probably cast a shadow on the lunar surface. But it seems to me that under the most favourable circumstances the shadows cast by even such a range of lofty peaks as the Andes, would require the exercise of the greatest care in discriminating between an irregularity caused by them and one due to inequalities on the surface of the moon. It might be possible to do so; but the edge of the shadows in all the eclipses I have observed has always seemed too ill-defined to admit of any great degree of certainty being attached to such an observation.

The frequent deviation from circularity of outline noticed by many observers during the progress of a lunar eclipse may, I think, be accounted for in many instances by the varying refraction and absorption of light, due to shifting of large masses of clouds over considerable areas of the earth's surface situated along the earth's limb as viewed from the moon; while the difference in colour, as noted by various observers of the same eclipse, is probably caused by the varying amount of moisture present in the air at the different places of observation. Observers might test the correctness of this view by noting at future eclipses the hygrometric condition of the atmosphere at their observing station.

Forest Gate, E., Dec. 3. **B. J. Hopkins.**

ASTRONOMICAL — "F.R.A.S." — STAR TESTS—OVERTAXED BRAIN.

[32963.]—I am very grateful, as, no doubt, many others are, for Lieut.-Col. Markwick's and Mr. Holden's accounts of the lunar eclipse of the 15th inst. Here (in London) it was entirely hopeless to see anything of it. With reference to Lt.-Col. Markwick's paragraph *re* the dark patch on the centre of moon, I noticed the phenomenon (just as he describes) in the 1888 eclipse, and, with the naked eye, the patch then seemed to have a gyratory motion at times, and then still, but was always in the centre of the moon's disc. It would be very interesting to know what some of our great scientists make of it, if not optical illusion.

I hope "F.R.A.S." will forgive my silence with regard to "Wega" and others' onset on his replies to letters and queries, and more especially with regard to his reply to my query *re* dividing power on ϵ^2 Lyræ with 2⅜in. I may tell "Wega" and others that I quite understood "F.R.A.S." in his reply as dealing with 200 power specified, and so would any right-thinking person. I have readjusted the o.g., and have had good results on other objects (which I sent to the "E.M." some time ago, but have never seen them in print, and have been too ill since to inquire about them). I distinctly saw the black shadow of No. 3 satellite pass over Jupiter on Sept. 10. Have divided γ Leonis, Castor, ϵ^2 Lyræ, and can see *comes* to δ Gemini; but have tried all powers on Polaris, and failed. In reply to "Jimmy," (32929, pp. 308), I have seen all three with 40, and 200 with a little attention, all four in Trapezium of Orion. What grand fields there are here, also σ Orion. I saw Wolff's Comet, 5th Oct., with power 30, exceedingly faint and ill-defined, forming a triangle with 91 and 93 Tauri; could not glimpse it in finder, power 10, 1½in. o.g. acro. What is the relative brightness of the nebulæ in Andromeda (32 M)—8 mag., and Orion, 5 or 6 mag.? What powers and objects in the close clusters department would be useful on this (2⅜) instrument.

I have had to desist from studying for the past two months, in consequence of an over-taxed brain, and have even had to pack away my instrument, to my disgust. My business keeps me indoors a good bit. Would long walks do me good? Any advice from any of your readers will be gratefully acknowledged. I find consolation in alcoholic drinks for the time, but it returns unless I keep up this. **C. H. Fridy.**

THE TRAPEZIUM OF θ ORIONIS—TEST OBJECTS.

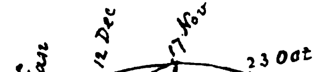
[32964.]—On referring to the 6th edition of Proctor's "Half Hours with the Telescope," I find the following with reference to the visibility of the stars in the trapezium of θ Orionis with small apertures: "A good 3in. glass shows four distinctly; but with smaller apertures only three are visible." "Jimmy" (letter 32929, p. 308) may rest assured that this is incorrect. Why, the fourth star of the trapezium was *discovered* in the 17th century with a refractor (of course non-achromatic) of 2·33in. aperture, and 23ft. focus, the highest power on which was about 92; and it is, of course, much easier to see an object when it is known to exist than to discover it. I have not time to look up many authorities; but I find that Burnham saw all four easily at Mount Hamilton when the asterism was 2 hours from the meridian, with 1in. aperture of his 5in. refractor. Gore has seen all four with 1¾in., and I saw them easily with 1½in. aperture of a 3in. refractor in Devonshire in 1874. On plate 15 of the Hon Mrs. Ward's "Telescope Teachings," there is a drawing of the nebula made with a 2in. refractor (power about 80) which shows all four distinctly. Some years ago I had a 2¼in. Wray-Clarkson refractor, and should have been much surprised not to have seen the fourth star on any clear evening, and this, too, within four miles of Charing Cross. I should like to know whether Mr. Grover failed to see the fourth star with his 2in. refractor. Late measures of α Piscium give 3·08" as the distance. "Jimmy" should examine γ Ceti. If he can see this double there is not much the matter with his eye or his telescope; he will probably require a higher power than 100, though. On good nights a power of from 170 to 180 could be used on stars with a telescope of that size.

Dec. 8. **H. Sadler.**

TEMPEL-SWIFT COMET AND SUITABLE TELESCOPES.

[32965.]—I found this comet on Oct. 22 with a 3in. o.g., 47in. focus, Ramsden eyepiece giving a power of 28 diameters, and field of view of 2°. It seemed about 8′ in diameter, and its light extremely feeble. I obtained positions on the 23rd and 28th Oct. and 2nd Nov. with these and the positions given in "Scientific News" column (Oct. 9th, No. 1385). I have been enabled to find an approximate orbit, from which it appears that its distance from the sun on Oct. 28th, the date of finding, was 1·29, and from the earth ·4 (the earth's distance from the sun being 1′). On or about Nov. 16th it was nearest to the sun 1·1, and its distance from the earth at the same time 3·03. Now, supposing it is illumined by the sun, it would be ·36 brighter on the latter date—that is, if 1° represents its brightness on the 28th Oct. Then 1·36 would represent it on 16th Nov., and I can only think that a mistake has been made in placing the decimals in the figures in Nos. 1,386, 1,387, 1,390, which, if placed after the first instead of after the second figure, will then agree very well with mine, and also with the comet on different occasions.

Fig 1



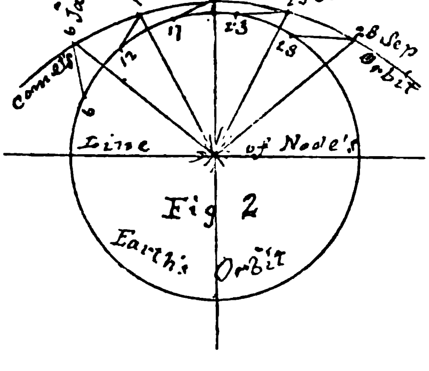


Fig 2

I inclose sketch of earth's orbit, and comet's path which will give a general idea of their relative motions, the same dates on each and the lines connecting them showing the direction in which the comet was seen. Fig. 1, elevation; Fig. 2, plan.

The visibility of this comet and other faint objects in telescopes does not seem to be well understood. Setting aside the question of personal equation, some people's vision being more sensitive to light than others, there is much to manage in the relation of focus to aperture. To illustrate this, let us suppose we can just discern a comet of 8 minutes of arc in diameter, with a telescope having a 3in. o.g. of 4ft. focal length, and having an eyepiece of just sufficient power to convey the whole of the light through the pupil of the eye. If, now, we take away the 3in. o.g. and place one of 6in. and 8ft. focus, all other parts remaining the same, we shall get four times the amount of light; but the image in the focus will also be four times the area, because twice the distance from the o.g., so that the increase of light will be spread over a larger area, therefore the illumination will be the same; and if we attempt to correct this by using a lower-power eyepiece we shall fail, because the beam of light issuing from it will be larger than the pupil of the eye, the iris acting as a light-stop. Again, if we take another o.g. of 2ft. focus and 1½in. in diameter, the same reasoning holds good; the cone of light-rays will come from the o.g. in each case at the same angle, but in this case the o.g. will only gather one-fourth as much light as the 3in., and the image in the field will be one-fourth the area, so it will be of the same brightness, and large enough to be very well seen.

It will also be seen that if we stop down the 6in. o.g. to the 3in. or the 1½in., we should take away a large amount of light without reducing the size of the image, which depends on its distance from the o.g., and so the object would have become quite invisible. The outcome of this is that a short-focused telescope with a large aperture, and eyepiece to bring all the light into the eye to the retina (the eye forming a part of the instrument), is the best for this purpose.

In conclusion, let me remind your readers that this only applies to objects having a sensible diameter, and not to points of light as the stars.

Wimbish, Nov. 27. **J. Lane.**

MESSIER'S NEBULÆ.

[32966.]—I am not able to trace the following numbers in Webb's "Celestial Objects," or in Proctor's "Smaller Star Atlas," Nos. 40, 45, 48, 91, and 102. No. 40 is shown in map 9, but it is not initialled. If any reader will kindly give me the R.A. and Dec. (N. or S.) of the five nebulæ, he will very greatly oblige. **Autolycus.**

THE STAR OF 1890, SEPT. 7-15, IN THE ANDROMEDA NEBULA—SOME UNRECOGNISED VARIABLES IN CYGNUS, LYRA, &c.

[32967.]—In reply to Mr. Espin's note (letter 32891), I beg to state that as soon as I was convinced that the star of Sept. 7-15, 1890, seen near the nucleus of the Andromeda Nebula had really undergone a change, I immediately wrote Dr. Copeland, and several other eminent observers, requesting them to look it up. Unfortunately, the star in the mean time had diminished below the 10th magnitude, and was therefore an object of less interest. The position of this star, as given in "E. M.," page 239, is for 1860, not 1890, as there stated. It follows the nucleus 56sec. in R.A., and is 6·1′ to the north. It does not appear that my request was followed up, and Dr. Copeland replied under date Oct. 10 as follows:—"I hope you followed up your observations of the star near the Andromeda Nebula, for I have not been in a position to examine it. Our temporary observatory is still a thing of the future, and Dunecht is, I am sorry to say, finally closed." I also requested the Lick observers to examine its spectrum with the great 36in. refractor on Mount Hamilton; but, as yet, have had no reply. My own observations are given briefly, as under, the comparison stars being D.M. 40·151°, 9·0 mag., and a faint 10·5-mag. star about 10′ N. preceding the nucleus:—

1890.	Mag.	1890.	Mag.
Sept. 7	8·5	Oct. 2	10·7
" 10	9·0	" 3	10·7
" 15	10·5	" 8	10·7
" 16	10·7	" 9	10·5
" 20	10·5	" 10	Very faint; hardly above 11 mag.
" 21	10·6		
" 22	Not seen; hazy.	" 11	
" 23		" 12	10·7
" 24	10·5	" 14	Not seen.
" 25	10·4	" 17	10·5
" 26	Not seen; moonlight.	" 22	10·7
" 28	v.ft.; perhaps 10·7, or less.	Nov. 4	10·5
		" 11	10·5

From the above it will be apparent that after Sept. 15 the star's fluctuations in light were comparatively small. It has been observed on every favourable occasion during the present apparition with a like result. One observation, perhaps, deserves notice. 1890, Oct. 2: this night I noticed a nebulous haze around the star, as if the background of nebulosity had suddenly condensed around it; the like was not seen around other stars in the neighbourhood, and it was less apparent on Oct. 3. This phenomenon has not been seen since. The above observations, with the exception of that of Nov. 4, were made with a 4¼in. refractor, power 40.

With regard to the star *Propus* = *H. Geminorum* referred to in "E. M.," p. 239, I also regarded it as an unrecognised variable, and watched for similar accessions of brightness. The fluctuations appear to be slight but evident. Sufi gives two estimates of its magnitude, 4·5 and 5·4 mag. I notified the discovery to two or three observers, and both Mr. Ingall and myself observed the star on April 25, when it had diminished a full half-magnitude to 4·3. Several other bright naked-eye stars have been found variable to a small extent. They do not appear to have been previously recognised as such.

δ^2 *Lyræ.*—This star has been variously rated by different observers. Zach, Herschel, and Houzeau place it above the stars ε and ζ Lyræ in magnitude. I had also noticed it brighter. In 1890 I was surprised to find it nearly half a magnitude fainter than either. The star has been carefully watched, and forty determinations of its brightness secured. These show fluctuations in its light of 0·4 mag. from 4·3 to 4·7, which may be periodical. These minor variations are probably subordinate phenomena, the true period being represented by the interval between two bright maxima. Such a maximum has not yet been recorded. The period is probably long, and the range of variation probably nearly a whole magnitude. The spectrum is a fine specimen of type III. Secchi calls it a perfect copy of α Herculis. I find the bands somewhat less dense, but very fine withal. 1891, Oct. 12, in steady air, seven or eight bands, very broad and defined, were visible with a small direct-vision prism on the 4½in.

32 *Cygni* xxh. 12m. N. 47° 21'.—This orange-tinted star fluctuates in its light. 1891, May 28, 32 was nearly equal to o^2 Cygni; on the 31st it had dimished 0·6 mag. I had previously noted some puzzling discordances in the magnitude of these two stars, and think that the variations of 32 will be found to possess much interest.

β *Andromedæ.*—This well-known star brightens and fades to the amount of somewhat less than half a magnitude, from 1·9 to 2·3 mag. It is frequently the lucida of its constellation. Its tint is suspected of varying also from orange-red to pale yellow. Its spectrum is of the third type, the bands in the green and blue being somewhat faint, and requiring a low dispersion to show them well. I have seen them thus most beautifully with a simple spectroscopic arrangement attached to my 4½in. refractor, which I hope to describe at length in my next note.

D. Packer.

CALCULATIONS CONCERNING THE LENS.

[32968.]—I have thought that a few brief remarks on the above subject might possibly be of some use to those who require optical data, but have not the time to make a thorough study of the science of optics itself.

In the use of the formulæ commonly applied to questions concerniug small lenses, the results arrived at are not always strictly correct, although very nearly so.

One reason of this is that the formulæ are calculated out for what are known as "thin" lenses, or those in which the effect of the thickness of the lens is neglected.

Also, it is assumed that the curves of the surfaces forming the lens are such that most of the reflected rays of light, so called (or their directions produced), from a point of an object, after passing obliquely through the lens, intersect somewhere on a central axis, this axis being, for all practical purposes, a line drawn from the point of the object, and through what is known as the centre of the lens. In other words, it is assumed that the rays for each point of the object emerge from the lens in the directions of the radii of a common sphere.

The two accompanying illustrations of a double-convex lens, though greatly exaggerated, will perhaps make my meaning clearer:—

It will be noticed that the image, unlike the object, is not a straight line; but for small lenses may be considered as such.

The value of the principal focus, or point x, where the rays parallel to the axis of the lens, after refraction, intersect the same, lies in the fact that, although lenses of different materials alter the deviation of a ray from its original direction, the relationship between the distances d, f, and D is independent of the material composing the lens.

An equation, not difficult to prove, which connects these distances in the case of a concave lens, when the thickness is ignored, and which is used as a standard, is—

$$\frac{1}{d} - \frac{1}{D} = \frac{1}{f}$$

By calling one side of the lens *plus*, and the other *minus*, this equation may be used for any kind of simple lens.

For instance, in Fig. 1 if D. = *plus*, then f and d = *minus*.

Suppose the sign and value of f to be unknown, and is required, and that D = 42" and d = 11", then—

$$-\frac{1}{11} - \left(+\frac{1}{42}\right) = \frac{1}{f}$$

$$-\frac{1}{11} - \frac{1}{42} = \frac{1}{f} \quad \therefore f = -8{\cdot}72'', \text{ nearly}$$

and being *minus*, shows us that the lens is convex. Fig. 2 shows the principle of the common magnifying glass.

FIG. 1.

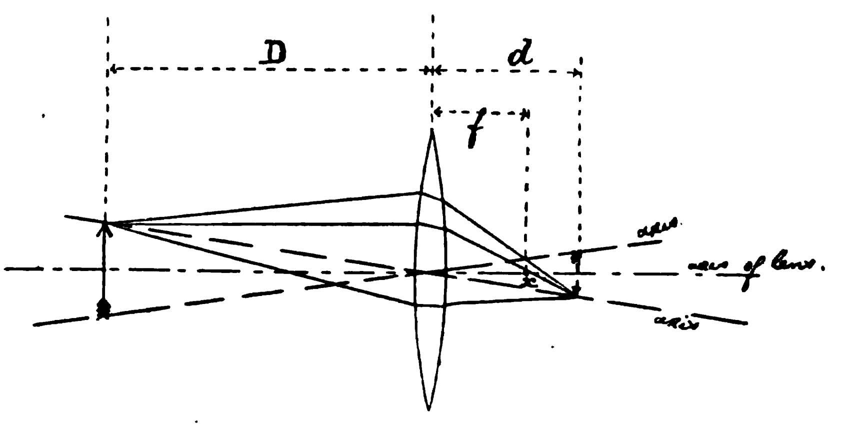
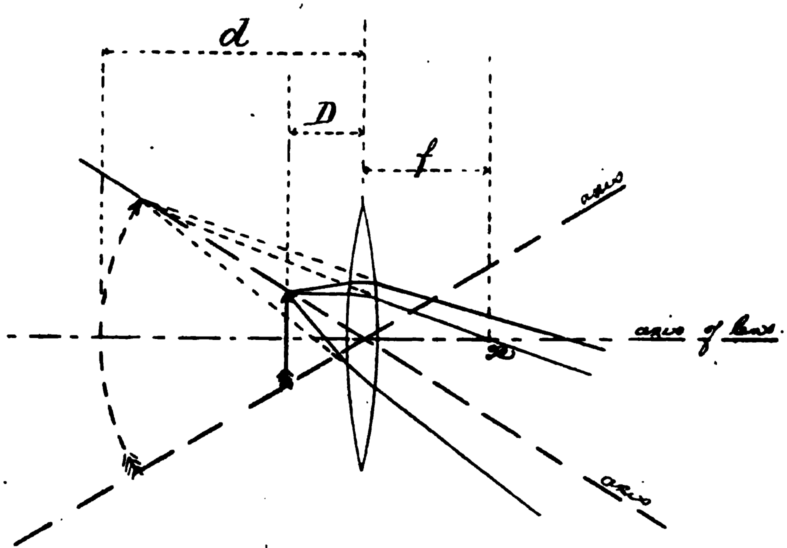


FIG. 2.



If the eye of the observer be supposed quite close to the lens, and about the central axis thereof, it will be seen that the magnification of the object depends on the distances d and D. But if d be not the distance at which the observer can see an ordinary object most distinctly, the image will not appear good; therefore, if the power of observation varies, d will be a fixed and separate distance for each observer, found by experiment. In ordinary cases, d is usually taken as being about 10".

We have, size of object : size of image : : D : d (if we assume the image to be straight); therefore $\frac{d}{D}$ = the number of times the image is larger than the object. But—

$$\frac{1}{d} - \frac{1}{D} = -\frac{1}{f}$$

$$\therefore \frac{d}{D} = 1 + \frac{d}{f} = \frac{f+d}{f}$$

If the actual distance of the eye from the lens is to be taken into account, perhaps the most satisfactory way is to find the power of the lens by experiment, which we will discuss later on.

A. Gadd.

(*To be continued.*)

PROJECTILES, AND ROTATION OF THE EARTH.

[32969.]—Having had some experience in laying rifled ordnance, I venture to offer a few remarks on the question under discussion. With respect to the deviation of a shot from the plane of the trajectory caused by the rotation of the earth, General Owen, in his "Elementary Lectures on Artillery"—which used to be a Woolwich textbook—says it "may be practically disregarded, for it would only be sensible in very long ranges, and in these the disturbing effects of different currents of air during a long time of flight would quite upset any calculation for such deviation." I have not General Boxer's book by me.

But the deviation to which your correspondent alludes has nothing to do with the earth's rotation. The technical name for it is "drift." All modern rifled guns give the projectile a right-handed rotation about its axis—that is to say, the upper part turns to the right, with reference to an observer placed behind the gun, and the drift is *invariably to the right*, the amount increasing with the range; so that the curve described by the projectile is one of double curvature. There is no drift in the flight of a round shot. The real cause of the projectile from rifled guns swerving to the right has engaged the attention of several powerful mathematicians—Prof. Greenhill for one; but opinions differ as to the explanation of this difficult problem. It is generally, however understood that the true explanation must be sought for in the theory—a somewhat difficult one—of the gyroscope. Readers who are interested in the subject will find a whole chapter on drift in Mackinlay's "Textbook on Artillery," an official and quite recent work. In laying a gun you allow for drift by throwing the leaf of the tangent scale a little to the right by means of the deflection screw adjustment. For ranges less than 2,000yds. the error from drift is so small that it may be disregarded, and for a range of exactly 2,000yds. the sight is correct and requires no adjustment. For ranges greater than 2,000yds. the rule—at least, for field guns—used to be, and probably still is, as follows:—

From 2,000 to 2,500 you give 3' deflection left.
,, 2,500 to 3,000 you give 5' do. do.
,, 3,000 to 3,500 you give 9' do. do.
,, 3,500 to 4,000 you give 15' do. do.

In order to make the adjustment for drift automatic, some tangent scales are set in slots which are not quite at right angles to the axis of the trunnions (or a line parallel to that axis), so that, as the stem of the scale is raised, the leaf moves to the right. The same object has, I believe, been attained by having a slightly curved stem.

Charing, Kent. J. R. C.

[32970.]—I have no doubt "A Fellow of the Royal Astronomical Society" will fully explain to "Ignoramus" (see letter 32953) the reason for projectiles acting in the manner mentioned by him in his letter of Nov. 27; but as I almost fell into the same error as "Ignoramus" apparently has, perhaps I may be excused if I try to enlighten him.

The poles of the earth are approximately at rest so far as rotary motion is concerned, and any place on the Equator is travelling faster than any other point on the earth's surface; therefore, any point between the North Pole and the Equator is travelling *faster* than any other to the north of it, but *slower* than any to the south of it *as far as the equator*.

Now, I think "Ignoramus" will see that if a marksman in the northern hemisphere fires due north, the point from which the bullet starts has a greater velocity eastward (or to his right) than the point at which the rifle is aimed, consequently the bullet tends to the right of the target; but when the man faces south, his spot of ground is travelling to the east (or to his left) slower than any point to the south of him, therefore, the bullet still tends to the *right*. So that a line representing the path of the two bullets would intersect the meridian at the point of fire. In the southern hemisphere, of course, the results would be *vice versâ*.

In conclusion, may I just mention that often times when I have felt tempted to attack the statements of well-informed and capable men, I have just kept on the considering cap for a little while longer, and then have generally found them to be correct. In this case I at first thought the same as "Ignoramus," but justly concluded that "F.R.A.S." was not likely to be wrong in such matters. **Walter Herbert.**

DEVIATION IN THE FLIGHT OF PROJECTILES.

[32971.]—Je ne vois pas comment le mouvement de la terre puisse exercer sur un boulet (projectile) une influence aussi âccentuée que celle signalée par le General Boxer.

Je n'ai pas le plaisir de connaître le traité d'artillerie en question, mais "F.R.A.S." pourrait peut-être me dire si dans l'exemple de sa lettre No. 32925, il est question d'un canon à rayures hélicoïdales ou rectilignes, ou même d'un canon à âme lisse. Dans un canon à âme lisse, les écarts souvent considérables sont excessivement capricieux; ils ont lieu tantôt à droite tantôt à gauche; mais avec un canon à rayures hélicoïdales, *la déflection est toujours la même quant au sens dans laquelle elle se fait*, pour une même arme, ce qui la rend plus facile à régler.

L'assertion de "N.S.W. Reserve Rifleman" est tout à fait exacte, et je m'étonne que "F.R.A.S." contredise une opinion fondée sur la pratique et qui se trouve expliquée dans la plupart des traités de balistique. Si nous en croyons "F.R.A.S." en tirant vers le Sud un projectile dans l'hémisphère Nord la déviation sera à droite, et il en serait de même si le projectile était envoyé dans la direction S.—N.; en écrivant cela "F.R.A.S." se contredit lui-même, car il est évident que dans ces deux cas l'influence de la terre sera diamétralement opposée.

De même "F.R.A.S." demande l'opinion d'un "Artilleryman" de l'hèmisphère Sud, mais "N.S.W. Reserve Rifleman" n'est-il pas un practicien aussi bien renseigné que tout autre puisque chucun peut lire dans sa lettre au *Standard*, "after two-and-a-half years' experience." D'ailleurs le rifle Martini-Henry est un fusil à âme à rayures hélicoïdales et dont les rayures vont de droite à gauche, l'assertion de "N.S.W. Reserve Rifleman" est donc confirmée une fois de plus. Cependant je serai très heureux, si "F.R.A.S." par une théorie assez courte pouvait m'expliquer le fait qu'il établit d'une façon péremptoire. **Brux.**

SOUNDS AT SEA, AND A STRANGE COINCIDENCE.

[32972.]—Following up the interesting case in letter 75562, page 335 of this week's "E.M.," I relate the following: I stood on the shore at Colwyn Bay, North Wales, many years ago, in front of a high cliff, and heard the strains of a brass band coming from over the sea. It was very indistinct and fluctuating, but sufficient to proclaim the nature of the sound. Not a sail was visible, not even any smoke of a steamer beyond the horizon. It was noon, and very hot. The sea, in full tide, was as calm as a duck-pond, and the air motionless and muggy. I concluded the brass band I could hear was on the Isle of Man steamer, which then left Liverpool daily for Douglas at 11 a.m. Now the distance to the path of the steamer would be about 35 miles. No doubt, the cliff behind me, by reflecting the sound, helped to make it sensibly audible.

I beg to mention here a strange and ominous coincidence, one of those duplicated occurrences that alarm the superstitious. The emigrant sailing ship *Ocean Monarch* left Liverpool for Rio de Janeiro on Aug. 20, 1848, and soon took fire. We watched the ship in flames from the shore at Llandulas on the afternoon of that day about five miles out. We could render no help, there being not one boat in the place. About 300 of the emigrants on board lost their lives. Exactly 20 years after—viz., on Aug. 20 (even the very day of the month coinciding with the number of years separating the two events), 1868—occurred that dreadful disaster to the Irish mail at Llandulas, when that train also took fire, and 33 passengers perished in the flames. The train going full speed dashed into some runaway trucks coming down hill to meet it and round a corner. The trucks were loaded with barrels of petroleum. In shattering these to splinters, the mail bathed itself in petroleum, which instantly ignited by the engine's furnace, enveloped the train at once with flame. The writer was an eyewitness of both these sad events and strange coincidences. The name of that battling engine too, was Prince of Wales, and the disaster happened in the pass of Tanyrogof (under the cave), the spot where the princes of North Wales used always to meet the onset of their Anglo-Saxon invaders, and generally with success, the position being good for the defenders and against the assailants. The lord of the Manor of a bygone generation of that region, has erected four tablets by the road-side, on that most sanguinary spot, recording the four most bloody of the many battles fought by the princes there in defence of their country.

T. H. Evans.

EXPERIMENT WITH SMALL DYNAMO.

[32973.]—The following may interest some of the readers of the "E.M.":—I placed the field magnets of a small dynamo (having laminated H armature) in circuit with an alternating machine. A wire was then fixed on each cheek of the commutator and a lamp connected to it, which was brilliantly lighted by the armature standing still in the alternating field. The light could, of course, be regulated or extinguished by turning the armature in or out the field.

Cambridge. **A. J. Dew.**

THE LATHE INDEX.

[32974.]—On reading the paper by "O. J. L." it occurs to me to wonder whether he had studied his Holtzapffel? and if so, what possible fault he can find with the counting-index figured and so lucidly explained in Vol. IV. Fig. 125?

With regard to his overhead, I am surprised that the method he has recently adopted is not more used, so much is gained in steadiness.

J. S. T.

COUNTING ON THE LATHE.

[32975.]—Referring to "O. J. L.'s" difficulty caused by the fineness of the teeth and the ratchet work, it might be possible to use three-toothed discs side by side; but set $\frac{1}{3}$ of a tooth in advance of each other, the discs would then be cut with only 120 teeth each, and there would be three ratchets instead of one. With the three ratchets acting independently each step would give $\frac{1}{360}$ of a revolution; with two ratchets coupled $\frac{1}{240}$, and with the three coupled $\frac{1}{120}$.

I am not sufficiently acquainted with lathe work to know if this is feasible in practice, but it seems right in principle. **Ratchet.**

LATHE MATTERS.

[32976.]—I am glad the lathe-men are awaking again. They have probably been digesting the excellent articles on Lathe Appliances, and are only now beginning to grow hungry.

"O. J. L." is at work on the Index; but I am sure he didn't mean that pillar to look so ricketty as it does, as if by laying the hand on the top of pulley you could move it to and fro at least $\frac{1}{8}$in., I think it doesn't want a screw to raise and lower the top of pillar, but a stronger bar, and a good strong set-screw in the lower part to fix it. In the case of a lathe with back-gear, the index-hinge or ball might be conveniently fixed on the arm or bracket which carries the gear-wheels.

I hope N. D. La Touche will send the description of his attachment to the eccentric cutters, and that "C. C. E." will write on the index, and tell us more about his new Birch lathe.

I have ordered one of Day and Co.'s gas-engines, and hope to be able to report upon it favourably before long. I saw it running beautifully at 500revs. per minute, and it will run forwards or back, whichever way it is started.

F. A. M.

INCUBATORS.

[32977.]—As the letter of your correspondent, J. Fraser, in the "E.M." of Nov. 27th, is calculated to convey a totally wrong impression to your readers, I shall feel obliged if you will allow me to state that my company have no desire to prevent the publication of a description of my patent. The objections which they find to Mr. Fraser's actions are: (1) He has made and used an incubator according to my patent, thereby traversing my company's rights, and obviously infringing my patent. (2) By writing and offering others the benefit of his experience, he induces them also to infringe my patent. (3) That he deceives the readers of the "E.M." by suppressing the name of the inventor, and thereby takes the credit of the invention to himself.

In the letter referred to above, he says: "I have never seen Hearson's or any other maker's incubator"; but he takes care not to state, as he does in a private letter to me, "I have got my information regarding incubators in the English Mechanic, and *Farm and Field*, and *Fireside*, and in lectures and papers." Those who, like myself, have the "E. M." bound from the commencement will have no difficulty in tracing the history of incubators, and on page 562, Vol. XXXVI., will find a full and illustrated description of my incubator, from which it will at once be evident where Mr. Fraser got his idea from. The letter of "Incubans" in your impression of Dec. 4th also deserves passing notice. He says: "Anyone may make a patented article for experiment, even if the patent be valid." Will he kindly refer me to any case in which such a decision has been arrived at? I generally find that those least versed in the law are most ready to give advice gratis, and I have a notion that it will prove so in this case.

Chas. E. Hearson.

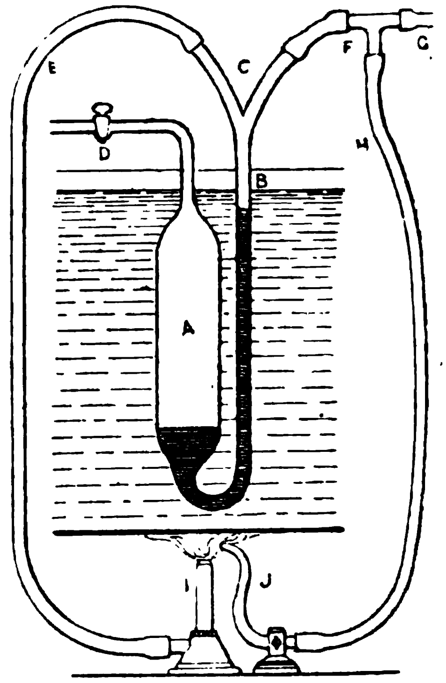
5, Templar-street, Knatchbull-road, Camberwell.

[32978.]—I take the opportunity of thanking "Incubans" for his letter in the "E. M.," and would like very much to hear what he or any competent legal authority has to say regarding patents and amateurs experimenting with them.

Although I apologised, and did as requested, I still continue to receive threatening letters from London agents. I don't know what they want. I don't make a penny from what I wrote concerning incubators. **Fraser.**

REGULATOR FOR INCUBATORS.

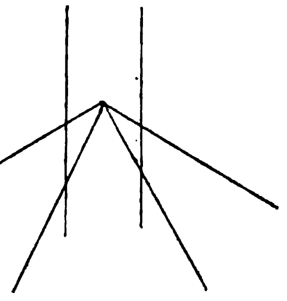
[32979.]—Herewith I send a copy of a metastatic heat regulator from the number for Oct. 31, 1884, which is adapted to maintain a constant temperature within any water or air-chamber heated by gas, the degree of temperature thus maintained being adjustable at will. The illustration shows an air thermometer so modified that the rise of mercury in the limb B will cut off the gas supply, which passes through its bifurcated extremity. Another modification is the accurately-filling stopcock D, connected with the air-chamber A, by means of which the tension of the air within the chamber, and consequently the height of the mercury within the tube, are readily adjustable. When the mercury is forced high up in B, a relatively slight increase in the temperature of the surrounding medium will be sufficient to so expand the air in A as to force the column of mercury to the point of shut-off. A far higher temperature will be needed to effect the shut-off when the columns of mercury in A and B are of the same height. In practice the adjustment is effected by placing the instrument in a medium of the required temperature; the cock D is opened and air slowly forced in with a syringe, until the mercurial column in B is nearly at the point of bifurcation, the precise height varying, of course,

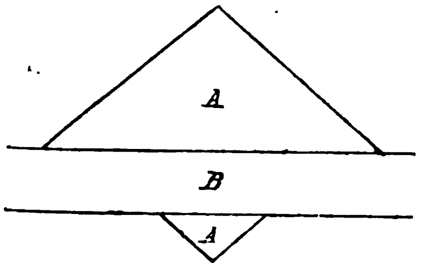


with the dimensions of the instrument, and being readily ascertained by practice. The pressure of the gas employed must be kept quite low; otherwise, as the mercury rises above the point of bifurcation, a portion will be blown out. A simpler gas-pressure regulator may be inserted between the source of gas supply and the heat regulator. It is well also that the diameter of limb C should be somewhat greater than that of its fellow, and also that its point of junction with B should be somewhat constricted. When the mercury rises in B a trifle beyond the point of bifurcation, the passage of gas from G to E is arrested, and the flame from the burner I is at once extinguished. A second, and very small, gas-jet, J, is so placed as to relight the burner I upon the renewed supply of gas. It is fed by the branch H. The surfaces of the mercury should be covered with a drop or so of glycerine, and the instrument must be kept perfectly vertical. It will be seen that the device is rather elaborate; but it is effective. **Incubans.**

OPTICAL ILLUSIONS.

[32980.]—I beg leave to send for your pages the two inclosed diagrams of new optical illusions, by the writer; the two parallel straight vertical lines in No. 1 appear as if they were bent inwards at and near the top, the illusion being caused by the four radiants in which they are entangled. In No. 2 a square, A, is partly covered by the band B, and the lower portion of the square appears as if it was part of a much smaller square than that drawn. Whichever way it is looked at, the illusion remains.





London. **T. H. Evans.**

VIOLIN VARNISH.

[32981.]—Mr. Pickering says that a violin is generally remarkably free in tone before it is varnished. Then why varnish it at all? I have heard it said that varnish was originally applied to preserve fiddles from worms. Will Mr. Pickering oblige by saying if there is any truth in this remark?

Also, whether Italian makers rubbed down their varnish in the way suggested by him. **Henricus.**

VIOLIN-MAKING.

[32982.] — The articles contributed by W. Pickering, "How to Make a Violin," involve a very interesting inquiry extending beyond mere details of construction. The strictures of "Scio" can have no claim to a fair spirit of discussion: they appear like the effusions of a jealous tradesman whose ideas on the subject do not extend beyond his bench. There is no substantial information in his letter: he must show more satisfactory credentials before we can believe in him.

The question arises: Why is it that the old makers of a past generation produced instruments of a quality of tone which at present one finds it difficult or impossible to imitate? I am of opinion that beyond the high excellence of their workmanship they had a definite scientific principle to work upon, held as a secret by themselves, and, therefore, lost to posterity. It is a fact that appeals to common sense that a violin must be considered in its entirety as a vibrating body, every item of which should be in mutual unison, and if for any reason, such as irregular formation or different thickness or density of wood, such portions respond to a different note, there will be an antagonism amongst the parts, and a consequent detriment to the tone will occur, however well the violin may be constructed in details of workmanship. My impression is that the great makers carefully *tuned* the bodies of their instruments, so to speak. That is, supposing the boards —i.e., the back and belly—to be finished externally. They then pared away the wood from the hollow or inner sides till the two boards vibrated in perfect unison. There is some confirmation for this statement, as it is on record that if a bad-sounding instrument were sent to them for improvement, they by some means could make the tone more perfect. The question is, how can the synchronous vibrations of the separate parts be indicated? For it would never do to rely on mere judgment alone, and pare away the boards on the trial and error system with risk of overdoing it, and so spoiling the whole work. Each board, if held lightly in the fingers, will, according to its structure and form, vibrate simultaneously with a note sounded on some musical instrument, such as a piano; but this would be only a rough and approximate method, not sufficiently accurate for the purpose; but it is so far sensitive, that pieces of wood of any form will vibrate sensibly, according to weight, when a certain note is sounded.

In the violin-boards there are probably two nodes of vibration, each in the upper and lower part of the boards. In a flat board the acoustic figures can be seen by Chladni's test—that is, sand sprinkled thereon will arrange itself in a symmetrical form, if the plane is symmetrical, with right and left sides alike. But the hollow form of the violin-board prohibits this mode of testing. We must, therefore, resort to the "kaleidophone" principle. Cut a piece of thin glass about ¾in. square, which should be silvered to serve as a reflector; clip this diagonally in the fork of a staple of thin brass, the corners of the glass entering into hollows at the end of the limbs. The little mirror can thus swing to catch the light of the sun or a lamp, and throw it on the ceiling or wall. If this is placed on any body free to vibrate when a corresponding musical note is sounded, the spot of reflected light will oscillate in various directions, these vibrations being more or less decisive, according to the part of the work to be tested upon which it is placed. I find that in a violin of excellent tone the wood is very thin within the rim. This is probably for the purpose of allowing greater freedom of vibration to the intermediate wood. It is known that some violins sound better by having bridges more or less heavy, and if this vibration theory holds to be correct, it may even be worth while to pare away the under-side of the finger-board, so that the free tongue may synchronise with the rest. As to the vibration of the body of air within the instrument, there is not much scope for material adjustment this way, though tone may be modified by having the *f*-holes more or less open, and varnish, no doubt, contributes to the clearness of tone. I enunciated these ideas in the "E.M." many years ago, and mentioned some experiments in corroboration. Some self-constituted authority of the "Scio" type came forward to say that my utterances were sheer nonsense. I have never found time to make a violin, and this may be asserted without contradiction.

F. H. Wenham.

DIALLING.

[32983.]—The article in your paper of Aug. 7, with illustrations and description of "Traveller's" sundial, interested me very much, because I have an instrument which I had often puzzled over, and is the same in general form, but in detail seems to be very different. Briefly, as far as I can judge, there is a great deal more of work and of minute subdivision and graduation on mine, than upon the one you figure.

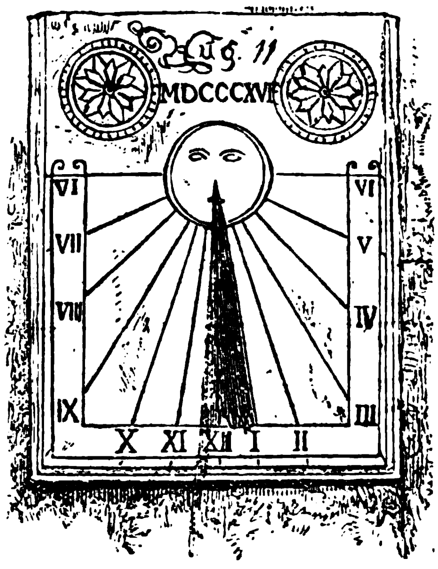
The back also is divided in a peculiar manner, and it would seem as if these, the indications, were to be taken by the employment of a line and plummet. A scientific friend thinks that, therefore, the instrument is an astrolabe as well as a sundial; but that is conjecture. Total diameter, 12in.; maker, "Tho. Wright, maker to His Majesty"; period, I should say latter part of last century.

If you thought that this instrument would be of sufficient interest for a notice in your paper, I should be glad to place it in your hands for that purpose. **William H. Patterson.**

[Should be grateful for a drawing and description.—Ed. E. M.]

[32984.]—I beg to thank those correspondents who have kindly forwarded additional useful information on this subject. The method of constructing a dial in paper is a decided novelty, and will be an excellent way of practising designing and constructing. The very easy way of setting out the hour-lines, &c., as described by "A. S. L." (32862), No. 1388, is quite new, and one of the simplest I have seen. I was glad also to see again the initials of "W. J. R.," and to read his generous offer for further information when required. I well remember his able and lucid article on "declining dials" to which he refers. Might I ask "F.R.A.S.," "E. L. G.," and other able mathematicians if they will occasionally and kindly give us the benefit of their knowledge upon this and other subjects pertaining thereto, so that the "E. M." may become the recognised authority upon advances in dialling, as it has long been upon every noteworthy advance in the useful arts and sciences?

Inclosed herewith is a photographic copy of the plan of a vertical direct south dial fixed on the Westmoor front of Killingworth Cottage, near Newcastle. It is interesting in having been the first joint work of George and Robert Stephenson, after the return of the latter from Edinburgh. It is the only dial I have seen in which the hour spaces are not subdivided into halves and quarters; this is probably due to the naturally sound judgment of the elder Stephenson, who studied dialling from "Fergusson's Lectures." The subdivisions are unnecessary, except in very large dials. The style, too, is a plate, and not a bar; this gives a larger shadow with but one edge. I do not quite see the object of carrying the sub-style down so close to the numeral XII., and it would, I think, have been an improvement if the hour-lines had been drawn only one-fourth or one-third the distance from the numerals to the dial centre, or to have had dotted lines or equidistant dashes and spaces, because the edge of the shadow becomes indistinct when crossing a continuous black hour-line. I would dispense with all ornamentation, and all unnecessary lines. The date, with the latitude and longitude, is a useful addition under the bottom edge of a dial in small, plain letters. Is it known whether the Assyrians, Egyptians, Grecians, or Romans have left any indications of the extent of their knowledge, if any, in the art of dialling? Could our instructive friend "Eos" give us any information relative to the great horizontal dial at Delhi, said to be very old, and the largest in the world? **C. H. T.**



[32985.]—On page 309 in the seventh line of the third paragraph under this heading, the word "hour-line" should be "hour-lines." Also on same page the diagrams have been transposed and wrongly numbered. Fig. 1 should be Fig. 2, and in this Fig. 1 the quadrants E F and G H referred to in the text have failed to appear. However, intelligent readers will, no doubt, be able to supply these deficiencies for themselves.

Edinburgh. **W. M. H.**

INFLUENZA.

[32986.]—I have been asked by friends for information regarding "Kreas Halonia," and have searched my numerous books on Indian materia medica and botany without result.

There are so many synonyms and dialectic appellations of plants and drugs throughout Hindostan, that I think it probable, in my case, this may be an old friend under a new name. Will Dr. Hunter be so very good as to enlighten me?

About thirty-five years ago, I, and every other European, besides nearly every native, were struck down in Central India by an epidemic fever of malarious character (said by experts to be produced by the disintegration of granite). The sequelæ of this violent disorder were: rapidly enlarged spleen, helpless debility, constant vomiting and purging, with (in my case) temporary paralysis of the arms, from the elbow to the tips of the fingers. My medical attendant was lifted into his carriage, and out of it, for he, too, was in the same plight as his many patients. He discarded quinine as improper treatment of the cerebral congestion, and substituted a little-known drug, Aconitum heterophyllum, the only non-poisonous individual of this dangerous family used by the native doctors for centuries, as "nirbikh"—i.e., without poison. The tubers contain a white farinaceous substance of the most intense bitter. I possess a drawing of the plant and tubers sent to me from the Government Botanic Gardens, which I will lend to "E. M." for copy, with some further particulars of the plant, if desired.

Eos.

AMŒBA.

[32987.]—Referring to the able article by Mr. F. Davis in your issue of the 4th inst., if amœba be stained with Gibbes's double stain the result will be that the ectosarc will be stained red, the endosarc blue. In fact, the differentiation will be exactly similar to that shown in the case of the ordinary bacillus and that of tuberculosis. The ectosarc of the amœba would appear to be a definite envelope, because the more attenuated a pseudopodium, the deeper the red colour, the point showing no trace of blue; the red becoming weaker and weaker, the blue stronger, as the pseudopodium increases in bulk as it approaches the main mass of the animal, where little or no red can be seen.

R. P. G.

REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75337.]—**Dynamo Defective.**—I wish to thank Mr. Bottone for the answer to the above. I have reduced my field-magnets, but I do not get the results that I expected. On looking back to the queries, I see it is mentioned 5lb. of No. 20 on field-magnets instead of No. 22 c.c. Do you think I have taken too much off through this mistake?

E. J. W.

[75395.] — **Vaucanson's Endless Chain** (U.Q.)—I cannot find the name of Vaucanson as being connected with any endless chain invention. Of course it would be used in the same manner as most endless chains, for instance, on a tricycle; but as to its construction I can find nothing.

C. G. M. Bennett.

[75676.]—**Legal** (U.S.)—I should think this querist might get the information by addressing the British Consul at the place where the testator died, or the nearest place. But he might, with advantage, address such a question to Mr. Wetherfield, the legal editor of the *Weekly Times and Echo*, who probably can tell him how to act in the most direct and cheapest way.—R. S.

[75676.]—**Legal.**—Write to the clerk of the County Court (or, if the county have over 100,000 inhabitants, to the Probate Judge) for copies of the will, inventory, and appraisement, and of the annual settlement of the executor or administrator, if he has made one. Those papers ought to give all the information required, unless there is fraud or concealment of assets. If the existence of the latter be suspected, "Legal" must employ a reliable lawyer, and he can most easily ascertain the name of one by writing to the judge of the Circuit Court of the county. Should "Legal" not know the name of the county, let him inclose his letters to the postmaster of the town, with a request to deliver them to the proper officers. The officer furnishing the copies will require about £1 in advance for his fees.

Westerner.

[75678.]—**Pocket Aneroid.**—This aneroid may want cleaning, but it would not be worth while to "alter the lever arrangement," even if that is practicable. Better let one of the instrument makers who advertise in these pages see to it. The only part that can want oil is the rack-and-pinion, if it is one of those in which the motion of the case is imparted to the index by that means.

X. T.

[75680.]—**Falling Bodies.**—I have to thank both Mr. Cooper and "J. R. C., Charing," for their kindness in coming to my assistance. "J. R. C.'s" letter in previous "E.M." gave the formula I required; but as a value was not assigned to μ, I was unable to use it till I saw his letter in this week's issue. I find the formula given accords rigorously with the $P\sqrt{\frac{1}{32}}$ for period, as I stated, and time for fall of a particle from moon's orbit to earth's centre, with the values I have, is by both methods $t = 419076{\cdot}6$ seconds.

Liverpool. W. S.

[75682.] — **Illuminated Fountains.** — "Old Subscriber" will find what he inquires about in the number for July 19, 1889.

S. R.

[75690.]—**Indicators.**—"C. W." will find a variety of indicators for electric-bell work in the numbers for March 1, April 5, and April 19, 1889. The descriptive matter is illustrated with large and clear engravings. An improved or different form of indicator is illustrated in the number for Oct. 24, 1890.

Index.

[75692.]—**Artificial Stone.**—The query can be answered only by trial of the felspar. Probably, if finely ground and intimately mixed with Portland cement, it would make stone. The manurial value depends on the quality of the felspar (potash): if mainly silica, it would not be much.

Nun. Dor.

[75701.]—**Steel Polishing.**—The querist does not say what articles of steel he means; but polishing generally takes the form of rubbing over with fine emery and oil (after draw-filing to a good surface), and then finishing with the burnisher. Small articles are polished by being placed in a "tumbling barrel" with fine emery, or rouge if a high polish is required. Burnishing is the very highest polish—a black polish, and is done by means of a piece of hard, round steel. See indices.

Nun. Dor.

[75703.] — **Enamel.** — Bedsteads are "enamelled" by first cleaning the metalwork, covering with stoving japan, and drying in a stoving oven at a temperature of about 300° Fahr. The enamel is usually made from asphaltum. See indices for several recipes, which are most likely entered under the title japan or japaning.

R. S.

[75707.]—**Organ.**—"Diapason" should apply to the secretary of the College of Organists for the recommendations of the college; but I have an idea they were given some time back in these pages.

X.

[75712.]—**Electric Bath.**—Get a zinc bath and place in it some acidulated water. Then take a copper plate and hold it over the varicose vein with one hand, while the other grasps the bath, the leg being immersed, of course. If there is sufficient faith, it may possibly give relief.

A. H.

[75716.]—**Restoring Faded Silver Prints.**—I do not think it is possible to restore faded photographic silver prints.

B. J. P.

[75723.]—**Electrical Indicator.**—Does the querist mean the index seen on the street machines? If so, that is worked simply by attaching a piece of string to the sliding tube which covers the primary coil and to the wheel carrying the index finger.

L. M.

[75731.]—**Motion for Equatoreal.**—Perhaps the following, taken from the August issue of the *Sidereal Messenger*, p. 370, will help you:—"Mr. Hopkinson, of Renoso, Pa., has an arrangement that, while costing but a trifle, performs very satisfactorily. He connects a large iron weight by a rope, or wire, to the axis of the telescope, and this he rests on a rubber bag filled with air. A small rubber tube leading from the bag to his hand controls the outlet of the air, and the consequent fall of the weight and motion of the telescope. . . . . With this arrangement he tells me that he is able to hold a star in the field of view for more than an hour."

Thomas Smith.

Saginaw, E.S. Mich. U.S.A., Nov. 25.

[75813.]—**Telescope Angle of View.**—In the first solution of this case, the second angle should obviously read D A C, not B A C; and in the second, ¾ log. sec. – 1075230 should be ¾ log. (sec. – 10) 52′ 39″. These are printer's errors; but I find I should have shown the value of the last as 0000349 instead of 0000169, making the number of seconds in B A C 3160·048, and the final answer 1° 45′ 2·0052″. I may add that the third query is simply a case of rule of three. If an object ·22in. wide can be seen at 4,700ft., at what distance will one of ·5in. be visible?

$$\frac{x}{4{,}700} = \frac{\cdot 5}{\cdot 22} \quad \therefore x = \frac{4{,}700 \times \cdot 5}{\cdot 22} = 10681{\cdot}8\dot{1}\text{ft.}$$

G. G. B.

[75848.]—**Jam.**—I should like to offer to your numerous readers the following suggestions, and shall be glad of their opinion of them. "Eos" (p. 313), in answer to the above inquiry, states that "hermetically-sealed tin cases are vastly preferable to corked jars," and I think an amateur might make use of provision tins. Condensed-milk cans (sixpenny) seem to offer the greatest advantage for this purpose, and on examining one of these it will be observed that the top is composed of two parts: first, the cover, with a hole in the centre through which the contents are introduced into the can, and second, a small tin disc, which has an air-hole in the centre, and fits over the hole in the cover; and if, on opening these cans, a hole sufficiently large to abstract the contents is made in the middle disc, and a small air-hole in the side near the top, it may be emptied and the small hole soldered up, when the can is complete again (excepting the disc, which anyone could cut out of a piece of tin with an old pair of scissors), and can be washed and put by for the season. To use these cans, remove the old discs by rubbing them with a hot soldering-iron until the solder melts round them; then they will be ready for the jam, which may be put in and soldered up by making some new discs in place of the old ones, which should have a small edge round them and a hole in the centre. Now put them all in a large pot and boil them for a short time, and take them out while at boiling-point and apply the hot iron to the air-hole in the centre, when the steam and air will come out with a rush, and it may again be soldered up and allowed to cool, when it is ready for storage. If when applying the iron to the hole, the steam does not "blow off," then the can leaks, and should be examined, and the disc soldered round and boiled again, and treated as before. The tins should only be filled to within about ¼in. of the top to allow space for the steam to accumulate. To open one of these tins, cut the top off just under the edge, and when emptied, the body of the can may be straightened and the cover soldered on again and used once more. The amateur need not confine himself to milk-tins, but make use of any other of the various tins in the market which are of a convienent shape and size. Meat-tins should be thoroughly washed and put in an airy place to take the smell away, should there be any. These tins would be very easy to make by anyone who has a spinning jenny, or any means of spinning an edge on a piece of tin. All the joints must be "sweated," and the best flux to use would be rosin dissolved in a little spirits of wine or oil, which could readily be wiped off with a piece of rag.

H. Robinson.

[75863.]—**Electric Shop-bell.**—You can fix an electric bell in your second floor of house, which can be made to continue ringing by opening the shop-door, and the electric current may be cut off by means of a switch fitted under your counter, connected with wires from the bell and door-contact. These door-contacts cost 2s. 6d. each; one will be sufficient, to be fitted to the door-post with the wires (two) connected thereto. One wire to run straight to the bell, the other to the battery, and another wire to go from the bell to the battery. One wire of the battery to connect with the zinc, and the other with the carbon (if of the Leclanché form of cell). You will have to pass one of the wires, leading from door, under the counter (if you wish to cut off the current) to the switch. Cut the wire and fix one end, and then the other to the two terminal screws of the switch, and you will be able to make contact, or cut off, at pleasure.

Alfred Taylor.

[75887.]—**Sundials.**—Would "W. J. R." oblige by giving instructions for constructing a sundial, both reclining-declining, and inclining-declining. I may state that his instructions for making a vertical declining dial have been of great benefit to me, and he would be conferring a further benefit by answering this query.

Bon-Accord.

[75899.]—**Compressed Air.**—Your correspondent "B. F." says I make a "curious mistake" in giving the weight of 1c.ft. of air at 32° as 12¾oz., and asks for my authority. My authority in this case was my own memory, and I find, on reference to a treatise on heat by Thomas Box, that I am correct within a minute fraction too small to be considered. It appears to me that the person who makes the curious mistake is "B. F." himself. Perhaps he will tell us the difference between 565·4 grains and 12¾oz.? This difference is likewise a minute fraction too small to be considered, and it would appear that your correspondent is confused by the difference in the number of grains in 1lb. troy and avoirdupois. I am not often caught in figures, and think that the one caught this time is "B. F." himself.

Thos. Fletcher.

[75901.]—**Inside Gouges.**—Emery wheels are sold for the purpose, to run in water. I do not fancy copper discs, fed with emery and oil would fret quickly enough. Water is most suitable for edge tools. Pattern makers frequently grind the flatter sizes of gouges upon the slightly-rounding edge of an ordinary shop grindstone. The smallest gouges cannot be ground thus, however. A new, fine-cut, round file will do very well for gouges under about ⅜in. But, of course, the best plan is to have

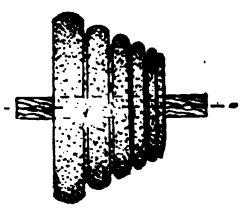


FIG 1

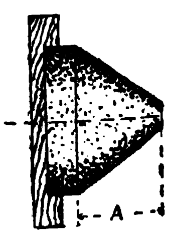
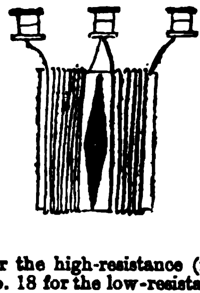


FIG 2

a proper stone turned up on a wooden spindle, as in Fig. 1, and run it between lathe centres, using the slowest speed. A discarded, worn-out shop grindstone can be used for the purpose. The convex profiles can be easily turned with a pointed bar of iron or steel, slowly rotated to present fresh-cutting facets to the stone. From six to eight different curvatures can thus be obtained upon a disc of stone of 5in. or 6in. in width, and as any single curvature will do for gouges, not only of the same sweep, but for those a little flatter, such a stone will serve the requirements of a whole shop. The spindle is of square section, and the stone is wedged upon it. Another method is shown in Fig. 2. A piece of stone is turned of a conical form, and cemented into a face-plate of wood, recessed to hold it more securely. The face-plate is carried by a common metal chuck, not shown in the figure, and so revolved in the lathe. In this case the gouge is held parallel with the axis of the lathe, instead of at right angles with the axis, as in the first figure, and the various curvatures for grinding are determined by the position in which the gouges are held on the height A of the cone. The nearer to the right hand the quicker the curvature imparted; the nearer to the left hand, the flatter the curvature. J. H.

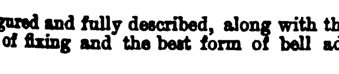
[75920.]—**Linesman's Galvanometer.**—You will find full instructions, with illustrations, for constructing the above in my book "Electric Bells, and All About Them," pp. 176 to 181. You may put about 2oz. No. 36, or 1oz. No. 38, silk-covered copper wire for the high-resistance (intensity) coil, and 1oz. of No. 18 for the low-resistance (quantity) coil. They should lie one coil on each side of the needle, and be connected-up as shown in annexed cut. S. Bottone.

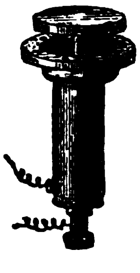


[75921.]—**Optical Lantern.**—"R. E. S. A." will not be able to get a parallel beam from a 4-wick lamp. His source of light must be a point. See back numbers of "E.M." or Lewis Wright's book. H. A.

[75928.]—**Crystallisation.**—The reason why supersaturated solutions would throw down crystals in rectangular bottles and not in round, would be, I should imagine, because the circular form is one of greater stability, and bodies possessing that form are less open to the attacks of disturbing forces than those having any other form. This, it might be argued, is a very slight cause: granted; but how slight a cause need be to make the difference between the liquid and solid states. I have seen a carboy of a supersaturated solution of a salt turn from the liquid to the solid condition, with a great evolution of heat, and the primary cause of change—a particle of crystal about the size of a mustard-seed. I do not think there are any grounds for supposing an intermediate state between the liquid and the crystalline; for the whole body of a liquid does not solidify together *en masse*, but the process of accretion—particle by particle into the crystalline form—can be closely watched under the microscope, and is one of the most interesting sights in science. A. E. B.

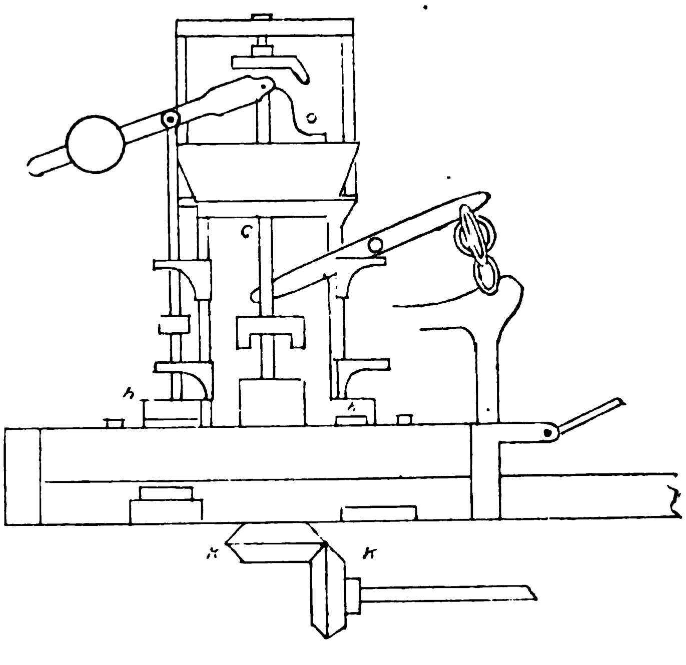
[75941.]—**Floor Contacts.**—To Mr. Bottone.—I give two forms of floor contacts. Both these are figured and fully described, along with the best mode of fixing and the best form of bell adapted for use with them, in my book "Electric Bells, and All About Them." S. Bottone.





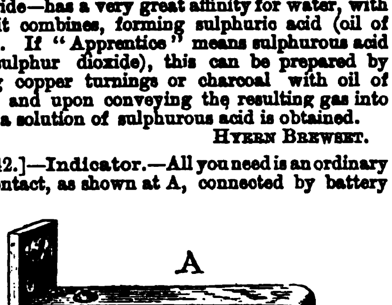
[75930.]—**Gas-Engine.**—Your trouble in starting the engine is most likely due to air, which gets into the gas-bag and pipes when the engine is not running. I had just the same experience with a Campbell engine until I found and stopped a slight leak in the pipe-joints between gas-bag and engine inlet. If your gas-bag is of good quality and gas-tight, leave it full of gas when you stop. Do you gain much by passing the gas through benzoline?

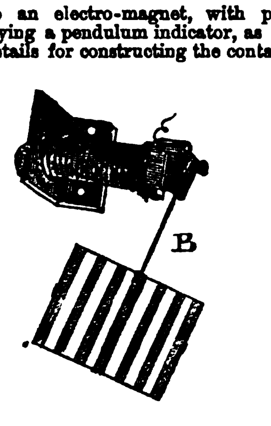
Brighton. T. C. Smith.



[75931.]—**Gases.**—Hydrogen is nearly insoluble in water, it requires 100 volumes of the latter to dissolve 1·9vols. of hydrogen. (Prof. Lewes.) Water will take up not more than $\frac{1}{10}$th part of ether. Sulphuric acid gas—presumably sulphuric anhydride—has a very great affinity for water, with which it combines, forming sulphuric acid (oil of vitriol). If "Apprentice" means sulphurous acid gas (sulphur dioxide), this can be prepared by heating copper turnings or charcoal with oil of vitriol, and upon conveying the resulting gas into water, a solution of sulphurous acid is obtained. Hyern Brewset.

[75942.]—**Indicator.**—All you need is an ordinary door contact, as shown at A, connected by battery and wires to an electro-magnet, with pivoted armature carrying a pendulum indicator, as shown at B. Full details for constructing the contact and the indicator, as well as best mode of connecting up, are given in my book "Electric Bells, and all About Them." S. Bottone.





[75943.]—**Brick.**—I don't think anyone will be able to say what sort of machine, without knowing nature of clay, and whether semi-dry or plastic, and quantity "Tile" wants to make per day. Fraser.

[75943.]—**Brickmaking.**—The machine I send sketch of I think you will find the best. The sketch represents only one frame with its stampers. This machine was brought out in 1839 by Messrs. Cook and Cunningham, in which two operations are successfully combined; it holds its own among the hosts of subsequent inventions. The clay is pressed out of the plugging cylinder into a box at its lower end at R by two radial arms attached to the inside of the plugging shaft. The mould frame acts at the bottom of this box, and the clay thus pushed in between it and filling the stamper is pressed into the mould by the descent of the stamper. The moulding frame is then made to slide until the brick thus formed is brought under one of the discharging stampers H H, which descends upon it and forces it into an opening in the sole on which the frame slides, and which forms the bottom of the mould while under the filling stamp. The brick, when forced through, is received by a boy, who places a board at K K to receive it. The motion of the stampers, and the traversing of the mould frames between the stampers, are affected by a combination of the usual shafts, cranks, wheels, &c., which would take up too much room to describe here. C. G. M. Bennett.

[75944.]—**Link-Motion.**—The length of the link has nothing to do with the distance the valve travels, that being determined by the throw of the eccentric. All that the link does is to change the position of the block from one eccentric to the other. The eccentric rods are fixed at the top and bottom of the link, and when the block is opposite either of these ends you have the full movement of the valve. I do not understand your drawings. Dynamite.

[75950.]—**Greenhouse Heating.**—The only important factor in this is the area of the glass exposed. One-foot run of 4in. hot-water pipes for every 5sq.ft. of glass will give a rise of 30° inside the house, for every 4sq.ft. of glass will give a rise of 38°, and for every 3sq.ft. a rise of 50°. For exposed walls allow one-third of the heat required for glass. It is easy to calculate from the above for any size of pipe and for any other temperature required. Thos. Fletcher.

[75955.]—**"Greater Britain."**—"Nun. Dor.," p. 338, asks, "If there is a better locomotive out than 'Greater Britain'"? Mr. Webb has certainly produced the most extraordinary engine built for many years; but it has given no results to show that it is "better" than those of other companies—indeed, it is doubtful if it is as good. It has been stated in the papers that "Greater Britain" has run 90 miles an hour, and is capable of 100 miles an hour. There is no truth in either statement. The fastest speed ever run on railways is 81 miles an hour; it will be a very difficult matter to surpass that, and certainly it will not be done by a "compound." Clement E. Stretton, C.E.

Leicester, Dec. 5.

[75959.]—**Telescope.**—I should imagine the fault to lie in the eyepiece; but you don't say whose make. The best eyepieces do not give the image perfect to the edge of the field. Get some friend to test both the o.g. and the e.p.'s for you; it is impossible to advise without seeing the instrument. It is quite possible that the o.g. may have got out of adjustment on the body tube. Rigel and Vega are both quite easy with a good 3in. H. A.

[75961.]—**Electric Lighting.**—When you drive a dynamo at a slower speed than that for which it is designed, you considerably decrease its efficiency — i.e., the percentage of mechanical energy that is converted into electric energy. Therefore (leaving out initial cost), you will not gain by using a machine larger than is necessary to well light the lamps you intend using; 5c.p. lamps are not much use, except for model or experimental purposes. I should use three 16c.p.'s.

Brighton. T. C. Smith.

[75965.]—**Precipitating Gold.**—This is very easy. Buy some protosulphate of iron; dissolve it, and add a strong solution to the gold solution, which, of course, contains copper. You need not be particular as to quantity, except to prevent waste. I always used to add the protosulphate till I could not see that any more gold was thrown down. Then pour off the liquid, and you have the gold in powder. Wash this well in a beaker with five or six waters, and then filter again, using plenty of water. Dry the filtrate, and you have pure gold, which you can melt without addition of anything as a flux. Now try the solution again with more protosulphate of iron, and as gold is scarce (it was with me), let it stand, and try again with a little heat. If after this nothing is thrown down, you have precipitated all the gold. Protosulphate of iron does not redissolve the precipitate, as is the case when precipitating silver from nitrate of silver, for in that case, if you add too much salt as the precipitating medium or agent, you redissolve some of the precipitate. I would here add, though foreign to the question asked, what beautiful objects for small museums can be made out of pure gold and pure silver treated as follows:—Melt, not adding any flux, and you then have (in each case), beautiful nodules of gold and nodules of silver as bright as bright can be. I have some of the pure silver thus treated more than five years ago as bright as the day it was thus treated, and the only exclusion of air has been by a champagne glass inverted over a large watch-glass. It is true that for nearly the last four years this has been in a room where no gas has been burnt. If it had been otherwise, I fear it would have been tarnished by sulphur ere this. Z. Y. X.

[75973.]—**Telephones.**—I presume you have bar magnets, having a soft iron pole-piece. If so, wind a little more than ¼oz. of No. 38 silk-covered wire on bobbins. Use same amount for each magnet. Mick.

[75974.]—**Band Saws.**—The quickest way to braze band saws is to hold the ends with a heavy pair of flat tongs previously made red-hot. The joint should be carefully fitted, and held in position by a clamp, so that the two ends exactly meet. Use fine spelter, and mix with powder borax.

Brighton. T. C. Smith.

[75974.]—**Brazing Band Saws.**—No one who understands band-saw brazing would ever recommend a gas blowpipe for the purpose; it scales the saw very much, and burns the carbon out of the steel, although there is no difficulty in getting any amount of heat with a proper gas supply. The ends of the saw should be cleaned, and between the overlap a piece of very thin brass, covered with borax, should be placed. If the joint is then compressed between the jaws of a heavy pair of tongs, red hot, it will be made soundly in a few seconds without any scale or damage. Thos. Fletcher.

[75975.]—**Winding for Dynamo.**—To Mr. Bottone.—You have put two queries in one, or, to speak more exactly, an answer to your requirements for a 40 volt. dynamo will not suffice for the one to charge 20 accumulator cells; 20 such cells will require, if charged in series, 50 volts. I will, therefore, give the amounts and gauges of wire required for the latter purpose, as you can get the lower voltage by driving a few hundred revs. per minute slower. Wind the armature with 2lb. No. 17 = 66 yards, or 6·6 yards per each section. The safe carrying capacity of this wire on a drum armature is just about 8 ampères, and the 66 yards will give you about 50 volts at 2,500 revs. per minute. Wind the field-magnets with 10lb. No. 20, 5lb. on each limb in series with each other, but in shunt with the brushes. S. Bottone.

[75977.]—**Dial Cutter.**—Wholesale tinworkers use just such a tool as you require—two small overlapping steel wheels, which form the shears, and a centre which can be fixed any distance off and screwed down on to the tin, which then revolves on this centre. You can cut three or four at once with it if you fixed the sheets together.

A. J. Dew.

[75977.]—**Dial Cutter.**—It is quite a new idea cutting out "dials" with shears. I suppose "tin" means tinplate, and I also suppose that any maker of stampers' tools would supply Mr. Jones with the die and sink for cutting his dials several at a time, according to the power applied. If Mr. Jones does not care to procure a stamping machine, he can have a cutting knife rigged up, either on a lathe or a table, which will turn out his "dials" faster than he can cut them with shears. By the way, how comes it that a man who has "constantly a great number to make" is so far behind his own business that he does not know of the simple devices briefly mentioned above? The "E. M." itself is more than seven, and the method has been fully explained many times. Nun. Dor.

[75978.] — **Locomotive Queries.** — The only locomotive ever constructed in this country with a 10ft. wheel was the "Hurricane," designed by Mr. T. E. Harrison in 1836, and built for the Great Western Railway by Hawthorn and Co., 1837-38. The cylinders and motion were upon a separate frame and wheels from the fire-box and boiler. This engine proved a failure. The largest driving-wheel now in use is 8ft. 6in. diameter, the engine being the London and North-Western Company's "Cornwall," built at Crewe in 1847, with the boiler under the driving-axle, but since rebuilt with a new boiler above the axle. The Bryce-Douglas valve-gear upon the Caledonian engine proved a failure, and is removed. Clement E. Stretton, C.E.

Leicester, Dec. 5.

[75980.]—**Soldering.**—If you get the cast iron hot enough to melt the solder when it is rubbed on it, and use spirits, you ought to have no difficulty. I expect you do not get iron hot enough.

A. J. Dew.

[75980.]—**Soldering.**—File a smooth surface on the iron free from grease; stand this in chloride of zinc solution for about ten minutes. You can easily tin the iron by this means.

S. Robert Bonney.

[75980.]—**Soldering.**—If you will thoroughly clean the surface of the iron, then rub it over with bluestone just moist, you will, I think, conquer your difficulty. I thought inconsistency was a speciality of my own sex; but it seems not, as you say you have tried every possible way, and yet ask for further information. Mrs. Chambers.

[75980.] — **Soldering.** — Cast iron should be thoroughly tinned before soldering. If the surface is uneven and awkward to scrape, pickle it in hydrochloric acid; but if flat, scrape or file it bright, and cover it with a solution of salammoniac and water, then heat it till the salammoniac begins to smoke, when you will find no difficulty in tinning with the soldering-iron. H. Robinson.

[75980.]—**Soldering Cast Iron.**—Clean the surface of the cast iron where you wish to tin it, cover it with powdered rosin, and place on it a few drops of solder; now heat the iron by means of fire, blowpipe, or other convenient means, until the solder begins to melt. Have a clean copper soldering bit ready and hot, and spread the solder until you have tinned as much of the surface as you require—easy enough you will find. Remember, you can never get solder to adhere properly to any surface unless you can heat up that surface to the melting point of the solder itself.

S. Bottone.

[75980.]—**Soldering.**—It would be interesting to learn what "Amateur" means by having "tried every possible way" to solder a piece of cast iron to tin—meaning tinplate, no doubt. He can do it easily enough by first zincing or tinning the surface of the cast iron by dipping it, whilst clean, into molten zinc or tin, and then applying it at once to the tinplate—also perfectly clean—as probably the cast iron can itself be made hot enough to act as its own "soldering-iron." I should like to know what "every possible way" "Amateur" has tried. I suspect the failures arose from the fact that "Amateur" did not get his cast-iron hot enough, but tried it cold, and so chilled the solder.

Nun. Dor.

[75980.] — **Soldering.** — "Amateur" says, though he has tried every means, he has not succeeded in soldering cast iron to tin; but he does not mention whether he used hard or soft solder, or what were his fluxes. I have soldered a good deal of work, and though I have never done so with cast iron, I should say the following would be the best method to proceed:—Take the piece of iron and file a clean, bright surface over the part to be soldered, then heat the piece to about the temperature of melted lead, and while thus hot proceed to coat it over with block tin, not solder, as the former has a certain affinity for uniting with iron. When the iron surface is tinned over, the soldering can, no doubt, be easily done. I cannot say what should be the flux; but those used in soldering are either resin, or borax, or soldering solution, the latter being a saturated solution of zinc in hydrochloric acid (spirit of salt). The cheapness of common resin is, no doubt, in favour of its use; but I have found myself that borax is somewhat superior to it as a flux. William Hutchinson.

[75980.]—**Soldering Cast Iron.**—This cannot be done directly; but if the surface of the iron is cleaned and then rubbed with sodium amalgam, the surface will then take the solder as readily as wrought iron or brass. Thos. Fletcher.

[75980.]—**Soldering Cast Iron** —This material is so porous and liable to absorb grease and dirt, that I have found previous treatment with concentrated muriatic acid, and then quickly tinning the piece, to be the only sure method of dealing with it during the process of soldering. Rub the cast iron first with sharp sand and water, and then immerse in a vessel of scouring liquor, made of soft water and washing soda, and afterwards rinse with a stream of clear water. Dry the metal rapidly by the fire, and then try to solder it, after treating the part to be tinned with the acid while rather hot. Eos.

[75981.]—**Edison Dynamo.**—1. Yes, the gauge and amount of wire is right. 2. I should prefer using less of No. 18, so as to keep the shunt coils nearer the F.M. cores, say, 90lb. No. 18 for the shunt coils, and on the series coils should have ¼ the R of the armature, say about 8lb. No. 11 for the series coils. 3. I should certainly use a solid steel shaft in preference to a tube. 4. The proportions to be adhered to in winding are:—Resistance of outer circuit, 20; resistance of armature, 1; resistance of series coils, ¼; resistance of shunt coils, 400.

S. Bottone.

[75982.]—**Interest.**—Surely such a query is prompted by laziness! If "T. V." remembers that 6 per cent. per annum is just 15·78 farthings per day, he could surely work out the sum for himself, adding interest and deducting payments. If accruing interest be made up half-yearly, he owed on the 24th June, 1891, £160 11s. 3d. H. B. F.

[75982.]—**Interest.**—As answer to this query, I get the following result:—

			£	s.	d.
Interest on £200 at 6 p.c. 26 10	from 24 Jan., 1888, to 24 Apr., 1888	=	1	9	11
,, ,, £173 10 ,, 25 0	from 24 April, 1888, to 6 Nov., 1888	=	5	7	5
,, ,, £148 10 ,, 10 0	from 6 Nov., 1888, to 23 Apr., 1889	=	8	4	0
,, ,, £138 10 ,, 10 0	from 23 April, 1889, to 23 Dec., 1889	=	10	2	2
,, ,, £128 10 ,,	from 23 Dec., 1889, to 24 June, 1891	=	23	3	0
Total interest..................			£48	6	6
Remaining principal..........			128	10	0
Total due 24 June, 1891			£176	16	6

Rifle.

[75983.] — **Kiln.** — If "Experiment" will say what size of kiln he would like, or whether the test he speaks about is for the bricks or kiln, I could send sketch to "E.M." Fraser.

[75985.]—**Clockmaking.**—There is no fixed rule as to relative sizes of fusees and barrels. The usual size in English eight-day dials is 2¼ barrel to 1¾ fusee at large end and ¾ at small end. It is purely a matter of convenience, in which the required number of revs. of fusee and the available turns of spring are to be considered. The curve of fusee must be adjusted to mainspring if accurate results are wanted. The duty of fusee is to equalise the force of spring, and it is thus evident that if mainspring is two and a half times as powerful when wound up as it is when at end of its work, the large end of fusee must be two and a half times diam. of small end to equalise the pressure. With regard to the shape, Fig. 2, on page 157 of Vol. LII., gives that usually used, and with a barrel of usual size a spring of usual number of turns and average strength gives the required adjustment near enough for most ordinary clocks. The vibration of a pendulum depends on the form of escapement. If a "dead beat" is used, 1in. vibration is sufficient, provided the pendulum is heavy. F. J. G.

[75986.]—**Medical Coil.**—Test for a break in the circuit. A. D. S.

[75987.] — **What Dynamo Will Engine Drive?**—To Mr. Bottone.—Without knowing pressure of steam and workmanship of engine, impossible to say. With 30lb. to the inch, if the engine does not waste much power in friction, &c., probably a 20c.p. dynamo. S. Bottone.

[75989.]—**Air-Vessel.** — If "Alltfab" would get part 8, Vol. X. of *Transactions* of the Mining Institute of Scotland, from Mr. James Barrowman, Hamilton, price 1s. 8d., post free, he will find all the information he requires, fully illustrated and explained. R. A. Muir.

[75990.]—**Boring.**—Begin the hole with the second or middle tap, and finish it with the plug-tap. As this is neither tapered nor backed off, it will cut a full thread to the bottom of a hole. If you cut the thread in a lathe, you must mark the lathe-bed at the spot where the saddle must stop travelling when the tool reaches the bottom of the hole, and make the movement of the lathe cease on reaching that spot. J. H.

[75991.]—**Hand-shaking Battery.**—Let the "patient" stand upon one piece of tin placed on the floor and the operator on another piece, each to be on a carpet and a few inches apart, and connect one with the knob and another with the outward coating of a charged Leyden jar, and then —"How do?" A. E. B.

[75992.]—**Nickel Plating.**—It is certainly not usual for hydrogen to form on cathodes; it is caused by too much battery-power, or the exposure of too large a surface of anode.
Brighton. T. C. Smith.

[75992.]—**Nickel Plating.**—The most important point is to keep the solution neutral—a very slightly alkaline—by occasional additions of ammonia sp.gr. 1·03. Use low E.M.F., so that little hydrogen is evolved. The anode surface should be larger than objects plated. See reply 75695, p. 249 for Nov. 6 this year; also 75749.
A. D. Southam.

[75992.] — **Nickel Plating.** — Similar queries have been answered before in this paper only a few weeks back. There should not be a quantity of gas given off at the cathode. You have got too much battery power, or the anode surface too great or too near the cathode. See to this, and I think your difficulty will be removed.
S. Robert Bonney, Electroplater, &c.

[75993.]—**Mining.**—You should obtain "Colliery Management," by Caleb Pamely, published by Crosby Lockwood and Son.
N. Edwards-Robson.

[75993.] — **Mining.** — I would recommend "Alltfab" to get "Gases Met With in Coal Mines, and the General Principles of Ventilation," by J. J. Atkinson, price 2s; also "The Theory and Practice of Ventilating Coal Mines," by W. Fairley, price 3s. 6d.—both from G. Buchanan, 12, Brandon-street, Hamilton. R. A. Muir.

[75993.] — **Mining Query.** — "Alltfab" can choose out of the following authorities on ventilation: Dr. Arnott's, Dr. Hale's, and Dr. Reid's. There is one more which I should advise "Alltfab" to adopt—viz., Prof. Tomlinson's "Treatise on Ventilation." There are also some very good notes on mining in Robert Routledge's book on "Discoveries and Inventions." These books can be obtained at any large bookseller's. C. G. M. Bennett.

[75994.]—**Transparent Varnish.**—No ordinary varnish will stand heat and all acids. 999.

[75994.]—**Transparent Varnish.**—"Kensington" wants an ideal varnish. If he refers to pp. 421-425 of Munro and Jamieson he will find several recipes, but no one fills all its requirements.
A. D. S.

[75995.] — **Blacking Zinc.** — Try a wash of charcoal, plumbago, and size. Lampblack and size might answer, or the black varnish given in reply 75766, Nov. 13. A. D. S.

[75995.]—**Blacking Zinc.**—Sandpaper the zinc so as to get a clean surface; make a strong solution of sulphate of copper in water, add a little size and lampblack, and paint over lightly with this mixture; allow to dry in a warm place. S. Bottone.

[75998.]—**Electric Lighting.**—A 10c.p. dynamo can be driven very well by hand or from lathe, if not wanted for long at a stretch.
Brighton. T. C. Smith.

[75998.]—**Electric Lighting.**—You can do this easily with one of my little so-called 5c.p. dynamos (see Sale Column). These absorb about $\frac{1}{24}$H.P. My son often uses one attached to the lathe when he wants the light close at hand. Of course, it makes the work heavier, because the dynamo absorbs power. S. Bottone.

[76000.]—**American Glass-Cutter.** — By the device of the little hard steel wheel you are enabled to bring a very intense vertical pressure to bear successively upon a very small point of the glass. This you would not do if the wheel were fixed, for your progress would be by a series of intermittent and unavailing jerks. The wheels must be small, because a large wheel would give too extensive a contact, and the intensity of the pressure would be correspondingly lessened. A. E. B.

[76001.]—**Egg-Tester.**—Get a piece of board, or tin, or even cardboard will do, providing you have it large enough to keep the light from your eyes when holding before lamp. Size and lampblack, or Japan black the side facing you. Cut a hole the shape of an egg ($1\frac{3}{4}$in.) at widest part $1\frac{3}{8}$in.; better still, make a box large enough to stand lamp in, with back and top minus, cut your hole so that it comes in line with flame of lamp same size as given, which will do well for hens' or ducks' eggs. If an assortment of eggs is required to be tested, from ostrich downwards, cut your hole to suit largest eggs, and by tacking a strip of tin on the outside of box, bent over at the edges so that you can slide a piece of tin or wood, cut with smaller holes to suit the eggs required to be tested down in front of the larger hole in box. This makes a good tester, as it keeps all the light to the purpose by confining all the light to the aperture; black outside of your box, and perform in a dark room. E. G. H.

[76002.]—**Fireirons.**—The cheaper classes of these are usually made of malleable castings. If properly made, they are as good as wrought-iron for the purpose; but they are much more liable to contain flaws and weak places than if made of wrought iron. 999.

[76005.]—**Killing Rabbits by Electricity.**—I have heard of rats and mice being so destroyed in America; but I greatly doubt if you will get a creature with such strong powers of scent and dainty of appetite as a rabbit to touch the wire with his nose, and unless his fur happens to be damp, it will repel a shock; nevertheless it will be a novel experiment. Some years ago a very ingenious mechanical invention was sold at an American shop in the Strand. This construction, when set, knocked the intrusive rat or rabbit dead with a short, heavy staff, and he fell many yards away. It was a repeater, and could settle many individuals in this fashion before being again wound up. In comparison with electrical dodges, I think it would "beat all creation." Eos.

[76007.] — **Charging Accumulators.** — The time required to charge your accumulators will entirely depend on the size of plates and their distance apart. The cells boiling freely and a milky appearance of the electrolyte is an intimation of their being charged; but a little overcharging does not affect them. F. Askew.

[76007.] — **Charging Accumulators.** — The time required will depend on two factors—1, the capacity of the accumulator cells themselves; 2, the output in ampères of the charging battery. With small pocket cells and pint bichromates, allow an hour's charging for each hour capacity of the accumulator. When the fluid in the accumulator cells boils up and looks all milky, it is charged. It does no harm to continue charging, beyond wasting battery current. S. Bottone.

[76008.]—**Charging Leyden Jar.**—Unless your Wimshurst is a very powerful one, and your Leyden jar unusually thin, you need not fear "bursting" (I suppose you mean "perforation"). Electrical machines are their own safety valves at a certain electrical pressure, for the passage from one pole to the other is only a question of an assignable resistance. A. E. B.

[76608.]—**Charging Leyden Jar.**—While the jar is still capable of taking a charge, you will find sparks will pass at a considerable distance from the Wimshurst to the knob of the jar. When the charge has reached its limit, you will find that you can hardly get a spark to pass at all. You will also hear a peculiar sizzling noise, caused by the jar partially discharging itself through the air. If your jar is of thin glass, and you attempt to overcharge it, a disruptive discharge, fracturing the glass at its weakest point, may take place.
S. Bottone.

[76011.]—**Lighting Fairy Lamp.** — A 4-volt lamp will give about $1\frac{1}{2}$c.p. You cannot tell the candle-power of a lamp by knowing its voltage only; you must also know the ampères it takes to make it give a fair light. Then multiply the volts by the ampères, and divide the product by 3·5, and the result will be the candle-power. Say, for example, a lamp takes 2 ampères at 6 volts to cause it to incandesce, $6 \times 2 = 12$. $12 \div 3{\cdot}5 = 3{\cdot}42$, or, say, nearly $3\frac{1}{2}$c.p. The product of volt × ampère is called a watt. S. Bottone.

[76012.]—**Transformer.**—To Mr. Bottone.—You can make a transformer on the same lines as an induction coil; but, of course, this is not the most effective form. If your supply of current is continuous, you must, of course, have a contact-breaker to produce the required alternations or breaks. If the supply is alternating, this will not be needed; but in neither case will the resulting current be a continuous one. From its very nature a transformer must give an alternating current. The alternations must be very rapid, say several hundreds per second, so that the resulting current is apparently continuous. The voltage of the induced current will be to that of the inducing, in the same proportion as the number of coils to each other. Say, for instance, 50 turns of primary and 50 turns of secondary, the E.M.F. in secondary would be the same as in the primary: 50 turns primary, 25 secondary; the E.M.F. would be $\frac{1}{2}$ that of the primary. If the section of this latter wire could be doubled, the current would be doubled, &c. If I am to advise you about the size for your transformer, and you cannot work it out yourself from above data, you must let me know—1st, E.M.F. of supply; 2nd, ampères in supply; 3rd, E.M.F. you require; 4th, ampères you require. S. Bottone.

[76019.]—**Wimshurst Plates, Fixing.**—I have tried nearly all recipes: none give me so much satisfaction as the following:—Cut a couple of brown-paper discs the same size as the bosses. Cut out the central hole. Soak these in boiling water. Surface dry them on a cloth. Now paste them liberally on both sides with good stiff flour paste, same as bookbinders use. Place them in proper position on the glass discs, rubbing out with a cloth any superfluous paste. When dry, glue the bosses down on to the paper with good hot carpenter's glue. When quite dry you will find you cannot remove the bosses without splitting the glass.
S. Bottone.

[76019.]—**Fixing Wimshurst's Plates.**—The better way to fix the plates to the boss is by means of a vulcanised fibre washer; and the best course to follow is this:—First clean off all the old cement from both the boss and the plate, then try whether the plate runs truly when lying upon the end of the boss; next, cut a washer of vulcanised fibre of about the same diameter as the boss, pierce it in the middle, making the hole to just fit the projecting end of the brass bush; then drill and countersink three or four holes, add a little hot bicycle cement to the underside of the washer, and press it down into its place upon the glass plate; then put the screws in, and when so held the plates will never work loose; see that the vulcanised fibre is of proper thickness before you cut it, for it will not do to have the fibre washers rubbing together; the ends of the brass bushes only must touch; while, on the other hand, you must remember that the closer together the plates can be made to run, the better is the efficiency of the machine. J. W.

[76022.]—**Waste in Magnetic Circuit of Dynamo.**—(1) No; you cannot remedy this without altering shape of pole-pieces. Can you not file away somewhat of the projecting pole-pieces? (2) This depends on the diameter of armature—if it be 3in. in diameter, perhaps 5 per cent; if $1\frac{1}{2}$in., as much as 25 per cent. You might line the inside of the pole-pieces with some sheet iron, nearly $\frac{1}{8}$in. thick, to overcome this defect. S. Bottone.

[76023.]—**Batteries.**—It is possible to charge any battery by means of another having a higher E.M.F.; but in many cases it would not be worth the while to do so. For instance, in the case of a spent bichromate cell, it would mean an expenditure of at least 200 watts for every 50 watts that could be afterwards recovered from it as a secondary cell. The Daniell, the Smee, the Walker, and the Leclanché, especially the dry cells, can be used as secondary cells. These latter will return about 50 per cent. of the energy put into them.
S. Bottone.

[76024.] — **Clicking Noise in Telephone Receivers.**—No doubt the noise is due to a loose contact in line wires or transmitters; sometimes too strong battery power will cause it. I have a short telephone line, and use strong battery power to work the bells; sometimes the noise in phones sounds like water flowing into a cistern, while at others a bubbling and ticking, which I know is due to the battery. You can remedy it either by increasing the resistance in the battery, or using less power.
Mick.

[76025.]—**Electric Lighting on Small Scale.**—The cheapest motive powers, in order of cheapness, are—1st, windmill; 2nd, water-motors; 3rd, steam-engine; 4th, gas-engine; 5th, hot-air engine. The power required to drive a 60c.p. dynamo is about $\frac{1}{4}$H.P. S. Bottone.

[76025.]—**Electric Lighting.**—If you have a stream or other supply of water at a high pressure, a water motor is at once the cheapest source of power. Failing this, a steam or gas-engine must be installed, the latter probably being the most convenient, though not so economical as the former. It is absurd to run a dynamo by an electric motor —at least, on the ground of economy—since the primary source of current will run more lamps direct than through the intermediancy of motor and dynamo. F. Askew.

[76026.]—**Electric Launch.**—A small drum armature motor, with reversing gear, similar to what I made for the Naval Exhibition, will cost £3. Six pint cells will work it for about an hour with once changing. Properly-made cells to fit hull of boat will cost about 5s. each. S. Bottone.

[76027.] — **Isinglass.** — Isinglass (a saturated solution of) in pyroligneous acid makes a splendid cement or glue. Will mend china, and stands hot water. Keep corked, and use as ordinary glue.
A. C.

[76029.]—**Hot Installation.**—It is quite evident from your statement that the armatures, and even the switches, get so hot that you are taking more current from the machines than they are intended to supply, and more than the switches can convey. The lamps you are using take at least 0·5 ampère each (rather more than less), hence you must have 350 ampères passing through your main switches. Each dynamo must be giving at least 175 ampères at 100 volts. Are you sure your dynamos were made for this output? From the great loss of potential at the far end, it seems very probable that there is a "ground" somewhere. This would to a certain extent explain the excessive heating. Of course, the use of lower voltage lamps at the further end would give a better light, but probably heat the dynamo even more, as these lamps would take more current. S. Bottone.

[76028.]—**Ellipse.**— In reply to "Libra," the circumference of an ellipse is = the sum of the two semi-axes × 3·14159, or, which is the same, half the sum of the axes × 3·14159. Therefore, in this case, we get as the circumference—

$$\left(\frac{12 + 5}{2} \times 3{\cdot}14159\text{in.}\right)$$
$$= (8{\cdot}5 \times 3{\cdot}14159\text{in.})$$
$$= 2\text{ft. } 2{\cdot}7035\text{in. correct to 4 places.}$$

AUTOLYCUS.

[76028.]—**Ellipse.**—The following formula is very nearly correct:—Circumference of ellipse $= \pi\left(\frac{D + d}{2}\right)$. Taking the example given by "Libra"—

$$\text{Circum.} = \pi\left(\frac{D + d}{2}\right)$$
$$= 3{\cdot}1416\left(\frac{12 + 5}{2}\right)$$
$$= 3{\cdot}1416 \times 8{\cdot}5$$
$$= 26{\cdot}7036\text{in.}$$

N. EDWARDS-ROBSON.

[76031.]—**Chamber Pipe-Organ.**—In reply to "T. A. L.," it is impossible to say for certain what is the cause of the hissing in his organ without an examination, especially as it is one of foreign build. It is possible that some of the pipes have been removed and not properly replaced. A mouse may have eaten a hole in the foot of one of the pipes, conveyances, or leather covering the grooves or bars, or there may be a leakage caused by the pull-down wires cutting the brass through which they work; they will do this if the setting out is incorrect—or is it a leakage of the bellows or pneumatic, appearing to come from the swell-box? I consider that colour injures the tone rather than not, and should certainly have the old colour cleaned off. I notice "Leo" suggests a method for converting a "recovering" pedal to a "balanced" one. I do not fancy that the weight-and-pulley arrangement would answer well, as, in consequence of the shutters not being hung on their centres, the leverage of the shutters varies considerably with their position, whilst the power of the balance-weight would remain the same. A better plan would be to "balance" the shutters themselves by weighting them; or, better still, if there is room for them to open sufficiently inside the swell-box—which is very unlikely—to rehang the shutters on their true centres. The objection to the balanced pedal is that it is difficult to close the swell, and it likewise offers no resistance to the foot. Now I am writing I should like to ask those of your readers who have adopted the plan described by me in last week's issue, if they would oblige me by giving their opinion upon it.

Sudbury. THOMAS ELLISTON.

[76032.]—**Lamp Resistance (Cold).**—This is best found by a Wheatstone bridge, using as low a battery power as possible, for the resistance of the filament falls rapidly as temperature rises.

A. D. SOUTHAM.

[76032.]—**Lamp Resistance.**—You cannot calculate accurately the resistance of a lamp filament. Roughly, it is about 2·5 times the hot resistance. But for anything like accuracy, this should be tested by low-tension battery, bridge, and coils. S. BOTTONE.

[76034.]—**Dynamo Hard to Drive.**—There is not enough resistance in the wire on field-magnets. Remove the wire you have on at present and wind with 2lb. No. 24 s.c.c. B.W.G., and I have no doubt you will get current all right. LAYMIX.

[76034.]—**Dynamo Hard to Drive.**—There seems to be a short-circuit somewhere. Are you sure you have the connections right? Run slowly on open circuit, and gradually reduce resistance. Test the insulation in F.M. and armature coils.

A. D. S.

[76034.]—**Dynamo Hard to Drive.**—I should think so, indeed. Why, nearly all the current is going round the field-magnets, and magnetising them up to the full. Take the No. 16 off the field-magnets, rewind them with 6lb. No. 20, connect up in shunt, and then report results.

S. BOTTONE.

[76036.]—**Galvanising Small Castings.**—This querist asks "how thick" the coating of sal-ammoniac on the molten zinc should be, but does not appear to have tried for himself. The salammoniac is simply to prevent the zinc from oxidising, and the thinnest coat or film will do, provided it is intact all over the surface. The idea of "6in. or more" thick is absurd, and tempts one to reply rather discourteously. Better try. It is evident the querist has not tried. Let him try it half an inch thick. NUN. DOR.

THE electric street railway construction account for the United States, for the seven months ending September 1st, 1891, is given as follows:—Increase in companies 85, in miles constructed 350, cars in use 575; making a total of 400 roads, with 3,000 miles of line, and 5,000 cars.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

Since our last, C. G. M. Bennett has replied to 75395.

75410. Xylophon, p. 141.
75430. Overshot Water-wheel, 141.
75432. Fusee of Spring Clock, 141.
75454. Making Platinum and Zinc adhere to Glass, 142.

75687. Casting in Lead. To "Practical Caster," p. 229.
75691. Electrical, 229.
75694. Logarithms, 229.
75699. "Berliner" and "Fiddler" Violins, 229.
75709. Gas-Making Machine, 229.
75725. Horse-power, 230.
75726. Double Bass, 230.

QUERIES.

[76038.]—**Compensated Pendulum.**—I want to make a heavy compensated 1 sec. pendulum for my sidereal clock. I would be obliged if Mr. Granger or any other practical man would give me the sizes of the different parts. I want to use zinc and steel, with a lead cylindrical bob to weigh about 40lb.—DARAMONA.

[76039.]—**Bunsen Burner, Substitute for.**—I have lately removed to a place where there is no gas, and am in want of a substitute for a Bunsen burner in my small laboratory. I shall be glad if any reader can suggest a plan for using the ordinary petroleum lamps for boiling retorts, &c., without getting a thick deposit of soot. If a chimney is used I cannot get near enough to the flame. The ordinary spirit lamp is too expensive. Could naphtha be safely used instead of spirit in one of the latter?—J. H. B.

[76040.]—**Converting a Grandfather's Clock into a Chime Clock.**—Would the writer of the paper on "Clockmaking," which appeared in the ENGLISH MECHANIC of Nov. 20, or any other reader, give a paper on converting a "grandfather's" clock into a chime clock. Many of our readers have these clocks, that formerly belonged to our grandfathers, and would prefer putting the quarter chimes to making a chime clock right out, there being less work. The forthcoming paper mentioned in the above paper on "Wheel-Cutting and Lantern Pinions Making" will, I am sure, be gladly accepted by all amateur clock-makers?—W. LEADBETTER.

[76041.]—**Softening Cast Metal.**—Having a quantity of thin cast metal to fix up, and scarcely one in six can be bored, I would like to know if there is no system of softening the above, there being a lot of cuttings, and every one has to be bored.—PLUMBER.

[76042.]—**Wheel-Valve.**—Which is the proper way to fix a wheel-valve for steam or water? Should the inlet go under the valve, or over the valve?—AMATEUR.

[76043.]—**Separating the Joints of Cast-Iron Hot-Water Pipes.**—Is there any preparation which will dissolve the borax, and loosen the borings with which the joints are made? Any information will oblige. —A GARDENER.

[76044.]—**G.W.R. Tender.**—Will any of our readers kindly give me description of Great Western Railway Co.'s tender for locomotive engine, with Adam's bogie?—ANXIOUS.

[76045.]—**Chemical.**—To MR. GREY OR J. T. M.—I thank you for replies as to quantity of CO_2 evolved from 1oz. of $HNaCO_3$ by means of tartaric acid, and would be much obliged if either of you, or anyone else, will tell me what quantity of commercial S_2HO_4 and water is necessary to evolve all the CO_2 from the 1oz. of $HNaCO_3$.—NOVICE.

[76046.]—**Feed-Water Heater.**—A friend of mine has an engine and boiler for cutting hay. The boiler is too small, as it only runs for half-an-hour, when the boiler has to be refilled. He has been advised to attach a tank to it, with a steam pipe running to its bottom within an inch from top of boiler. There is also a pipe connecting tank to boiler below gauge-line. By this arrangement he expects to run a full hour. Can you tell me if this will act, and be safe?—LEVER.

[76047.]—**To Mr. Bottone.**—Please would you tell me the candle-power I could obtain from a ½H.P. water motor, and also some idea as to the cost of the materials for making the dynamo for the same?—C. MORRELL.

[76048.]—**Engine for Lathe.**—I have a vertical slide-valve engine 2½in. by 3½in. stroke, 10in. flywheel. Should like to know what size lathe it would drive at 40lb. to 50lb. pressure?—FREDOS.

[76049.]—**Electro Motor.**—Will any readers advise me how to make an electro motor to drive a sewing machine, and to be worked from a dynamo giving 6 ampères and 45 volts? Kindly give me a rough description, dimensions, size, and quantity of wire, &c., and best method of winding? I have plenty of tools to work with. —MOTOR.

[76050.]—**Hook and Eye to Gut Band.**—Will someone kindly tell me the best method of fixing hook and eye to ½in. gut band. I pare the end, insert a small wood core, and put the hook on warm, but it does not always make a good job; the gut seems to get rotten by the hook. What is the best dress to use for tool; one that will not rust the lathe? I require very little, therefore cost is a secondary consideration.—IRON AND STEEL.

[76051.]—**Chemical Laboratory.**—Can any chemical reader assist me by answering the following questions, viz:—1. What is the best means of obtaining heat for evaporations, &c., in a country district where gas is not available? 2. Is there a maker of balances called Sartarious, and are his instruments good and reliable? 3. What is a good book to work qualitative and quantitative analysis from? I used Valentin some years ago, but would like advice.—DAVID WELSH, B.Sc.

[76052.]—**Solution of Dextrine.**—Can any of our chemical readers assist me in obtaining a permanently clear solution of dextrine in water, equal parts in each. I find that, after standing for a few days, the solution, which was clear at first, gradually becomes opaque, and looks like a mixture of flour and water. If anyone will take pity on me, and help me out of the difficulty, I shall be extremely obliged to them.—DEXTRINE.

[76053.]—**Bicycles.**—What are the advantages of bicycles with long wheel-base?—H. W. STANLEY.

[76054.]—**Electric Light.**—Can anyone inform me how to make a small 8c.p. electric-light set, supplied by primary-battery power, and the number and kind of battery most suitable, and how to make? Also, how to make small accumulator for small electric scarf-pin lamp?—CYCLA.

[76055.]—**Steam-Boiler Safety-Valve.**—Will any of our readers kindly assist me in the following question, and give rule in plain figures how to work out and re-adjust weight on valve to blow off at a given pressure? Length of lever, 3ft. 4½in.; distance of valve from fulcrum, 3¾in.; diameter of valve-seating, 4½in.; dead weight, 55lb.; lever, 11½lb.; valve, 2lb. 6oz.—A YOUNG MECHANIC.

[76056.]—**High-Pressure Boiler.**—Can any of our readers give me some information as to the working of a high-pressure boiler? If I put three or four gallons of water in, I can get hot water at the bath in 20 minutes, and if I have the cold-water tank full and the high-pressure tank full, I cannot get more than milk-warm water. I would thank some of our readers for information as to what size of high-pressure tank ought to be. The hot-water tank is 3ft. by 2ft., and stands 2ft. high; the cold water tank is 5ft. 2in. by 5ft., and stands 2ft. 2in. high.—ONE THAT DOES NOT KNOW.

[76057.]—**Galvanising.**—Wanting to fit up plant for galvanising, will any reader give me particulars.—INQUIRER.

[76058.]—**Observing Chair.**—Would any astronomical reader kindly describe and give a sketch of a suitable observing chair or ladder for use with a 12in. equatorial reflector? I find an ordinary step-ladder very awkward and uncomfortable, especially when examining an object for any length of time. Some contrivance supporting one's back when observing would be a great boon. Greatest height of eyepiece from ground is 9ft.—ACIDE.

[76059.]—**Reflector.**—Given a 8½in. reflector of unknown focus, and a suitable plane or flat. How can I find the exact distance the latter should be placed from the former?—ACIDE.

[76060.]—**Dynamo.**—Will any expert kindly answer the following? I have made a dynamo, of which I give dimensions. It is well made and very carefully wired, insulation good. I should like to know what revolutions most suitable to run at, what the voltage will be, number of ampères it will give, how many lamps it will supply. Armature ring type, 5in. dia., 3in. wide, 10 sections, wound with 2½lb. No. 18 d.c.c. wire; field magnets wrought iron, 2½in. dia., 4in. long, with round plate 5in. dia., ½in. thick at one end; the other end has stud in to screw into poles of cast iron; field magnets wound with 12lb. No. 20 d.c.c. wire, shunt wound.—SHUNT.

[76061.]—**Switchback Railway.**—Can any of "ours" give me scantlings of timber and all necessary particulars for building a switchback railway; also details of the car and track?—FRANCISCUS OCCIDENS.

[76062.]—**Projectiles, and the Rotation of the Earth.**—If a projectile be shot up into the air a considerable distance, it will not return to the same spot, owing to the rotation of the earth. Can any of our readers demonstrate this mathematically?—KINETIC.

[76063.]—**Influenza.**—Would Mr. Hunter kindly explain of what "Kreas Halonia" consists, as, having asked for it, I found it was not known by chemists in this (foreign) city. On the other hand, "Salypyrin" is said to be the present great medicine for influenza in Germany. Would Mr. Hunter, perhaps, give the prescription in Latin or in German?—M.

[76064.]—**Steam Jet Cupola.**—Can any of our friends give particulars of this patented cupola in which the pressure blast is superseded by a steam jet aspirating the air under negative pressure? Its main purpose is for pig-iron melting, but it is also used, as I am informed, for reducing copper and lead ores, &c., and for the calcination of lime and selenite.—M.

[76065.]—**Smoky Chimney.**—Dr. Wordsworth, Bishop of Winchester, wishing to cure a smoky chimney, studied the literature on chimneys, and found that the ancient Hebrews used an inflated bladder, or wineskin, in their chimneys, to which he thought the words in Psalm cxix. verse 83, "I am become like a bottle in the smoke," might refer. What is known about this practice? And what construction of chimney was then in use to which it was applicable? The bishop tried a bladder without any good effect.—J. S. C.

[76066.]—**Condensation in Lead covered Hut.** —Can any brother reader inform me how to prevent the above, which takes place in a hut covered with lead and lined with match-boarding, causing great annoyance? Would brown paper on felt coated with tar prevent it?—W. HOLLIS.

[76067.]—**Astronomical Eyepieces.**—Will someone who has had practical experience with a 3in. inform me the best power to use for each of the following? 1, Sun; 2, Moon; 3, Jupiter; 4, stars of 1st mag. Also, on what celestial object could I obtain the best result with a power of 180 on the same instrument—a 3in. refractor?—ASTRONOMO.

[76068.]—**Great Western Engines.**—Can any of "ours" give particulars of the new and converted Great Western engines which are being put in hand, and which will work the narrow-gauge expresses next May when the broad-gauge is discontinued? I suppose the broad-gauge engines will convert to narrow without very much expense.—ENGINEER.

[76069.]—**Lathe.**—I have a 3in. centre lathe with round grooves in pulleys, and I cannot get any work done on account of the belt slipping, and when I have the belt tight the hooks come off. Should the grooves be V-shaped, or is there something to rub belt with to make it stick? If any reader could give me information as to where I am at fault, and advise as to which is the best belt for a lathe this size, he would greatly oblige.—A Constant Reader.

[76070.]—**Electrical.**—To Mr. Bottone.—A week or two back I asked you to give me instructions how to make a charge for a 4-celled box battery to light a 5c.p. lamp. The answer you gave me was chromic acid 3 parts, sulphuric acid 3 parts, chlorate of potash ⅛th part, and water 21 parts. Not being very well up in figures, I got a friend of mine to work it out for me, making the answer thus: Chromic acid 1lb. 2oz., sulphuric acid 1lb. 2oz., chlorate of potash ¾oz., and water 7lb. 8oz. I obtained the acids and mixed them up, putting the sulphuric acid to the chromic acid, then the potash, then the water. I let it stand for a day or so, and then I charged the battery. but it only made the filament of the lamp a good red light, and only lasted for about four hours. I should be very pleased if you would inform me if he has made a mistake in the figures, also a hint or two where it might be wrong. I have one of your books—"Electrical Instrument Making for Amateurs"—if there is anything there you would wish to refer me to.—Glengall.

[76071.]—**Model Loco. Boilers.**—Should this come under the notice of any of our experienced contributors, will they kindly explain the thickness of metal the tubes should be, and the inside firebox, for boiler 18in. long and 6in. diam., to burn charcoal or coal? I have had repeated failures with this size of boiler, the tubes being too thick, or the inside firebox plates being too thick for the heat to pass through. Again, there is always a difficulty in getting charcoal or coal to burn in this size boiler, there not being sufficient air-space in a firebox 5in. or 6in. long and 7in. deep. When blast-pipe is turned off, the fire at once goes dull, consequently a continual supply of steam cannot be kept up.—G. W.

[76072.]—**Wood Bending.**—How is it done successfully? Have tried young green wood, soaked in water for three days, steamed from fifteen minutes to one hour and a half, but have had most of it split somewhat in the bending, although protected with a band of zinc on the outside. Does it require any particular pressure of steam, or exposure to the steam for any given time according to bulk? My experience is with ash ¾in. thick.—Ash.

[76073.]—**Lalande-Chaperon Cell.**—I have recently set up one of these cells, and have made solutions of caustic potash varying in strength downwards from 33 to 22 per cent., with similar results—they all dissolve the oxide of copper, more or less, and then attack the zinc on open circuit. I shall feel obliged if any correspondent who has had experience of this cell would kindly explain what is to be done to prevent solution of the oxide, and state the proper strength of potash solution.—J. K. R.

[76074.]—**Mill Work.**—I would be glad if some reader would give me some information how to make a small hand-mill, with drawings? How can I find out the speed for drums?—Young Mill Repairer.

[76075.]—**Siemens Dynamo.**—Would Mr. Bottone tell me if I can alter a small Siemens dynamo, so that it will give shocks? Also, what battery would be best suitable for lighting an 8c.p. lamp for about two hours per week; how often would it require recharging, and the probable cost?—R. S. V.

[76076.]—**Brass Colour for Solder.**—I have had some brass articles to solder, and should like to colour the solder the same as the brass without electro-plating, and have been told there is a solution which, if rubbed on, will turn it. Could any reader kindly tell me if such is the case, and what the solution is composed of?—H. Robinson.

[76077.]—**Silvering.**—Will Mr. Bottone, or others, say what the proportions are of silver, nitre, ammonia, sugar of milk, and what kind of potash is required for making solution for silvering mirrors? Or would be glad for other receipts for same considered as good?—George Sellars.

[76078.]—**Boring Square Hole.**—Having been informed that it is possible to bore a square hole with a brace and bit. Can anyone explain the modus operandi?—Old Subscriber.

[76079.]—**Battery for Electric Light.**—I have a battery of 22 accumulators, each cell consisting of 3 lead grids (cast), each 1-16in. thick, 2¾in. high, and 3½in. broad. Two of these form the — element, and the other the +. The three when pasted weigh 8oz. They are immersed in H_2SO_4 solution, s.g. 1·180 to ¼in. over — plates. How many ampère hours could I get discharging safely? Would there be sufficient current to maintain a small arc light? If so, how many c.p. could I expect? What current shall I use to fully charge them, and for how long could I charge them off a spare 100-volt lamp circuit, or would the voltage be too excessive?—G. R. S.

[76080.]—**Typewriter Ribbon.**—Can any reader give me the process for re-inking above? The machine is a bar-lock, and the ribbon itself is in excellent order, but the ink is faint. It is a blue copying ribbon, but I should like recipe for re-inking record ribbon as well.—Typist.

[76081.]—**Motor for Boat.**—In No. 75420 T. C. Smith says he is in possession of sketch and description of a simple oil engine and would be pleased to send the same to someone wishing to make an engine. Would he publish same, or forward me the drawings and particulars necessary to enable me to make such an engine, for which I will be most willing to pay all charges incurred? As I don't know anything about this class of work, please let him be very explicit in details. I would like to make an engine of about 2H.P. to 4H.P. actual.—P. Vertees, Government Telegraph Works, Alipore, Calcutta.

[76082.]—**Electric Lighting.**—Would one of your electrical correspondents give me the following particulars for lighting two 1c.p. incandescent lamps (in parallel for choice) for about four hours at a time at most, best cells to use, number required, and size? The total length of circuit is 30 yards, and wire used about No. 16 B.W.G.—J. W. M.

[76083.]—**Cork Cutting.**—Can any of your readers oblige me with information how I can cut the centre out of corks 11-16 diameter, ¾ deep, bore to be ⅝in., same as used for sauce bottles with glass stopper? I have had some steel cutters made and they cut very nicely indeed; but the difficulty lies in holding the corks steady, as if they rock about they would not all be bored in the centre of the cork. Perhaps some of your readers could tell me who are the makers of these cork-boring machines?—George Fisher.

[76084.]—**Earthquakes.**—Can any able correspondent give me any information with regard to the behaviour of the barometer during earthquakes, the same to be not drawn from a popular description of the phenomenon. Encyclopædias appear to studiously avoid this most important aspect of the question. Is it because people are too much engaged at such times to consult their glasses? —A. E. B.

[76085.]—**Voltmeter.**—Would Mr. Bottone kindly give a sketch of a bobbin for the above-named instrument, to read about 5 volts, the needle to be hung in vertical position?—E. J. W.

[76086.]—**Resilvering Reflector.**—I have a Gregorian reflector. The metal speculum is rather stained and scratched. Can it be silvered in the same manner as the silver on glass specula? If so, how?—A. E. W.

[76087.]—**Formula Wanted.**—I am investing my savings in an ordinary bank, in which I get 2½ per cent. interest per annum. I put in various amounts at intervals. What is the simplest method of calculating the interest, interest not being allowed on fractions of a month?—Inquirer No. 1.

[76088.]—**Electric Light Installation.**—Would Mr. Bottone or F. Allsop kindly inform me the best form of dynamo for the largest output I could run off a 2 man-power gas-engine, the lamps being 8c.p., taking, I should think, 25 volts? What would the outlay be for fitting up the gas engine and dynamo in position, lamps and fittings, switchboard, wires run in casing, exclusive of the cost of engine and dynamo? The lamp-fittings would be a china ceiling rose, with fuse, flexible wire, enamelled iron shade, with holder. Would it require a voltmeter and ammeter to be included on switchboard in so small an installation, as these are expensive items? Or could a board be fitted with the main switch and automatic cut-out? Any information would oblige—An Enthusiast.

[76089.]—**Brass Melting.**—Can any reader give me the following information? (1) How much borax should be put into the crucible with the brass, and in what condition? (2) What is done with the borax when pouring off into the mould? (3) Is there any risk of burning the brass, and how should it be avoided?—W. W.

[76090.]—**To Mr. Allsop.**—Having made two microphone transmitters with induction coils to your instructions in the issue of September 18, would you kindly say what amount of 40 s. wire I must put on the straight bar magnets of the receivers, the circuit being about 50 yards? I wound the coils in a lathe, and they are very unevenly wound, as I found it impossible, under the circumstances, to wind them evenly. Please say if they will be very detrimental?—J. H. B.

[76091.]—**Boiler.**—To "X. T."—Thanks for your answer to my query on the boiler. It is my fault for not explaining it properly. The boiler is 2ft. long over all; firebox is 6in. by 8in.; the barrel or round part, with flues through, is 1ft. long and 6in. diam., and the other is the smoke-box. It is like a portable boiler. I want it to drive a lathe and circular-saw to saw 4in. thick, both of which I have to work by hand-power at present. What size flue would you advise? Also say whether I can get ¼H.P., and what it would cost to get the flue put in? It is inconvenient to have a larger boiler. An answer will oblige a hard-working man.—Boiler.

[76092.]—**Glass.**—I have read somewhere that the glass residue left after silica and sodium carbonate have been fused together is soluble in water. Could this be made into a paste for moulding or casting, like plaster of Paris? Or does anyone know of a transparent, or semi-transparent, substance, to stand considerable heat, which could be used like this?—Smyrna.

[76093.]—**Relacquering Chandeliers.**—I have to relacquer chandeliers, steel bronze, and also bright copper colour. Would some kind reader inform me how this is done? I am used to red bronzing and other colours, but don't know how to get the colours first mentioned. Perhaps some reader could tell me the title of a good book on the subject?—Brass.

[76094.]—**Coil Construction.**—To Mr. Bottone.—If, instead of the usual arrangement of primary and secondary, we wound the secondary (insulated as usual) in a close spiral on to the primary (just as the brass strings of a piano are "covered" with a copper wire), and then wound the compound wire on to a core, what would be the effect?—A. S. L.

[76095.]—**Physiological.**—To B.Sc. or others.—Could you give me any advice or assistance in the construction of instruments used in physiological work, such as Marey's tambours, kymographs, sphygmographs, &c.? Surely some instruments less complex in construction than those figured in Prof. Foster's "Text-Book of Physiology" would answer the same purpose. Also, could you tell me if those who wish to experiment in this direction require any license before they can do so?—X. Per.

[76096.]—**Atmolysis.**—About eighteen months ago I came across the term "atmolysis" in an examination paper. I had never seen the term before, and have not seen it since. Will some kind friend please explain its meaning?—A. E. B.

[76097.]—**Dulcimer.**—Will some reader assist me in the construction of a dulcimer by giving me the particulars as to the length of the longest string, also the length of the shortest, and the distance of the strings from each other? How many strings are there on a full-sized dulcimer?—W. Taylor.

[76098.]—**Rouge.**—Will some of our readers kindly inform a silver polisher of a simple way of making his own rouge? I have tried to dissolve sulphate of iron to collect the settlement, but have not been successful.—S. P.

[76099.]—**Gauge-Glass Washers.**—I find that the ordinary grey rubber washers (owing, I am told, to the sulphur in them) slowly, but surely, eat away the brass fittings in which they are. Would it be better to use red rubber? I have heard they have given up the use of rubber on some of the railway co.'s, and use asbestos instead. I am afraid the ordinary asbestos yarn would be too hard.—A. J. Dew, Cambridge.

[76100.]—**Air Current.**—I wish to induce a current of air by means of a steam-jet. What is the best shape of blower or blowpipe, and position of steam-jet therein, to get the maximum amount of air to pass, and does this vary directly in any way with length of blower, shape, and pressure of steam?—F. Scarf.

USEFUL AND SCIENTIFIC NOTES.

Prof. De Volson Wood has recently had carried out an efficiency test of a pulsometer. The pulsometer had 4in. suction and delivery valves, and a 1in. steam pipe fitted with a throttle valve at a distance of about 2ft. from the pump. Pressure gauges were placed on each side of the throttle valve, and a mercury well and thermometer were fitted beyond the throttle, by means of which a definite knowledge of the steam was obtained. The wire-drawing through the throttle valve caused superheating. The lift was 25ft., and the steam pressure used was 19·30, 43·8, and 26·1 foot-pounds respectively. The efficiency of the pump, calculated on the basis of useful work ÷ heat absorbed, was only ·013, and the duty per 100lb. of coal ranged from between about 12,000,000 and 13,000,000 foot-pounds.

Feed-water.—Feed-water containing magnesium chloride should not be directly used. Treatment with caustic soda in the boiler itself is frequently resorted to; but the great difficulty lies in ascertaining the amount of caustic soda necessary, and in keeping only slight excess present. Usually samples are drawn off from time to time and tested, litmus being used as indicator; but a simpler method would seem to be the introduction of an indicator into the boiler. Most indicators become colourless on heating under pressure; Mr. A. Goldberg—*Chem. Zeit.*—proposes, however, sodium para-nitrophenolate, which does not possess this disadvantage. In taking an observation it is only necessary to blow off the water from the water-gauge and to admit a fresh portion from the boiler. The indicator in the pure state is dear; but perfect purity is not essential. Continuous use of the indicator is not necessary, for when once the working quantity of caustic has been ascertained, the indicator may be dispensed with for a while. With regard to the working of this indicator, so long as the water in the boiler is alkaline there is direct indication; but directly acidity prevails, reduction takes place to amidophenol and direct indication ceases. The indicator is best prepared on the spot by dissolving para-nitrophenol in a dilute solution of caustic soda.

Explosives Used in Coal Mines.—Prof. Bedson, of Newcastle, has issued his report on the action of the fumes of roburite and tonite upon the health of miners, he having been appointed some time ago to make experiments with these substances, Dr. Hume and Dr. Drummond acting as professional advisers. At Elmore colliery experiments with roburite were made; and at South Hetton roburite, tonite, and gunpowder were used; whilst at Haswell gunpowder alone was employed. The results obtained are practically similar to those obtained by Prof. Dixon, F.R.S., of Owens College, who, with Mr. Hannah and Dr. Mounsey, made experiments on behalf of the miners and colliery proprietors at Garwood collieries, near Wigan, some time ago; the conclusions arrived at were at the time published in our columns. Prof. Bedson states: "Under the ordinary working of a mine I have been able to detect in the fumes two deleterious substances—viz., carbon-monoxide and sulphuretted hydrogen; and whilst carbon-monoxide is produced by each one of these materials, sulphuretted hydrogen is formed by gunpowder alone." Dr. Hume and Dr. Drummond, in their report, state that they have been led to the conclusion, from the cases they have seen, that the ailments complained of were not from the effects of the explosives used, but found their origin "in the conditions of their work—the absence of light, the confined and occasionally foul air; and no doubt the carbon-monoxide, which is the product of all the explosives fired in coal, is a factor of their production." The conclusions are set forth in a tabulated form, and are practically as follows:—1. The use of tonite and roburite is not more deleterious than that of gunpowder. 2. That, as a result of the use of roburite, no nitro-benzine was met with. 3. That the quantity of carbon monoxide was small, and it is quickly dissipated by the air current. 4. An interval of at least five minutes should be allowed after firing the shot before re-entering the place. 5. As burning of the fuse gives rise to part of the gases formed, the cartridges should be fired by electricity. It will be remembered that the cases of illness seen by Mr. Hannah and Dr. Mounsey were caused, not by the results of the explosions, but by the careless handling of the roburite.—*Lancet.*

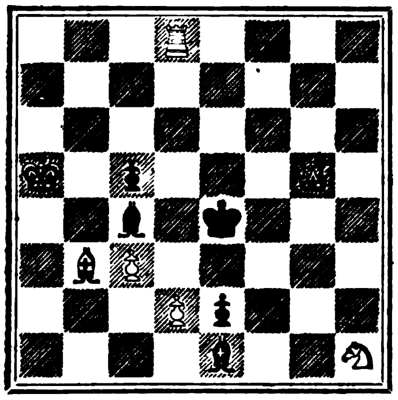
CHESS.

All communications for this column to be sent to the Chess Editor, at the office, 332, Strand.

PROBLEM MCCLXXXIV.—By R. W. Houghton.

(Third Tourney Problem.)

Black.



White. [7 + 5.

White to play and mate in two moves.

Solution to 1282.

White.	*Black.*
1. Kt to B 6.	1. Any move.
2. Mates accordingly.	

NOTICES TO CORRESPONDENTS.

Correct solutions to 1282 by F. Slade, H. P. Hosken, W. T. Hurley, Alex. Anderson, T. H. Billington ("moving the position one square to the left does away with the R and improves the problem"), R. W. Houghton, James Kistruck, Biene; to 1281 by F. H. Guest and T. Guest, and C. S. Bright (Genoa).

J. Nield.—In your 2-mover No. 1, Black can prevent the mate by R-K 2. No. 2 is correct. Will you please correct No. 1 and re-send it?

H. P. Hosken.—Your queries are answered in the conditions published in issue of 27th Nov. The tourney problems will be consecutive.

W. T. Hurley.—Thanks for problem. In 1280 Black cannot queen a pawn.

H. Hilbrand.—Both your attempted solutions of 1282 are wrong.

T. H. Billington.—Problems received with thanks.

The Boden-Kieseritzky Gambit.—Resuming the discussion of this opening at Black's 8th move (for preceding moves see last week's issue) we last week gave the variation 8. B-K 3: 9. B-Q 3, P-K Kt 3. Next suppose 9. Kt-B 3; 10. Q-R 5 ch, B-B 2; 11. Kt-Kt 6, B takes Kt (if Q-Q sq; 12. Q-R 8, &c.); 12. B takes B ch, K-Q sq; 13. B takes P, Q-K sq; 14. Q takes Q ch, K takes Q; 15. B-Kt 6 ch, &c., and the game seems even. If Black play 9. B-B 2 (?), White may proceed 10. Q-Kt 4 (threatening Kt-B 5 as well in the check at B 8, &c.), Q-Q 2; 11. B-B 5, Q-B 3; 12. B takes P, threatening mate in two moves. Another move at Black's 9th move is P-K Kt 3; 10. P-K B 4, B-B 2 (if); 11 Q-B 3, P-B 3; 12. P takes P, B P takes P (Q P takes P is perhaps better); 13. R-B sq, Kt-Q 2; 14. B-K Kt 5, Q takes B; 15. Q takes B ch, K-Q sq; 16. Kt-B 3, Q-K 6 ch (?); 17. K-R sq, B-K 2; 18. Q R-K sq, Q-Kt 3; 19. Kt-Q 4, &c. We will next consider the results on Black playing 8. P-K Kt 3, instead of B-K 3.

It is said that half the tin of the world is exported from the Malay Peninsula, where mining is carried on almost entirely by the Chinese. The mining is that of flood tin, and the metal is taken from the lowlands near the mountains, where it is found in pockets 10ft. to 20ft. or more below the surface.

Extract of Male Fern.—The physiological properties of the ethereal extract of male fern have recently been investigated by MM. Prevost and Binet of the University of Geneva, who find that grave results seldom follow even large doses introduced into the stomach of man and warm-blooded animals in consequence of the slowness with which the drug is absorbed, but that hypodermic, and still more intra-peritoneal injections, kill animals by paralysing the heart and respiration. The most prominent symptoms are paralysis and early rigidity of the voluntary and involuntary muscles, preceded by vomiting, dyspnœa, shivering, and cold. The chief cause of death is paralysis of the heart, which is found immediately afterwards firmly contracted in systole, and incapable of responding to stimuli. The vagus does not lose its inhibitory power until just before death. A great loss of vermiform movements is observed in the intestine in the case of the rabbit, the rat, the guinea-pig, and the pigeon. When the drug is applied to the conjunctiva the sensibility of the cornea is diminished, and subsequently arrested without any change being observed in the pupil. In cold-blooded animals the central nervous system is quickly paralysed. There would seem to be a special action on the protoplasm which causes the muscular and other changes observed.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, December 9, and unacknowledged elsewhere:—

W. E. S.—Siphon.—Sekon.—J. R.—Dundas.—H. F. A.—Iota Data.—R. H. W.—An Old Reader.—T. C. Smith.—J. H. B.—J. S. B.—Dr. Aveling.—C. G. M. Bennett.—O. J. L.—A. S. L.

The Kenyon Pipe. (Mr. Kenyon sends us other samples of his pipe which we noticed last week, and points out that there is no smell from them; and that, as we stated last week, his patent is quite independent of any material of which the pipe can be made, and is equally applicable to meerschaum, briar-root, clay, or any other substance. The pipes sent smoke well and dry.)—Alba. (The white substance which would not burn was probably asbestos; but it might have been slag-wool. Most likely it was asbestos, which you can obtain from the dealers, or on putting an advertisement in the Wanted Column, samples would, no doubt, be sent you.)—A. B. C. (Harmoniums are, as a rule, louder than American organs with an equal number of reeds. They are also harsher in tone. Four rows of reeds will naturally give more volume of sound than two rows. Possibly, an instrument with two rows of reeds and an octave coupler would suit you.)—H. Gilbertson. (The best way to dry bullock's blood—probably the cheapest—would be to put the blood into shallow trays in a closed chamber and pass hot dry air through; but you do not say whether you want to dry it as it is or after the serum is removed. The air pump and the chloride of calcium would be of little use, and would add materially to the cost. Bullock's blood dries naturally in shallow trays exposed to the air.)—J. T. (We do not know of any works devoted to the subject; but there are chapters on it in the standard works on physiology. Probably there may be some tractates which specially deal with the question of "kinship marriages," and no doubt an advertisement in the Wanted Column would elicit the information you require. A note addressed to some of the large booksellers would be the best way of getting at the prices of such works, if there are any dealing with the subject specially.)—Mikado. (See the indices of back volumes, as the various processes have been described. There is a work by Mr. W. T. Wilkinson, published by him at Otley, Yorkshire, which may be of use. It is entitled "Photo-Engraving on Zinc and Copper in Line and Half-Tone and Photo-Lithography." But there are several articles on the subject and on details in back volumes. Particulars of such arts are rarely published in book form.)—Evil. (The cost of a mirror in speculum metal can be ascertained on application to those who make such things. It would probably tarnish by exposure to sea air. Is it wanted for telescopic purposes, or for what? The methods of silvering glass mirrors for reflecting telescopes have been frequently given; but if a mere looking-glass is required, that has the reflecting agent preferably on the back of the glass. See the indices for methods of silvering flats and specula.)—Constant Reader. (No doubt "A. S. L." will give the most useful notes to use in the organettes, but the "scale" may be anything preferred by the maker.)—Reflector. (The usual method of silvering glass specula will be found on p. 471, July 15, 1887. Brashear's silvering process was given by him in the number for June 11, 1880.)—Anxious. (We think you will find all that is required in the numerous diagrams of telephone connections given in back numbers even recently. 2. Several electro-motors have been illustrated and described in back volumes.)—A Sufferer. (See indices about galvanic belts—the index of the last volume, for instance.)—Arthur Wilson. (Rouge, used by jewellers as a polishing powder, is simply sesquioxide of iron. It is prepared by roasting sulphate of iron over a slow fire, stirring with an iron rod continually, until it takes the form of a greenish-yellow powder. Crush and sift, and calcine in a new crucible, exposed to the heat of a smelting stove. As soon as the salt ceases to give off vapours, the rouge is ready for the further treatment, which consists in washing and settling, keeping the finer particles for use as jeweller's rouge, the coarser for polishing steel and other hard metals.)—Plant. (We presume you mean "Electric-Light Installations, and the Management of Accumulators," by Sir David Salomons (London: Whittaker and Co.), a work frequently mentioned in our columns. Any bookseller can procure that.)—H. E. (Information could be obtained from machine-makers in Sheffield. Devices of the kind are almost two hundred years old, and you will have a long list of patent specifications to search through to make a valid patent—that is, one that has not been anticipated in some point or other.)—Derby. (The ordinary rubber cement sold at all rubber shops and grindery stores will do. Or you may dissolve pure rubber in bisulphide of carbon, and use that.)—W. M. Hardie. (In type.)

Mr. Wm. Gunn, the celebrated Nottingham Cricketer, writing from the County Cricket Warehouse, 14, Carrington-street, Nottingham, says:—"You will be glad to hear that Harness' Electropathic Belt has quite cured the rheumatism that prevented me from playing football last winter, and it has been of great benefit in sustaining strength of nerve and endurance, which qualities are both of great importance to cricketers." The marvellous invigorating, health-restoring properties of this genuine Electric Belt are now well known. They give wonderful support to the spine and internal organs, are light and comfortable to wear, and are invaluable in all cases of nervous, muscular, or organic weakness. Descriptive pamphlet, book of testimonials, and consultation free of charge, either personally or by letter, on application to the Medical Battery Company, Limited, 52, Oxford-street, London, W. Those who cannot call should write at once.

Protective Lining for Boilers.—Dr. Carl Kelner, of sulphite pulp fame, describes a process which aims to facilitate the lining of boilers or digestors with an acid-resisting medium. It relates principally to the use for this purpose of blocks, slabs, or tiles in combination with a preparatory cement of composition. The *Chemical Trades Journal* says:—The first coating consists of a cement formed from ground slate mixed into a paste with silicate of soda or water glass. Dr. Kelner states the cement may be varied with the addition to the ground slate of burnt clay ware, such as broken tiles, bricks, &c., ground to a powder or mixed into paste with silicate of soda or water glass. Upon this cement as a foundation is applied—whilst it is in an adhesive state—blocks or slabs formed by preference of the following mixture:—About one part of ground slate, two parts of ground glass, and one part of Portland cement mixed into a paste with a solution of water glass. The blocks or slabs after being moulded are allowed to become dry, and are then placed in position upon the coating of preparatory cement, and the interstices filled in with the same mixture of which the blocks or slabs are composed. Instead of using blocks or slabs composed as above, a combination may be used with the preparatory cement of blocks or tiles made from toughened glass or from burnt clay or other compositions or materials which possess the requisite acid-resisting qualities.

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The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, DECEMBER 18, 1891.

LATHEWORK FOR AMATEURS.*—X.

(*Continued from page* 299.)

Turning Handles.

NOTHING is more useful to a beginner than turning handles for his tools. Therefore, as soon as he has acquired sufficient skill to turn a cylinder, he should by preference practise this work, because he who has acquired the skill to make a handle well may venture to turn all sorts of work on the dead-centre lathe. As it is supposed that he will require more than one trial before attaining success, he is advised to use only common woods at first. It is acknowledged that handles made of common woods are not very elegant; but when sufficient dexterity has been attained, it is easy to use hard or foreign woods instead.

Amateurs frequently make their tool handles uniform in shape. This gives a pleasing appearance when they are arranged in their racks; but the uniformity should not extend to the lengths and diameters of the handles, these being determined solely by the strength and size of the tools, which vary even in those of the same kind. It is apparent, for example, that a small gouge or a small chisel should net be fitted into handles like those used for large tools of the same kind, which require a greater force of leverage and greater means of resistance when they are used upon large work.

Without wishing to fix rules on this subject, it may be said that to make a handle, of whatever size it may be, the wood must be prepared, and mounted on the lathe, in the way explained when speaking of the cylinder. The piece is left from 1¼in. to 1½in. longer than the handle is required to be, and is roughed out with the gouge, leaving one end larger than the other, so as to be able to make at its larger end a pulley from ⅜in. to ⅝in. wide between the rims to take the driving cord. This pulley and the cord are placed on the left cone centre, so as not to necessitate changing the cord when the shaping of the work is proceeded with. The end to take the ferrule is cut in sharply at right angles to the axis; and a deep groove is cut, with the point tool, near the pulley; this determines the length to be given to the handle, and affords the means of being able to prepare and finish the head of the handle when the remainder is entirely completed.

The handle should be bored up for a great part of its length, to take the tang of the tool. Tang is the name given to the tail of all tools put into handles. As this hole should be central and straight, all methods of boring, other than on the lathe, are not to be depended upon; it is therefore indispensable to bore in the boring collar. For this purpose the ferrule of the handle is finished conically by rounding the sharp angle of this part. The right-hand poppet of the lathe is removed for a while, and in its place the poppet of the boring collar is fixed. The conical end of the handle is introduced into the large side of the hole in the cone plate, taking care that it fits tightly enough to turn without shaking, and to facilitate the rotary motion the cone is lubricated with soap.

The T-rest is placed at the front, the handle is turned by means of the bow, and through the narrow side of the conical hole in the boring collar it is bored the whole length of the tang of the tool. with a drill (see Fig. 122). Bored is this way the hole is always straight, and will serve, when the handle is finished, as a guide for the gimlets employed to enlarge it to the requiste size for taking the tool. When the amateur has become expert he will be able to understand that the use of the cone plate is not absolutely indispensable, and that it is possible to bore a handle on the dead-centre lathe without its aid. The T-rest, which is used for the running mandrel lathe, must then be used. The right-hand poppet is withdrawn, the T-rest is put in its place, facing the end of the handle to be bored. The bit which is to bore the hole is put into the little hollow cone in the end of the handle formed by the cone points just removed, then, holding it firmly bearing on the T-rest, the wood is put in motion.

As the bit penetrates it is forced forward, and when it is choked the handle is taken in the left hand and the bit is withdrawn to empty it; it is afterwards replaced in the hole, and the operation of turning recommenced. There is no occasion to meddle with the cord, which always remains in its place whilst the handle is being held. This method of boring is very convenient, and can be applied to other work than boring handles; but it requires practice and confidence.

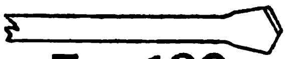
FIG. 122.

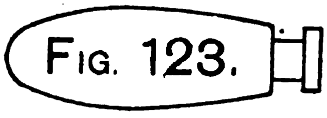
FIG. 123.

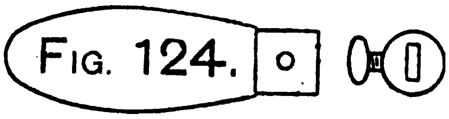
FIG. 124.

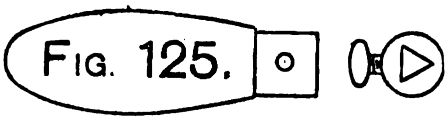
FIG. 125.

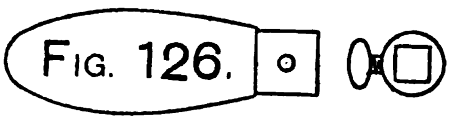
FIG. 126.

Ferrules for Tool Handles.

In order to give strength to a handle, and to prevent its splitting when the tang of the tool is driven in, it is very important to furnish it with a ferrule. A certain number of brass ferrules of different sizes should be at hand. One is selected and trued on one of its edges by putting it, for three-fourths of its height, on a piece of common wood, either turned or octagonal, which is put momentarily on the lathe in place of the handle. To chamfer the side of the ferrule a graver is used. The ferrule being withdrawn from the kind of mandrel on which it has been turned, the handle is replaced on the lathe. Then, taking the exact height of this ferrule by means of the calipers, cut in at right angles, or even slightly undercut that part on which it should rest. Then, either with the chisel or with a small gouge, make the tenon the requisite size, that is to say slightly larger at the upper part than shown by the calipers (using those known as dancing master, and illustrated on page 298, Fig. 121), with which the inside of the ferrule has been measured, and making the tenon of such a size that it will go in when forced.

Place the ferrule upright, the edge which has been turned uppermost, and present the handle to it. To make this enter strike it with a mallet on the opposite end, and continue to do so until the ferrule touches equally all round the shoulder made for it. Afterwards replacing the handle on the lathe, turn the ferrule on its surface, and chamfer the end, using the graver.

Ferrules of Cast Pewter.

This is the time to make known a more ingenious method of making ferrules for tool handles, it is to cast them in pewter on the handle itself. To do this cut a groove with the upper angle of the chisel at about ¼in. from the end of the handle; enlarge this groove with the lower angle of the chisel to about ⅛in. or ¼in. in depth. The same is done higher up at a distance of ⅜in. to ⅝in. Then with a medium-sized gouge remove the wood remaining between these two grooves, so as to leave a cylindrical groove as shown at Fig. 123, and slightly undercut.

Take the handle from the lathe, and in the circumference of the cylindrical groove make three or four very small hollows, 1/16in. deep at the most, by the aid of a very small gouge. Take a strip of a playing-card twice the width of the groove, and of such a length that one end may overlap the other slightly after having encircled the handle. Roll this strip on the groove so that each side of it overlaps the groove slightly on to the full wood. The strip is fixed by a wet string, making several turns round each side and knotted, taking care that it does not overlap the groove. With the point of a sharp penknife make a cross-shaped incision through the card and in the centre of the groove; then lift up the flaps of the crosspieces to form a kind of funnel.

Everything being thus prepared, in an iron spoon having a lip melt some hardened tin. In melting, the zinc or antimony, which are mixed with the tin to harden it, come to the surface and do not readily melt. To reduce them, the alloy to be melted must be covered with a rather thick layer of pulverised brick. Care must be taken to remove this before the material has cooled, because it would then form a crust, and remelting alone can enable it to be taken off. If antimony is used, one must not inhale the vapours of this metal, which are pernicious. When the pewter is hot enough, which may be known by the appearance of a skin of a greyish colour, or, properly speaking, the oxide which will form upon the tin, it is to be poured into the groove through the funnel made, taking care to pour in enough to leave a runner projecting outside, as otherwise the alloy on solidifying will become hollow at this point.

When the pewter is cooled the card is removed. If a projecting runner remains it may be taken off with a rasp or a float, and the handle replaced on the lathe. To turn this ferrule, a graver is used, and a flat chisel to finish with. The end of the handle is cut at right angles, and afterwards rounded to make it more elegant, and it is finished by bringing the wood level with the ferrule, which leaves in front of it a small circle of wood forming a kind of ornament, the appearance of which causes much astonishment by leaving the imagination to divine the means by which this ferrule has been inlayed in the wood. Turners who are clever and wise prefer iron ferrules. Those of tin soil the fingers, and those of brass smell badly. A gun-barrel furnishes beautiful and strong ferrules; the soft tenacious iron of these is very good for the purpose.

Ornamentation of Handles.

Many beginners think to give a certain elegance to their tool handles by overloading them with mouldings and all sorts of ornaments. Far from blaming this excessive luxuriousness, the abuse and inconvenience of which they will soon recognise, we approve of it in this way, that in practising themselves thus they become familiar with the tools, and prepare themselves to produce any of these ornaments with exactness on any work and materials to which they are suited.

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* "Lathework for Amateurs" is mainly adapted from "L'Art du Tourneur," by Desormeaux; but deletions and additions are numerous and extensive. The illustrations are new, and the treatise entirely remodelled.

Convinced by experience that lavish ornamentation on handles only inconveniences the workmen, we say that the method of making them most plainly is the better. A tool handle turned cylindrical for two-thirds of its length, narrowing uniformly up to the ferrule and terminating at its upper part in an elongated pear, regularly made, is the most convenient of all forms; because, sliding easily in the hand and having a swelling at its upper end, the workman can hold his tool better without fear of its slipping. An elliptic form without any moulding is very pleasing; these handles are called egg-shaped.

Finishing the Handles.

It now remains but to finish the handle at the end opposite the ferrule—that is to say, at the head. The notch near the pulley is deeped with the chisel, the wood being cut so as to make the pear part of the handle to the desired shape, avoiding leaving any ribs or irregularities. When nearing the thin part, which still holds the pulley to the handle, manage the foot-strokes carefully, because this part, having become weak through the incision, would not withstand much strain, and is liable to break. The least inconveniency of which would be disfiguring the handle by the roughness which would surely be left at the head of the handle.

Whilst the pulley is still left connected to the handle, the latter is finished as well as possible. It is polished, and the part which connects it is reduced to the smallest possible size, so that when it breaks, either naturally or by a shake given purposely, the roughness left by the break at the head of the handle can be cut away with a penknife, or some such tool, without showing any signs of the breaking, which might spoil the shape of the handle.

The details of the operations necessary for turning a tool handle have been greatly extended. But in this the purpose kept in view has been less the special object itself, which at first glance seems to be of no great importance, than to indicate more particularly the way to use to best advantage on all occasions the principal tools used on the dead-centre lathe. Therefore the repetition of details just given will be dispensed with when it is a question of other work to be done on this lathe. It has already been made clear that when an amateur has succeeded in acquiring the knowledge of turning a cylinder properly, and of shaping a handle, he may undertake any of the work that can be done in the dead-centre lathe.

Fitting Tools in Handles.

By means of the hole bored up the handle on the cone plate, the fitting of a tool into it becomes easy. First taking a small bit, slightly larger than the one used with the cone plate, the hole is enlarged to the bottom. Next, other bits of gradually increased size are successively used, and the largest part of the hole is made very nearly the size of the tang of the tool. All tangs of tools are tapering, and if the hole were parallel in all its depth, the tang, although it might be tight near the ferrule, yet it would be loose at the bottom, and would shake in the handle. Care must be taken not to allow the bits, as they grow larger, to enter more than enough to make the hole slightly conical. By this means the tang will be equally tight for all its length, and the tool thereby firmly handled.

When the drilling of the handle has been carried out to the desired extent, the tool is put in the vice, where it is firmly held with the tang upwards. The handle is put on and pressed as far as it will go by hand; then, taking a mallet, strike upon the head of the handle until the tang is entirely in. In this operation extremes must be avoided, because, if the tang drives too easily, the tool may come out of the handle at the least strain, and if forced too hardly the handle may be split.

In order that the jaws of the vice shall not damage the tool, it suffices to strike upon the handle; the tool being held hanging downwards, it will drive in from the effect of the rebound. This is an effect useful to know. A large log may be split with a chisel by first making it hold by a mallet-stroke, then, taking up the chisel with the left hand, and holding the log suspended, strike heavily with a mallet on the chisel handle; the log comes up of itself, and splits without causing the floor to shake.

There are few amateurs who have not in their workshops tool handles of some kind, called "universal" and "lazy-man's" handles. Two or three kinds are made; some for tools with flat tangs, such as files, chisels, &c.; others for triangular tools, which are very subject to breaking in their handles; others, again, for taking tools with square tangs. These three kinds are shown by Figs. 124, 125, and 126. Universal handles are not made with round holes, owing to the facility of handling tools with round tangs; moreover, there are very few of these.

Making Needle-Cases.

After having spoken of the cone plate, we are naturally led to touch on the manner of making needle-cases. It should be observed that what is now to be said about making needle-cases is particularly intended to instruct beginners. If all the processes described were gone through in making them, it would be difficult to understand how retailers who hold needle-cases at third hand can sell them at such a low price, including material. There must, therefore, be processes by which this kind of work is done much more quickly. There are factories in which needle-cases are not fitted together, being all made to uniform dimensions. A certain lot of workmen make the cases, whilst others make the covers, and others afterwards put them together. Those who do this last work have the cases on one side and the covers on the other; they then try them and fit them together.

Though needle-cases are generally considered to be work for the running-mandrel lathe, they can be easily made on the dead-centre lathe, especially by using the cone plate. For this work choose perfectly sound wood without any split or crack. After mounting a piece on the lathe, it is roughly shaped to a cylindricel form with the gouge. The length is divided into thirds, and that part on the right is reduced to the diameter intended for the neck of the needle-case. This should be as much less than the body part as it is intended for the thickness of the cover. This neck is turned with the greatest care, so that it may be perfectly cylindrical from end to end, and to succeed in this, after turning it with a small well-sharpened gouge, it is finished with a chisel, taking off but very little wood at a time, and taking care to gauge it frequently with the calipers.

Care will be taken to make at the left-hand end of the piece a pulley to receive the cord so as not to impede the progress of the tool on the work. The shoulder of the neck against which the covers should rest is smoothed with a graver and slightly undercut so that the edges will join better. Next the neck is polished with moist Dutch-rush, crossing the lines for fear of taking off too much in some places and not enough in others. When it is seen that all the lines are obliterated, the Dutch-rush is no longer moistened, but the polishing is continued till the neck is dry. Then the wood will be seen to become much paler in colour than it is naturally. This paleness is only due to the polishing material, which penetrates into the pores of the wood. To restore the natural colour it suffices to put one or two drops of olive oil on the neck, which is then rubbed rather hard with a woollen cloth, turning it the while to take away as much of this oil as possible, as if allowed to remain it makes an ugly polish, which becomes tarnished on being touched.

To polish with Dutch-rush, take from four to six pieces and break them at the knots; make a small bundle of them and use this, frequently plunging it into clean water. But care must be taken that the knots do not touch the part to be polished, because these being extremely hard would spoil the neck instead of polishing it.

Making the Cover.

Another cylinder of the same wood is turned to make the cover; but increased care must be exercised that it has no split or crack. This cylinder, for greater convenience, will be made larger than it is wanted, so as to make at its left-hand end a pulley to take the cord. When it is turned, the end which is to be hollowed to form the cover is made perfectly smooth, so that it may rest nicely on the shoulder of the body of the needle-case, and even this end should be slightly undercut. At a short distance from the end—that is to say, at a distance at least equal to the thickness of the cone-plate used—care will be taken to leave a shoulder suited for holding the piece in the cone-plate; the use of this will be explained.

When these two pieces are thus prepared, take away the right-hand poppet of the lathe, and in place of it put the cone-plate poppet. First take the piece intended to make the body of the needle-case, put the neck in one of the conical holes in the plate, which should hold it without shake. If a brass cone-plate is used, the inside will be smeared with a little olive oil; if a wood one, the inside will be rubbed with a little common soap. The pulley end of the piece is replaced on the cone point of the left poppet, and the neck is inserted in the cone-plate up to the shoulder which is to receive the cover.

Boring the Case and the Cover.

The needle-case is first hollowed with bits of different sizes until approaching that desired. Next use the side-tool, which cuts at the left side and at the end, holding it on the rest with the left thumb and gripping the poppet with the other fingers. The needle-case is hollowed out without altering the position of the tool in the slightest degree, so that it may be as true inside as it is outside. The tool will be withdrawn from time to time, and the distance measured on the outside of the needle-case to see if near enough to the bottom, which may be between ⅛in. and ¼in. thick. The neck will be reduced to a thickness proportionate to the quality of the wood, and the interior will be rounded off in such a way that it terminates in almost a sharp edge. The mouth of the needle-case will be polished dry, and in this state the inside and the neck are finished.

The cover remains to be made, and this is not an easier job. The piece intended to make the cover is put in a cone-plate, the hole of which will be equal in diameter to the body of the needle-case, measured outside. It is pushed forward up to the shoulder, which was mentioned in speaking of roughing out the cover. The cover is hollowed out with the same tools, and in the same way as the needle-case itself, making it slightly deeper than the height of the neck, so that this will not press against the top of the cover, and so hinder the needle-case from closing tightly. But as the cover should fit equally its whole length on the neck of the needle-case, here especial precaution must be taken to bore truly, and to fit the cover perfectly to the neck. For this the in-and-out calipers, Fig. 121, page 298, must be frequently used. There are several ways of testing the fit of these two pieces, which should appear as one when the needle-case is closed. First the cover should join perfectly all round the circumference of the shoulder which ends the neck. If this is not so, it proves that the shoulder or the end of the cover is not level or true. Next, if on sharply drawing off the cover, which has been put upon the neck, it does not ring, this proves that it is too slack, or that air enters through the parts not being perfectly round, either on the outer part of the neck or in the bore of the cover.

Finishing the Outside.

When the needle-case has been finished inside, it only remains to turn the outside. To accomplish this, close the case, which should fit sufficiently tightly to withstand the strain it will receive in the process of turning in finishing and polishing. To make it bind, rub a little chalk upon the neck before closing it. Replace the two pieces thus united upon the dead-centre lathe, and put the cord on the pulley which is at the bottom of the needle-case. First take off with a small gouge, and then with a chisel, the shoulder and all the inequalities which remain upon the surface of the needle-case. Bring this surface to a perfectly cylindrical form, and polish it in the manner explained in speaking of the neck.

If it is decided to leave the ends of the needle-case square, use the upper angle of the chisel to cut it at a sharp angle at the place marked for this purpose. This, as already stated, should leave a thickness of wood from ¼in. to ⅛in., taking the precaution to measure as indicated in speaking of the cylinder. If it is desired to finish the ends by rounding them off, this rounded part will be formed by a point tool, well sharpened.

If, in spite of the precautions taken to guard against it, a roughness is left at the ends, caused by the breaking off of the pulleys when the connecting part has been turned down very small, a small arbor can be made and mounted on the cone-plate by a shoulder. Then, turning this arbor first to the size of the inside of the cover, finish the end of the cover without leaving the slightest signs of the rupture; next turn the arbor down to fit the body of the needle-case, and treat it the same.

Many amateurs ornament the needle-cases they make with rings of ivory and shell, and even inlay the necks with these materials. These ornaments cannot be well done except on the running mandrel lathe, and cases which are so ornamented should be considered more particularly as work for this lathe. We pass them over for the present, not wishing to anticipate, as we are now confined to work which belongs to the dead-centre lathe.

Another Method of Making Needle-Cases.

There is another way, both quick and sure, of making a needle-case on the dead-centre lathe. It is as follows: Take two boring bits of different sizes, the larger for making the cover, the smaller for making the case. With the smaller bit bore a piece of wood to a depth of about 2½in., more or less, according to the length desired for the case. Then turn a small arbor chuck, which will serve for as many cases as desired. The arbor, made of wood, will be 3in. long, and will have at its left end a pulley for placing the cord. The right end will be a true cylinder 2in. long, and precisely the same diameter as the hole made by the smaller of the two bits. When it is made, force it into the hole in the case, into which it should fit sufficiently tight to carry the piece round with it. Then, leaving the remainder in the rough, the neck of the needle-case is turned, reducing it to exactly the diameter of the large bit—this may be gauged by means of the calipers. The neck finished, bore with the larger bit another piece of wood to a depth exceeding the length of the neck by ¼in. Remove the arbor and push the neck into the cover, then put the whole on the lathe, so as to smooth both the needle-case and the cover together.

The only difficulty encountered in this operation is that of centring exactly. This is overcome in the first case, for the body part, by carefully watching the motion of the arbor. If it does not turn straight, the case is not properly centred. See which side projects, by placing one finger on the rest; that part which touches should be pushed towards the centre. This operation, though difficult to explain, is easy enough to perform. As to the cover, this is more difficult, but here the needle-case serves as a guide. This method of making needle-cases quickly is good when a large number are to be made, otherwise it is better to use the running mandrel lathe.

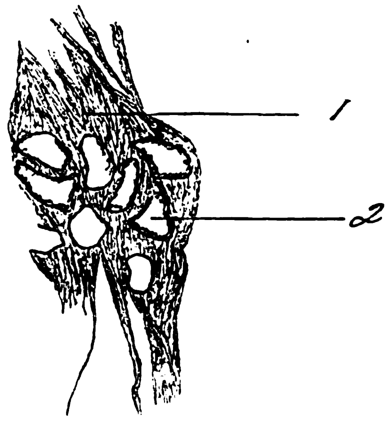
In factories workmen display their skill on needle-cases. I have known a turner who boasted of making fifty an hour. I have never witnessed such feats, and confess I should not give entire credence to this man. He nevertheless often surprised me with proofs of rare dexterity. I have seen him make an embellished snuff-box, polished and varnished, in twenty minutes; but before endeavouring to make so quickly, I ask my readers to endeavour to make well.

(To be continued.)

PRACTICAL MICROSCOPY FOR STUDENTS.—XI.

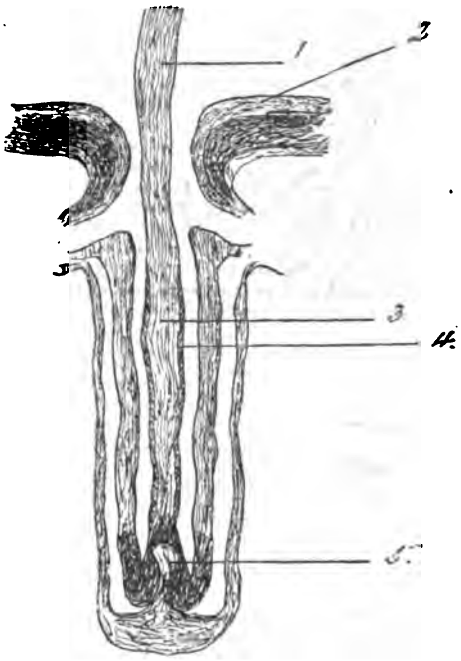
By Frederick Davis, B.Sc.

It now becomes our duty, for the right understanding of the various tissues to examine, the epidermis, or outer layer of the skin. We find externally a hardened or horny layer, termed the "Stratum Corneum," consisting of several layers of flattened cells, destitute of a nucleus, and separated in layers by interstratal spaces filled with air. These spaces are merely narrow clefts, the upper layer being in a constant state of desquamation. Beneath this we have the stratum called the Stratum lucidum, which is composed of similar flattened cells as the external layer, excepting that a flattened or very much compressed nucleus may be seen in each cell, and after traversing several layers of these horny cells we arrive at the portion known as the Rete mucosum, or Stratum malpighii. The upper portion is observed to be much flattened, and around each nucleus we have granules of an elliptical shape, considered to be an intermediate character of protoplasm and keratin. The epidermis is possessed of no blood-vessels. The actual growth of the epidermis occurs in its deeper layers, the cells of which become pushed upwards and flattened, and occupy the place of those which, in the process of desquamation, have become rubbed off and removed from the outer surface. Beneath the epidermis we have the dermis. This portion is well supplied with blood-vessels, and is possessed of the sense of touch; it is also provided with an abundance of nerves, termed peripheral nerves; in and beneath this layer we find the sudoriparous, or sweat-glands, provided with ducts, and beneath these the fat cells.



Connective Tissue showing Fat Globules.—1, Connective tissue; 2, Fat globules.

The sense of touch is due to the so-called tactile papillæ. These permeate to the epidermis, and, in consequence, the portion of the epidermis where these bodies exist is much thinner than elsewhere. Sometimes we find a mass of these papillæ; it is then termed a tactile corpuscle. We have, in addition to the organs enumerated, the sebaceous glands. These glands are well supplied with blood-vessels, called blood capillaries, and are generally lobular in shape and very minute; they are found over the entire surface of the body, more especially hairy parts, but are not observable upon the soles of the feet or palms of the hands; it would appear to be their duty to empty their secretion into the hair follicles for purposes of nourishment. The secretion consists of an oily or fatty substance. The layer containing these glands is sometimes called the "Stratum adiposum."



Human Hair.—1, Hair shaft above the skin; 2, Horny layer of skin; 3, Cortical portion of hair; 4, Cuticle; 5, Papilla.

Reverting to the structure of the sweat or sudoriparous gland, we find them to be of about $\frac{1}{300}$in. in diameter, provided with a duct which passes entirely through the corium to the external air. These ducts are regulated by nerves which, as we know, in a state of excitement become relaxed, with the consequent result that the sweat is poured out more rapidly, and appears in globules or beads of perspiration upon the surface of the skin. Such a state of affairs is called sensible perspiration; but if the secretion evaporates from the surface of the skin as quickly as it is formed, we apply the term of insensible perspiration.

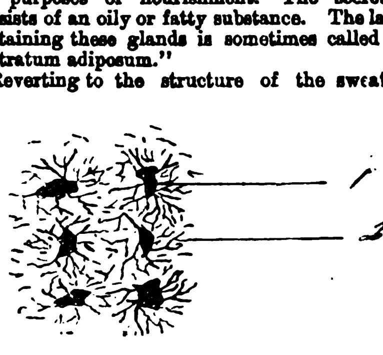
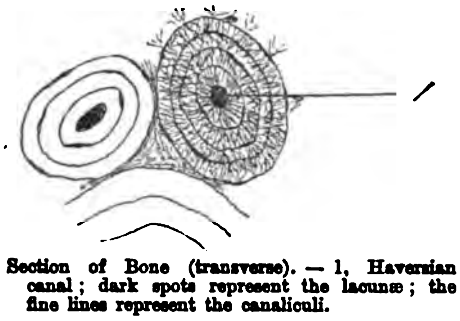


Diagram of Lacunæ and Canaliculi of Bone.—1, Lacunæ; 2, Canaliculi.

It is assumed we have about two millions of these ducts upon the surface of the body. The ducts themselves consist of a portion termed the "lumen," and lined with a delicate structure called the cuticle.

This terminates our examination of the skin proper; but we have in addition certain modified forms, such as nails and hairs; these are composed of a substance known as "keratin," which is a form of albumen and sulphur—it is, in fact, nitrogenous matter. The student may have observed the curious odour produced by burning either hair or nails, which will at once carry his thoughts to the shoeing-forge, where the smell produced by the burning of the horse's hoof is essentially the same—in fact, the horny substance of the hoof is keratin. Let us examine a "hair." We shall see that under the microscope its characters are very different to the appearance it presents to the naked eye. We shall observe the root of each hair is placed in the so-called hair-sac, at the base of which we find two sebaceous glands; these glands pour out their oily nourishment for the support of the hair-shaft; this shaft by growth is pushed further and further above the epidermis of the skin until at a certain period of its existence it gives off a little bud at its base; it then ceases growing itself, and awaits the arrival of the new hair to occupy the position previously held by itself, and then dies down or becomes brittle and breaks off. This, in health, goes on continually, one hair taking the place of the other; but in certain cases the new ones cease to be formed, and the individual, in case of human beings, becomes "bald."



Section of Bone (transverse). — 1, Haversian canal; dark spots represent the lacunæ; the fine lines represent the canaliculi.

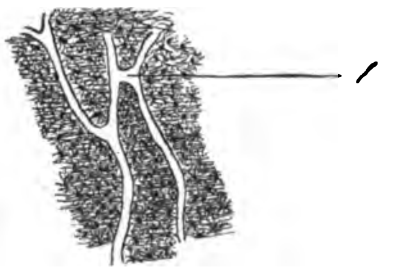
The hair-shaft consists of essentially three layers or portions, the central termed the medulla, an intermediate layer or cortical portion composed of elongated cells and, the cuticle. The colour of the hair is produced by pigment cells.

For purposes of study the hairs or wool from the neck of the sheep should be examined. Any butcher will supply the student for a few pence with a piece of the skin with the wool attached from this part of the animal, which, having in his possession, soak for some time in spirit until well hardened, having previously removed the hair or wool, then imbed in paraffin wax as before described, and cut a thin section, when the hair-sacs, with the position of the shaft, will be well defined. The sebaceous glands will also be evident with their oily secretion. It is to this oily substance contained in the wool we give the name of wool fat, adeps lanæ; or when mixed with 30 per cent. of water, Lanoline. Connective tissues may be divided into groups—namely, fibrous tissue, cartilage, and bone.

Fibrous, generally called connective, tissue is found between every organ of the human body, and forms the bulk of ligaments and tendons of every kind. It also exists in the sclerotic portion of the eye. It consists of fibrous, wavy masses, which, by treatment with acetic acid, may be divided into fibrillæ.

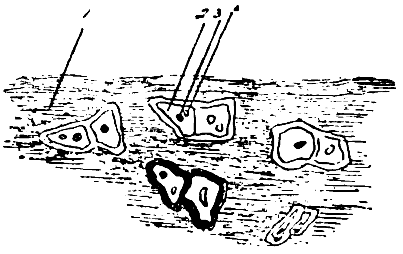
The student should obtain a ligament of any animal, preferably a rat or rabbit, cut a very small portion, and heat with a little salt solution; when cold, place upon a slip to examine under a cover-glass in the ordinary manner: it will be found to consist of a number of wavy fibres of a whitish-grey colour If now we let fall upon it, after removing the cover-glass, a drop of acetic acid, the filaments will become extended, swollen, and transparent; frequently flat globules will be found intermingled. Cartilage is different in its structure. Physically, it is elastic and firm, rather more bluish in colour than fibrous tissue, and formed of cells, which are nucleated, between which we observe globules of fat, and separated from one another by the intercellular substance, which gives the characteristic firmness and elasticity of this substance.

Cartilage may be cut sufficiently thin for microscopical purposes without imbedding, its substance being strong enough to resist the razor or microtome; the best to examine is that obtainable from the rib-muscle, called physiologically costal cartilage. Bone is very beautiful and interesting; chemically it consists of animal tissue, in which phosphate and carbonate of calcium have deposited themselves, causing the animal substance to become hard. If we take the thigh-bone of any animal and cut it across with a saw as thinly as possible, then rub upon a stone with powdered pumice until it is very thin, being careful to keep it moist during the process with water, and after this take a piece of cork, place the bone upon a hone and rub gently for some time, we shall obtain a section sufficiently thin for the microscope. Care must be taken, however, after this treatment to wash out all particles of grit by water and a camel-hair pencil from the interstices; place the specimen thus prepared upon a slip and examine. We shall observe a vast number of small dots or holes; these are the blood-vessels which supplied the bone with its nourishment, physiologically termed Haversian Canals; around these we have the bone substance arranged in distinct strata, called lamellæ. The whole of this arrangement is the so-called Haversian system. In addition to this system we find other little pores, called lacunæ, and minute lines issuing from these, termed canaliculi. This, then, constitutes the essential characters of bone. The student should not, however, rest until he has also prepared a longitudinal section, and compared carefully with the transverse.



Section of Bone (longitudinal).—1, Haversian canals.

The bone is encased in a layer of tissue known as the periosteum. In the fœtus the cartilage receives the deposits of salts at a very early period excepting in certain parts, the salts of calcium eventually becoming deposited throughout its substance. The entire process is termed ossification. The deposit takes place first at the extremities and centres of the cartilage and connective tissues, then gradually filling in the remaining portions. This is the method in the healthy subject; but in some cases, as in rickets, we find the exremities of the bone receive larger deposits than other portions. This produces nodes or excrescences, generally at the joints.



Cartilage.—1, Matrix; 2, Cartilage cell; 3, Nucleus; 4, Fat globule.

GEOLOGY FOR STUDENTS.

By EDWARD AVELING, D.Sc. Lond., Fellow of University College, London.

Chapter XIX.—Classification of Animals

(*Concluded.*)

IN the preceding chapter we studied the chief divisions of the kingdom Vegetabilia, as given in Table X. (p. 256), and then gave in Table XI. the chief divisions of the kingdom Animalia. Of these we considered, in Chapter XVIII., the sub-kingdoms PROTOZOA, PORIFERA, CŒLENTERATA, ECHINODERMATA. In the present chapter, the four higher sub-kingdoms, and the classes belonging to them, will be briefly dealt with.

For convenience of reference, I repeat the Table in question:—

Kingdom.	Sub-Kingdom.	Division.	Class.	Example.
ANIMALIA.	Protozoa		*Gregarinida.*	Gregarina.
			Rhizopoda.	Rotalia.
			Infusoria.	Paramœcium.
	Porifera.		Plethospongiæ.	Spongilla.
			Calcispongiæ.	Grantia.
	Cœlenterata.		Hydrozoa.	Hydra, Sertularia.
			Actinozoa.	Actinia, Coral.
	Echinodermata	Echinozoa.	Echinoidea.	Echinus.
			Asteroidea.	Starfish.
			Ophiuroidea.	Brittle star.
			Holothuroidea.	Sea cucumber.
		Pelmatozoa.	Crinoidea.	Pentacrinus.
			Cystoidea.	Hemicosmites.
			Blastoidea.	Pentremites.
	Annulosa.	Scolecida.	*Platyelmia.*	Tape worm.
			Nematelmia.	Round worm.
			Rotifera.	Wheel animalcule
		Anarthropida.	*Gephyrea.*	Spoon worm.
			Myzostomida.	Myzostoma.
			Annelida.	Earthworm.
			Chætognatha.	Sagitta.
		Arthropida.	Crustacea.	Lobster.
			Arachnida.	Spider.
			Myriapoda.	Centipede.
			Insecta.	Cockroach.
	Molluscoida.		Polyzoa.	Entalophora.
			Brachiopoda.	Rhynconella.
			Tunicata.	Ascidia.
	Mollusca.		Lamellibranchiata	Oyster.
			Gastropoda.	Snail.
			Polyplacophora.	Chiton.
			Scaphopoda.	Dentalium.
			Cephalopoda.	Cuttlefish.
	Vertebrata.		*Leptocardia.*	Amphioxus.
			Pisces.	Salmon.
			Amphibia.	Frog.
			Reptilia.	Lizard.
			Aves.	Fowl.
			Mammalia.	Cat.

ANNULOSA. Ringed animals. *annulus*, a ring. This sub-kingdom has three divisions.

The division Scolecida includes the parasitic worms that infest other animals, and also the Wheel animalcules met with in water where plants have been some time present. σκωληξ

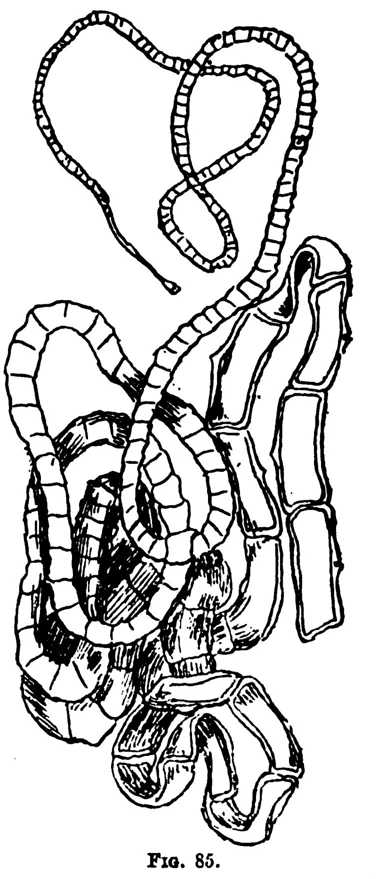


FIG. 85.

(skolex), a worm. This division has three classes.

Class 15. *Platyelmia.* πλατυς (platus), flat; ελμινς (helmins), an intestinal worm. Tape-worm, Fig. 85.

Class 16. *Nematelmia.* νημα (nema), a thread. Round worm, Fig. 86.

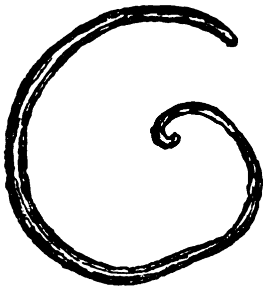


Fig. 86.

Class 17. *Rotifera.* *rota*, a wheel; *fero*, I carry. Aquatic animals, never longer than $\frac{1}{25}$ in.; met with in vegetable infusions. They take their name from the circles of cilia (see Class 3, Infusoria, p. 256) at one end of the body. These, in active movement, give the appearance of revolving wheels. Wheel animalcule, Fig. 87.

None of these three classes, either by habit or structure, admits of preservation in a fossil state.

The division Anarthropida includes worms generally—not parasitic. The limbs of animals belonging to this group are not jointed. α (a), without; αρθρον (arthron), a joint; πους, ποδος (pous, podos), a foot. This division has four classes.

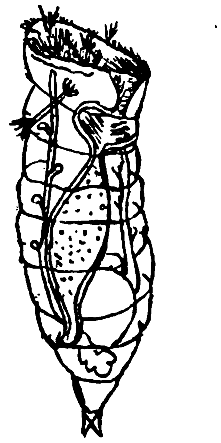


Fig. 87.

Class 18. *Gephyrea.* γεφυρα (gephura), a bridge. The Sipunculus or Spoonworm (Fig. 88) that burrows in the sands of most European seas, or dwells in the shells of class 30, the Gastropoda. Not known as fossils.

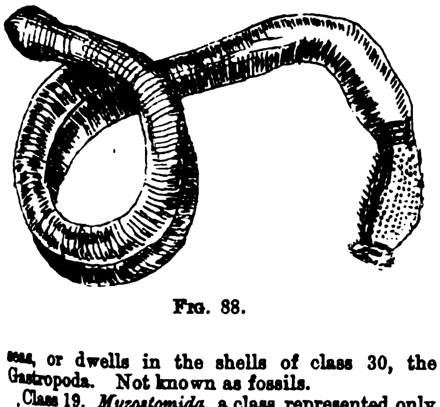


Fig. 88.

Class 19. *Myzostomida*, a class represented only by Myzostomum, a curious parasite upon the Crinoidea (Class 12, p. 257). μυζω (muzo), I suck; στωμα (stoma), a mouth. In Fig. 89 a Myzostomum is shown upon one of the arms of a crinoid

Class 20. *Annelida.* *annellus*, a little ring. The earthworm, leech, and their allies. Neither the earthworm nor the leech can be preserved as a fossil; but the Tubicola, an order of this class, play an important part in palæontology. *tuba*, a tube; *colo*, I inhabit. Aquatic or shore animals with shells of chalk or sand or pieces of other shells, from the free open end of which a proboscis and breathing apparatus can be extruded. Fig. 91.

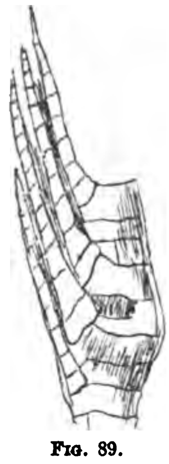


Fig. 89.

Class 21. *Chætognotha.* χαιτη (chaite) hair; γναθος (gnathos), a jaw. A class only represented by Sagitta (Fig 92), a singular marine animal, about an inch long, transparent, with usually six sets of bristles near the jaws, and a delicate fin-like tail. Not represented among fossils.

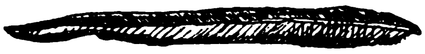


Fig. 90.

The division Arthropida includes four classes, whose members have jointed limbs.

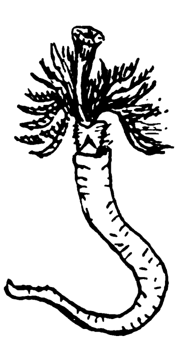


Fig. 91.

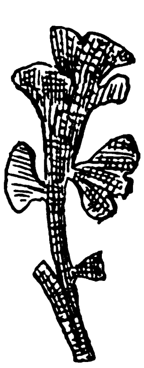


Fig. .

Class 22. *Crustacea.* *Crusta*, a crust. Examples: lobster, crab, barnacle, water flea.

Class 23. *Arachnida.* αραχνη (arachne), a spider. Examples: Scorpion, cheese mite, spider.

Class 24. *Myriapoda.* μυριος (murios), countless; πους (pous), a foot. Examples: Millipede and centipede.

Class 26. Insecta. *insectus*, cut into. Insects.

The sub-kingdom Molluscoida includes three classes that lie between the Anarthropida (worms) and the Mollusca (soft-bodied animals). *Mollis*, soft; ειδος (eidos), likeness.

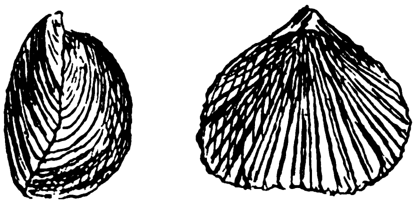


Fig. 93.

Class 26. *Polyzoa.* πολυς (polus), many; ζωον (zoon), an animal. Colonies of minute animals, such as the sea-mat (Fig. 92). In this respect, of living in associations, the Polyzoa resemble the compound Hydrozoa (class 7), p. 256, and the corals of the Actinozoa (class 6); but the individual members of the Polyzoa colonies are much more highly organised than the individua members of the Cœlenterate colonies.

Class 27, Brachiopoda. βραχιων (brachion), anl arm. "Lamp-shells," with two long fleshy arms, really extensions of the foot, one on each side of the mouth. A very important class, palæontologically speaking. The skin or "mantle" of these sea animals secretes a bivalve shell of calcareous matter. The two valves of the shell (see Fig. 93, left), are placed against the front and back of the animal (are ventral and dorsal), and are of unequal size. On the other hand, a line drawn from edge to edge of one valve (right, Fig. 93) divides the valve into equal parts. Rhynconella, represented in Fig. 93, left, and Terebratula are well-known forms.

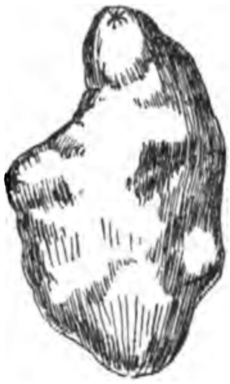


Fig. 94.

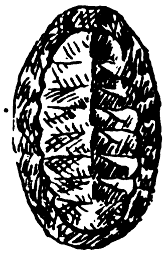


Fig. 95.

Class 28. *Tunicata*, or Ascidioida. Tunicata, on account of the leathery integument, or tunic. Ascidioida, because Ascidium (Fig. 94), the bag-like sea animal, with two openings seen attached to rocks, is a typical form. ασκος (askos), a bag. The class is of no importance palæontologically, as its members do not persist as fossils. It is of importance genealogically, as, possibly, the original offshoot from the invertebrate animals (without back-bone) that was the primary ancestral form of the Vertebrata, or back-boned animals, was allied to the Tunicata.

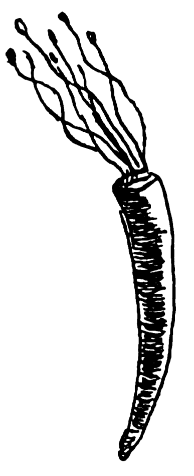


Fig. 96.

The sub-kingdom Mollusca, or soft-bodied animals, comprises five classes.

Class 29. *Lamellibranchiata.* *lamella*, a plate; βραγχια (branchia), a gill. Animals with flat, plate-like gills and a bivalve shell. The valves of the shell are placed against the sides of the animal, and are of equal size. On the other hand, a line drawn from edge to edge of one valve of an oyster-shell, e.g., divides the valve into unequal parts. Oyster, mussel, scallop.

Class 30. *Gastropoda.* γαστηρ (gaster), stomach. Animals with a univalve shell and the alimentary canal extended into the foot. Snail slug, limpet.

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PRACTICAL ELECTRO-PLATING.—I.

By [illegible]

IN these papers I shall endeavour to give [illegible] electro-plating.

Although these papers are written chiefly for the benefit of amateurs and jewellers, who may require to deal with small work, I shall endeavour, in a future article, to give such particulars of the plant, &c., used in large establishments, as may be useful to those who contemplate working on a large scale.

Before commencing operations, it will be as well to perform the following simple experiments, which will give a good idea of the theory of electrolysis. If two small pieces of platinum are connected by conductors to the poles of a battery, and immersed in water (which may be slightly acidulated with sulphuric acid to increase its conductivity), it will be seen that the water is divided, by the passage of the current through it, into its two elements, oxygen and hydrogen; the former will rise in bubbles round the plate that is connected to the positive (carbon), and the latter round the plate that is connected to the negative (zinc) pole of the battery. The two pieces of platinum are termed "anode" and "cathode" respectively, and the acidulated water, or other solution used, the "electrolyte." If, instead of water, a solution of sulphate of copper is used, and the platinum anode replaced by one made of copper, the oxygen will no longer rise to the surface of the solution, but will combine with the copper, forming oxide of copper; at the same time, part of the copper sulphate becomes reduced to its metallic form, and is deposited on the cathode, setting free the acid with which it was combined, which, in its turn, at once dissolves the oxide formed on the anode, thus keeping the solution in exactly the same state. On carefully weighing both the anode and cathode, it will be seen that the former has lost in weight exactly what the latter has gained. Much the same action takes place (with very few

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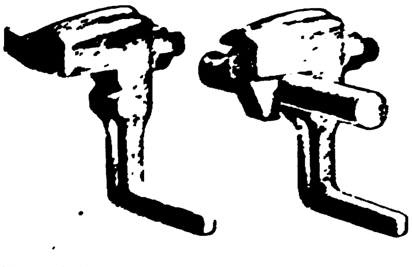
(To be continued.)

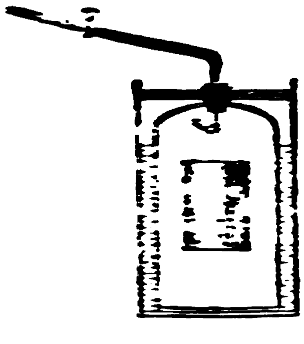
A NEW LATHE DOG.

WE give with this two views of a new lathe dog, which, as will be seen, differs quite essentially from the usual construction. It consists of the outer frame, which is a steel casting, and a bolt which in form resembles what is known as a gib-bolt, which is tightened upon the work by the nut at the back. It will readily be seen that this dog can be placed over the work at any point after it is in the lathe, or that it can be put between collars. It also has a wide range with respect to the sizes it will hold, four of them usually including as wide range of sizes as are covered by twelve dogs of the ordinary pattern. The bolt is made of cast steel, hardened. The dogs are made in four sizes, to take work from ¼in. to 3in., by N. S. Ashworth and Co., Amber and Adams-streets, Philadelphia, Pa.—*American Machinist.*



SIMPLEX GAS GENERATOR.*

THIS new pattern gas generator possesses several advantages over those now in use. It may be used equally well to prepare hydrogen, carbonic acid gas, chlorine (using the compressed chloride of lime), or sulphuretted hydrogen. The last mentioned can best be prepared by using commercial hydrochloric acid, mixed with an equal bulk of water. [illegible] delivers [illegible] generator, and [illegible] The parts [illegible] half jar [illegible] with the solid and [illegible] almost half-full. The [illegible] may be any size or shape, provided it is not [illegible]. Any part of the apparatus can be had separately [illegible]



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* By C. G. Moor in *Chemical News.*

THE ESTIMATION OF FAT IN MILK.

VERY numerous attempts have been made to accurately and rapidly determine the quantity of fat contained in milk. Hitherto one or other of these requisites has had to be sacrificed; speed and scientific accuracy are difficult to combine. Yet to the analyst who has every day to report on many samples of milk for trade purposes, such a method is essential.

A process which at present seems to meet that desired is described in the December number of the [illegible]:—

Mr. A. W. Stokes, public analyst to Paddington, uses a small vessel consisting of a [illegible]c.c. flask, having a neck [illegible] long and [illegible] diameter. This is surmounted by another flask of [illegible]c.c. capacity, terminating in a mouth of [illegible] diameter. Into this [illegible] grammes or [illegible]c.c. of milk are placed; this is then heated on the water-bath, or over the lamp, to near boiling; hydrochloric acid is now poured in roughly up to the [illegible]c.c. mark, a little below the beginning of the neck. The mixture is boiled over a flame for about one minute, left hot for three minutes, then cooled by placing it in a basin of water. Its shape causes it to float, so that there is no danger of its being immersed. When cool it is filled with ether up to about the middle of the upper bulb, a cork is inserted in the mouth, and the whole violently shaken. On letting it stand for about three minutes, it will be found that the brown acid liquid comes up to about the middle of the neck, with a very slight layer of fluffy white casein between it and the clear, ethereal solution above. Taking out the cork, a double glass tube arrangement, like that of the ordinary wash-bottle, is inserted; the longer tube of this is forced down till it almost touches the casein layer. A weighed flask is placed under the upper end of this tube, and by blowing into the other tube the ether-fat solution is driven into the weighed flask. About [illegible]c.c. fresh ether is placed in the apparatus, the whole is shaken, allowed to settle about three minutes, and the ether added to the first quantity by the same means. Another shaking up with and separation from ether leaves the acid liquid practically free from fat. The weighed flask is connected to a condenser, the ether is distilled off and recovered, the flask is placed in the air-bath for about 15 minutes to dry, and is then weighed. The increase of weight gives the quantity of fat in 10c.c. or in 10 grammes of milk. If the latter quantity were originally taken, it is only necessary to multiply the weight of fat by 10 to get the percentage. If 10c.c. of the milk were originally taken, the weight of fat must be divided by the specific gravity of the milk, and then multiplied by 10.

The results obtained are excelled in accuracy by no other method; while for speed, cheapness, and ease of working with whole milk, skim milk, cream, sour milk, and condensed milk (sweetened or unsweetened) no other method at present can compare with this. The whole process can be completed in about 30 minutes.

STATIC ELECTRICAL MOTORS.

THE devices of Mr. Wimshurst are watched with much attention in the United States, and the following developments by Mr. W. McVay, of New York, which we find in the *Scientific American*, will interest those who are experimenting with these remarkable machines. For instance, Mr. McVay employs two glass discs, each 12in. diameter; the

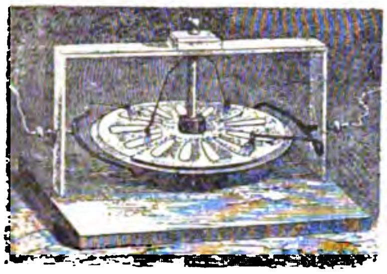

Fig. 1.

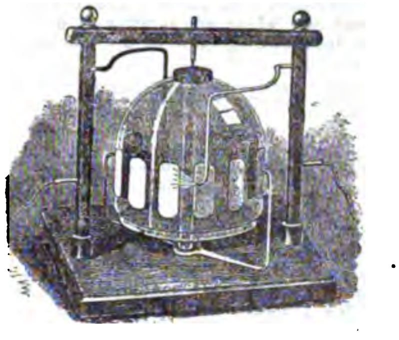

Fig. 2.

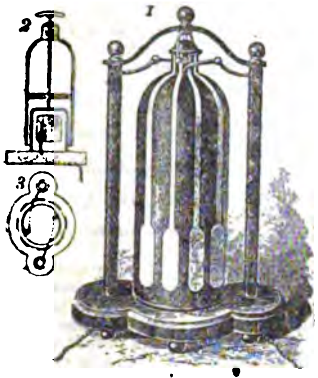

Fig 3.

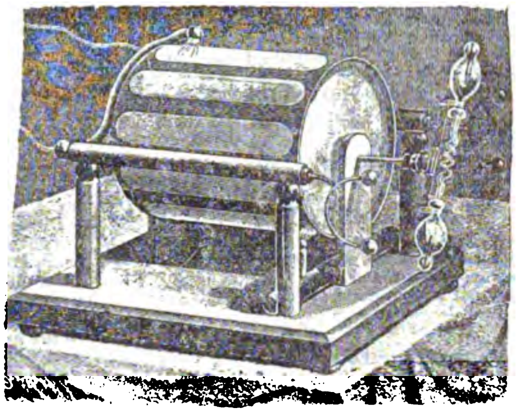

Fig 5

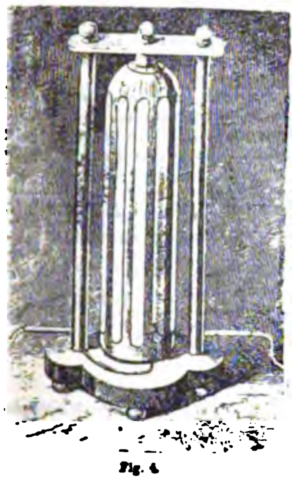

Fig. 4.

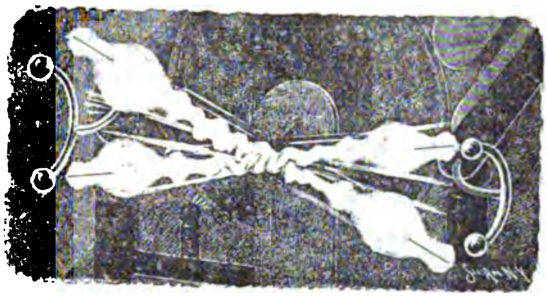

Fig. 6.

upper one, which rotates, bears upon its upper surface sixteen tinfoil sectors, 3in. in length, and in width from ¼in. at the *inner* ends to ⅝in. at the *outer* ends. The lower disc, which is stationary, carrying the 90° sectors, is supported 4in. above the base by a piece of hard rubber tubing. The spindle to which the upper disc is attached is also of hard rubber. The metallic conductors, supported at either side of the discs by the standard of the frame, have each two arms, bearing at their extremities small brushes made of tinsel. One arm of each conductor passes under the lower disc, Fig. 1, and presses its brush against one of the 90° sectors of the stationary lower disc, and the other arm is extended over the upper disc and presses its brush lightly against the sectors of the rotating disc as they pass. When the sectors of the rotating disc are brought into contact with a brush carrying a charge of electricity of one sign, they become similarly charged, and are, consequently, attracted by the sector on the lower disc, which is constantly charged with electricity of opposite sign. The equalising rod, the position of which may be seen in the illustration, serves to discharge the sectors and put them in a neutral condition preparatory to their being recharged.

The motor may be made to turn with equal velocity in an opposite direction by connecting both sets of charging brushes with one pole of the machine and attaching the conductor from the opposite pole to the equalising rod or by "grounding" the rod. In fact, it is a very accommodating motor, willing to do anything within its power to oblige. It occurred to Mr. McVay that there was no good reason for an adherence to the form of motor adopted by Mr. Wimshurst, and as a result he has produced four motors of his own design, which we illustrate. They furnish an excellent example of the evolution of an idea. In Fig. 2, Mr. McVay employs two glass shades as substitutes for the glass discs. The smaller shade is supported by a glass tube, and is stationary, while the larger one is placed over it and turns on a point fixed to the top of the inner shade. Our artist has done his work so well that further explanation of the construction is not deemed necessary. A more elegant design is shown in Fig. 3. This motor stands about 19in. in height, and has the appearance of being constructed entirely of hard rubber and brass. A glass shade is also used in this case; but instead of utilising another shade as a carrier of the 90° sectors, as in Fig. 2, an inverted battery jar serves the purpose, and at the same time furnishes a support for a glass spindle upon which the cylinder turns. Thin brass brushes are substituted for the tinsel used in making contacts in the previous motors. When one sees this motor in operation, running, as it does, at a high rate of speed, it seems incredible that the motive power is static electricity.

Fig. 4 is so simple in its construction that the principle upon which it works can be understood at a glance. In the construction of this device a glass shade is also employed. It carries upon its surface eleven strips of thin sheet brass about 6in. in length, and ¼in. in width. In this case the pillars at either side serve the same purpose as the 90° sectors in Figs. 1 to 3, as they are constantly charged with electricity of opposite sign, and consequently there is a strong attraction between them and the sectors carried by the cylinder when they become charged in turn by coming in contact with the brushes, which are so situated that they come in contact with the sectors when the latter are about an inch away from the pillars—which, by the way, are also of brass. The speed attained by Fig. 4 is remarkable; and when it becomes thoroughly charged it shows such a decided inclination to leave its base that it has to be held down.

In Fig. 5 we have the static electro-motor in its most efficient form. It does actual work, and is here shown rotating a Geissler tube, which is lighted by the same machine that furnished the power for the motor. The optical effect of the rotation of the tube is shown in Fig. 6. This motor is constructed entirely of brass, rubber, and wood, and consequently is less fragile in appearance, and is suggestive of real power.

The cylinder of this motor is of hard rubber, and is 6in. in length and about 4½in. in diameter, with brass sectors ⅜in. in width running along the full length of the cylinder. The cylinder has a $\frac{3}{16}$in. iron rod passing through it. The rod has steel ends where it comes in contact with the brass bearings. The supports for the cylinder are of hard rubber, as are also the supports for the pole pieces, which will be seen at either side of the cylinder. The dielectric used as a covering for the pole pieces is sheet rubber. The points at which the sectors receive their charges may be seen at the right hand side of the cylinder, at the rear, and at the left hand side of the front end. The position of the Geissler tube is well shown in the accompanying illustration. The projections from the ends of the pole pieces are for the purpose of lighting the tube, which presents a very weird appearance in a darkened room. The subject of the motive-power of static electricity is one filled with interest for the student and well worthy of attention. Mr. McVay has in mind a modified form of Fig. 5, from which he hopes to obtain greater efficiency and a decided improvement in appearance.

LESSONS IN THE DIFFERENTIAL CALCULUS.—III.

By Richard A. Proctor, B.A., F.R.A.S.

Author of "Other Worlds than Ours," "Sunviews of the Earth," &c., &c.

AGAIN, notice how the differential coefficient implies the rate of change. We know that cos. x is unity, or has its greatest value, when $x = 0$. As x changes from 0, then the sine changes fastest. Again, cos. x is nought when x is a right angle, and very small when x is nearly a right angle. Hence the sine changes very slowly as the angle is passing the right angle.

I leave the reader to prove by a similar construction that,

If
$$y = \cos. x,$$
$$\frac{dy}{dx} = -\sin. x.$$

Obviously also, if
$$y = a \sin. x$$
$$\frac{dy}{dx} = a \cos. x.$$

and if
$$y = a \cos. x$$
$$\frac{dy}{dx} = -a \sin. x.$$

We could also easily prove in the same way, but for the present it will suffice to state that—

If $y = \tan. x$
$$\frac{dy}{dx} = \sec.^2 x$$

If $y = \cot. x$
$$\frac{dy}{dx} = -\operatorname{cosec.}^2 x$$

If $y = \sec. x$
$$\frac{dy}{dx} = \sin. x \sec.^2 x$$

and if—
$$y = \operatorname{cosec.} x$$
$$\frac{dy}{dx} = -\cos. x \operatorname{cosec.}^2 x$$

And plainly that—

If $y = a \tan. x$
$$\frac{dy}{dx} = a \sec.^2 x$$

If $y = a \cot. x$
$$\frac{dy}{dx} = -a \operatorname{cosec.}^2 x$$

If $y = a \sec. x$
$$\frac{dy}{dx} = a \sin. x \sec.^2$$

and if $y = a \operatorname{cosec.} x$
$$\frac{dy}{dx} = -a \cos. x \operatorname{cosec.}^2$$

These are all the simple functions whose differential coefficients the beginner is likely to require. (In another lesson I shall add the few which remain.)

But the great point remains. How are we to find the differential coefficient of complex functions and functions of functions? Here I wish to lay down the rules in an easily-remembered way, without giving the proof; the reader can study the latter at a later stage.

Here, then, are two rules, which include all the cases. Let not the reader be alarmed at the long words; the illustrations which follow will explain what is meant.

First, *to determine the differential coefficient of a composite function differentiate each component function as if the rest were constant, and add the results.*

Secondly, *to determine the differential coefficient of a function of a function, differentiate with respect to the latter, and multiply the result by the differential coefficient of this latter function.*

Note.—It is hardly necessary to remark that if the differential coefficient of any expression is known, the differential coefficient of a times the expression (a being a constant quantity) is also known, being a times as great.

To illustrate the first rule, take the following cases:—

Required the differential coefficient of $a + x - x^2$ with respect to x. The differential coefficient of a is 0; that of x is 1, that of $- x^2$ is $- 2x$. Hence—

If
$$y = a + x - x^2$$
$$\frac{dy}{dx} = 1 - 2x.$$

Again, put
$$y = (a + x - x^2) \sin. x.$$
Then the differential coefficient of $(a + x - x^2)$ is $(1 - 2x)$, and the first portion of the required coefficient is therefore
$$(1 - 2x) \sin. x.$$

Again, the differential coefficient of $\sin. x$ is $\cos. x$. Hence the second part of the required coefficient is
$$(a + x - x^2) \cos. x.$$
We add according to our first rule, and so we get
$$\frac{dy}{dx} = (1 - 2x) \sin. x + (a + x - x^2) \cos. x.$$

Now, to illustrate the second rule, though we shall presently have to go back to the first:—

Let
$$y = (\sin. x)^n.$$
Here y is a function of $\sin. x$. So that by second rule we treat $\sin. x$ as if it were the quantity with respect to which y is to be differentiated. We know that if y were equal to x^n, its differential coefficient would be x^{n-1}. Hence, in this case, we have for the first factor of our coefficient $n (\sin. x)^{n-1}$. But the rule tells us we are to multiply this by the differential coefficient of $\sin. x$—that is, by $\cos. x$. Hence we have finally
$$\frac{dy}{dx} = n (\sin. x)^{n-1} \cos. x.$$

Take another case.

Let
$$y = (a^2 + x^2)^{\frac{1}{2}}.$$

Here it is a function of $(a^2 + x^2)$. Hence by the second rule we treat $(a^2 + x^2)$ as if it were the quantity with respect to which y is to be differentiated. If y were equal to $x^{\frac{1}{2}}$ we know that its differential coefficient would be $\frac{1}{2}x^{-\frac{1}{2}}$, or $\frac{1}{2x^{\frac{1}{2}}}$. Hence the first factor of the required coefficient is $\frac{1}{2(a^2 + x^2)^{\frac{1}{2}}}$. We are to multiply this by the differential coefficient of $(a^2 + x^2)$—that is, by $2x$. Therefore we have finally
$$\frac{dy}{dx} = \frac{2x}{(a^2 + x^2)^{\frac{1}{2}}} = \frac{x}{\sqrt{a^2 + x^2}}.$$

Yet one more case of the second rule.

Let
$$y = \frac{1}{\sin. x}$$
We know that if y were equal to $\frac{1}{x}$ or x^{-1} its differential coefficient would be $- x^{-2}$, or $- \frac{1}{x^2}$. Hence the first factor of the required coefficient is $- \frac{1}{(\sin. x)^2}$. We must multiply this by the differential coefficient of $\sin. x$, that is by $\cos. x$. Thus we get finally:
$$\frac{dy}{dx} = - \frac{\cos. x}{(\sin. x)^2} = - \cos. x \operatorname{cosec.}^2 x.$$
This, be it noticed, is one of the results tabulated above. But observe specially that the differential coefficient of the reciprocal of any quantity may be shown in precisely the same way to be the reciprocal squared multiplied by the differential coefficient of the quantity taken negatively. For example:—

If
$$y = \frac{1}{a^2 + x^2}$$
$$\frac{dy}{dx} = - \frac{1}{(a^2 + x^2)^2} \times 2x = \frac{- 2x}{(a^2 + x^2)^2}$$

And now finally (so far as the present lesson is concerned) let us take a case in which both the above rules are applied.

Let
$$y = \frac{\sin. x}{\cos. x}$$

By the first rule we get at once the first portion of the required coefficient. For treating $\cos. x$ as a constant we take the differential coefficient of $\sin. x$, that is, $\cos. x$, and get the first portion—viz., $\frac{\cos. x}{\cos. x}$ or 1.

For the second part we treat $\sin. x$ as a constant, and have to multiply it by the differential coefficient of the other factor $\frac{1}{\cos. x}$. By what was shown in the preceding case, this is $- \frac{1}{\cos.^2 x} \times - \sin. x$, or $\frac{\sin. x}{\cos.^2 x}$. This multiplied by $\sin. x$ gives for the second portion $\frac{\sin.^2 x}{\cos.^2 x}$. Hence the required differential coefficient is
$$1 + \frac{\sin.^2 x}{\cos.^2 x} = \frac{1}{\cos.^2 x}.$$

Now let the reader note that by the same method we get in any case where one function is divided by another, the following value for the differential coefficient:—
$$\frac{\text{numerator's dif. coef.}}{\text{denominator}} - \frac{\text{numer.} \times \text{denomtr's dif. coef.}}{\text{denominator})^2}$$
that is
$$\frac{\text{numr.'s dif. co.} \times \text{denom.} - \text{denom.'s dif. co.} \times \text{numr.}}{(\text{denominator})^2}$$

It is well to remember that this rule, usually given independently, is a case of the application of the two rules given above.

We have now had a good deal of rule-stating and rule-illustrating; let us begin to apply some of the rules to a few problems of maxima and minima. Probably some readers who have begun to grow weary may be induced, when they see the value of the rules, to master them more thoroughly than they have yet done.

A sphere has a radius, r. What is the greatest right cone which can be inscribed in the sphere?

Let B D (Fig. 3), the height of the cone A B C, be x. Then D C, the radius of the base, is a mean proportional between B D and D E. That is
$$DC = \sqrt{x(2r - x)}.$$
Hence the area of the base
$$= \pi x (2r - x),$$
and the content of the cone
$$= \pi x (2r - x) \times \frac{x}{3} = \frac{\pi x^2}{3} (2r - x).$$
(I assume a knowledge on the reader's part of the relations between the content and surface of cones, cylinders, spheres, and so on.)

Now put y for content of cone—that is put
$$y = \frac{\pi x^2}{3} (2r - x),$$
and find the differential coefficient of y according to the first rule. We can write it down at once, thus,
$$\frac{dy}{dx} = \frac{2 \pi x}{3} (2r - x) - \frac{\pi x^2}{3}$$
(The reader will see at once that the two portions of this value are obtained by the first rule given above).

Now so long as by increasing x, y increases, we have not a maximum cone. Hence, since the differential coefficient expresses the rate of increase, we must have $\frac{dy}{dx} = 0$,

or
$$\frac{2 \pi x}{3} (2r - x) - \frac{\pi x^2}{3} = 0,$$
that is
$$2x (2r - x) = x^2,$$
or
$$4rx = 3x^2. \ldots\ldots\ldots\ldots \text{(i.)}$$
This gives $x = \frac{4r}{1}$, and therefore D must be where it is shown in Fig. 3, or D E must be equal to twice O D. The reader will notice that (i.) is also satisfied if $x = 0$. We see that when $x = 0$, the volume of the cone is also nought. This is a minimum, not a maximum value. It is clearly quite as necessary that the differential coefficient should vanish to give a minimum as to give a maximum. In all cases like the present, and, indeed, in nearly all the most useful simple applications of the calculus, the conditions of the problem itself show us when we have a maximum or a minimum. There *are* rules for analytically determining this; but I shall not trouble the reader with them. He sees in this case that the content of the cone starts from 0 when the height is 0, to 0 again when the height is $2r$; hence at some part of the passage from 0 to 0 the cone must have a maximum value; and the above process shows him (what he could not readily find by any other) that the cone has its maximum value when shaped as in Fig. 3.

Let us now take a case where we want to find a minimum value.

A person is in a boat, B (Fig. 4) three miles from the nearest point A, of a straight shore-line, C D. He wishes to reach E, a point five miles from A, as quickly as possible. He can walk five miles an hour, but only row four miles an hour. Where must he land?

Suppose F is the point where he should land, and call A F x. Then B A is perpendicular to C D.

And
$$BF = \sqrt{BA^2 + x^2} = \sqrt{9 + x^2}.$$
Hence time taken in traversing B F is $\frac{\sqrt{9 + x^2}}{4}$

Again
$$FE = 5 - x,$$
and time taken in traversing F E is $\frac{5 - x}{5}$.

Thus if y = total time occupied in reaching E, we have
$$5 = \frac{\sqrt{9 + x^2}}{4} + \frac{5 - x}{5}.$$

Now, following the two rules we have above, we get readily,
$$\frac{dy}{dx} = \frac{x}{\sqrt{9 + x^2}} - \frac{1}{5}.$$
This expresses the rate at which the time increases as F is moved away from A. One can see that when x is very small the value of $\frac{dy}{dx}$ is negative, since a negative increase is decrease. This shows that our man will get to F more quickly by landing to the right of A (close by) than actually at A. And as long as $\frac{dy}{dx}$ continues negative this shortening continues. But as x increases, we reach at last a value for which $\frac{dy}{dx}$ ceases to be negative and becomes positive, passing through the value *nought*. When x has that value, the shortening has reached its utmost; so that to obtain the maximum we require, we have only to solve the equation,
$$\frac{x}{4\sqrt{9 + x^2}} - \frac{1}{5} = 0.$$
$$\text{or, } 5x = 4\sqrt{9 + x^2},$$
$$\text{i.e., } 25x^2 = 16 (9 + x^2 = 1)$$
$$= 144 + 16x^2.$$
This gives
$$9x^2 = 144$$
$$3x = 12$$
$$x = 4.$$
So that our traveller must land four miles from A, or one mile from F.

We see that whether for a maximum or minimum we must equate $\frac{dy}{dx}$ to zero. The question itself will show whether a maximum or minimum exists for the deduced value of x.

One more example will close the present lesson.

The captain of a racing boat has a vacancy in his crew, and is desirous of so filling it as to counterpoise the boat as much as possible on the side of the new comer. The breadth of the thwart to be filled is 2ft.; assuming a man's weight to be proportional to the space he occupies on the thwart, and that a man who would occupy but half the thwart weighs six stone, what would be the best weight for the new oarsman?

Let A C, Fig. 5, represent the width of the thwart, A M that of the rower. Let $AM = 2x$, so that the man's centre of gravity is over G, where $GA = \frac{1}{2} AM = x$.

Then the man's weight is proportional to the cube of x, and may be represented by mx^3. (The m will not trouble us.) And the moment y of the man's weight around the centre line of the boat's length is
$$= mx^3 \times GB,$$
or $y = mx^3 (1 - x)$. Since $AB = 1\text{ft.}$

Hence, following first rule given above,
$$\frac{dy}{dx} = 3mx^3 (1 - x) - mx^3.$$

We must equate this to zero, giving
$$3mx^3 (1 - x) = mx^3,$$
or
$$3 (1 - x) = 1$$
$$3x = 2$$
or
$$2x = \frac{4}{3}.$$

This must be the amount of thwart occupied by the oarsman if his weight is to be most effective. Since a man occupying a width of 1ft. of thwart would weigh six stone, our oarsman should weigh
$$6 \times (\tfrac{4}{3})^3$$
or,
$$\frac{128}{9}$$
i.e. 14st. 3⅓lb.

SUGGESTIONS IN PHOTOGRAPHY.*

THE field of photography has been enormously enlarged by the perfection of the different methods of artificial illumination. An entirely different class of subjects is rendered available, and persons whose business monopolises all of the day-

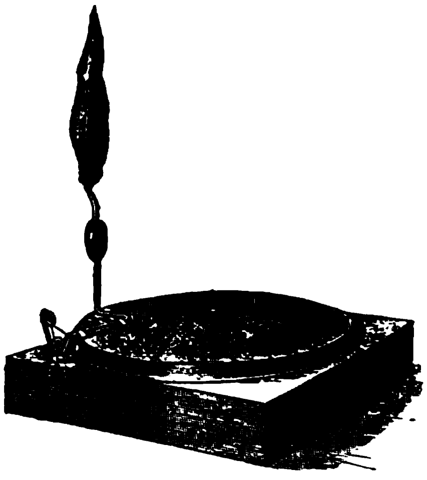

FIG. 1.—Simple Flash Light.

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* By GEO. M. HOPKINS, in the *Scientific American*.

light are furnished opportunities for the gratification of photographic tastes, provided their ambition does not lead them to a desire to "take all out of doors" at night.

In times past, some fault has been found with flash-light pictures on account of the anxious expression of the subject caused by the expected explosion of the powder, or the closed eyes which are characteristic of pictures secured by flash lights that are not practically instantaneous.

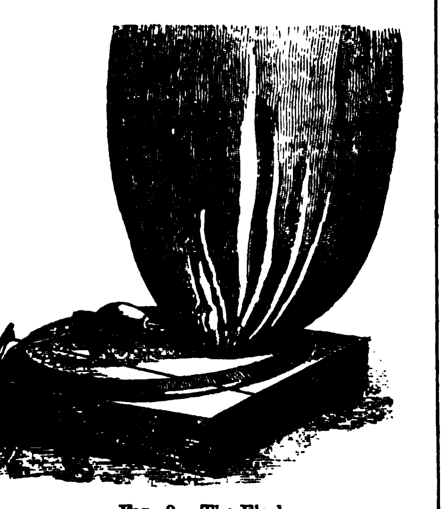

Fig. 2.—The Flash.

It follows that a flash light must do its work "quicker than a wink," and that it must be ignited by some device other than a fuse or strip of paper, either of which gives warning and thus puts the subject on guard. Flash-light lamps are undoubtedly good; but, so far as the writer is aware, they are all limited in certain ways. In the first place it is necessary to compress a bulb to force air through a greater or less length of tube. This requires some effort on the part of the operator, and practically prohibits him from including himself among his subjects. If he does attempt to do this, the rubber tube leading from the bulb to the lamp must necessarily form an unsightly addition to the picture; and, furthermore, the tube is limited as to its length, on account of the air friction, which so reduces the blast in a tube of considerable length as to entirely defeat the operation of the light.

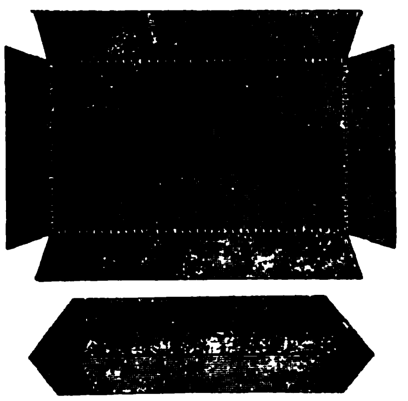

Fig. 3.—Inexpensive Tray.

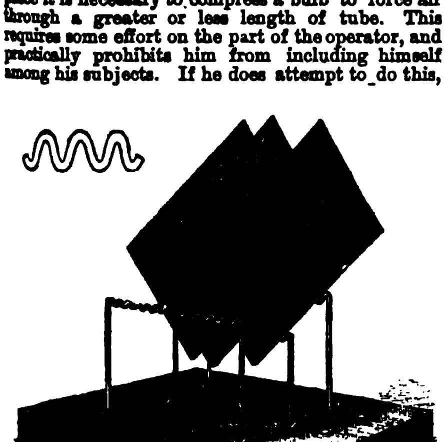

Fig. 4.—Plate Rack.

After enumerating these objections to the ordinary flash-light lamp, it is perhaps unnecessary to allude to the matter of expense. However, the lamps range in price from 1·50dol. upwards.

In Figs. 1 and 2 is shown flash-light apparatus, the cost of which is practically nothing, as the needed materials may be purchased for a few cents, and the labour involved is a matter of only a few minutes. A description is hardly necessary; the engravings tell the whole story.

Two loops soldered to the bottom of a small tin pan receive a wire, which is bent at one end, forming a spiral, into which is inserted a little roll of asbestos. A fish-line sinker is placed on the wire previous to bending, and near the pan the wire is bent to form a shoulder, which holds the wire in a stable position when raised, as shown in Fig. 1. The other extremity of the wire is bent at nearly a right angle and formed into a loop, then returned to form a practically T-shaped arm with an open eye at its extremity. A stout black thread of sufficient length to reach as far as may be required is tied in the loop.

At the point in the surface of the pan where the asbestos strikes when pulled over, a shallow cavity is formed by burnishing the tin with a rounded instrument like a tool handle, the tin being placed over a cup, a box cover, or something of that kind, which will support the metal around the cavity during the operation of burnishing.

The pan is secured to a heavy wooden block or to any fixed support by means of two or three tacks driven through its rim. One or two boxes of Blitzpulver should be placed in the cavity in the tin; a few drops of alcohol are poured on the asbestos; the apparatus is placed on a step-ladder or other high support, which is located at the side of the camera in such a position as to prevent the light of the flash from entering the camera tube. A large piece of white paper is suspended at the back of the apparatus, and from 18 to 24in. distant. If the operator is not included among the subjects, the black thread is simply connected with the lower loop, so that a rearward pull of the thread will tilt the wire arm forward. If the operator desires to include himself in the picture, the thread is slipped into the eye at the end of the wire, so that pulling the thread from the front will tilt the wire arm forward. Now, everything being ready, the alcohol is lit, the operator takes his position, pulls the thread, and the thing is done.

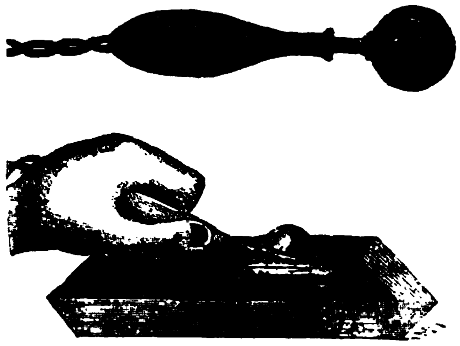

Fig. 5.—Electric Tray Illuminator.

When the subjects are so posed with reference to the source of light as to produce undesirable dark shadows, this trouble may be avoided by arranging newspapers so as to reflect more or less light on the shaded side.

To secure good flash-light pictures, two things in addition to a good instrument are required: one is an instantaneous light of sufficient intensity, the other is an instantaneous plate of the kind known as isochromatic or orthochromatic.

Among the items of expense in the list of the amateur photographer's supplies will be found trays for developing, fixing, intensifying, toning, &c., and the temptation is often great to make one or two trays answer all purposes; but modern photography forbids the double use of trays, so that the operator must either purchase or make trays for himself. In Fig. 3 is seen, in the upper figure, a pasteboard blank, which, when creased as indicated by the dotted lines, bent up and fastened at the corners by pieces of cloth glued inside and outside as shown, forms a foundation for a serviceable tray. All that is required to complete the job is to fill the pores of the pasteboard and cloth with paraffin.

There are two ways of doing this. One is to dip the tray into paraffin melted in a pan of suitable size; the other way is to melt the paraffin by means of a hot iron, and allow it to drop on the pasteboard, afterwards spreading it with the hot iron. In either case a liberal supply of paraffin should be left in the corners. Paraffin candles will furnish the material for saturating the tray when paraffin in bulk is not available.

In Fig. 4 is represented a simple, easily made, and efficient negative rack. It consists of thin wire frames pivoted to the base-board, and provided with corrugations for receiving the edges of the plates.

In Fig. 5 is shown a method of dark-room illumination, which permits of examining the negative thoroughly during the process of development without unduly exposing the plate. It consists of a two-candle power incandescent lamp attached to a handle, and inclosed by a hemispherical reflector closed at the front with a disc of dark-ruby glass. The lamp is held near the plate. All of the light is thrown downward, so that the eyes receive only the light reflected from the plate. Furthermore, only a small section of the plate is exposed to the light at any time. When the lamp is not in use in the manner described, it is either laid face down on the table, or suspended so as to light the dark room.

THE PHYSIOLOGY OF TEARS.*

NO object has yielded more poetry than that of tears. The statement often made that insane persons do not shed tears is not all true, but there is some truth in it. I have seen the insane weeping, but I must admit that on visiting the wards of great asylums there is a remarkable absence of weeping in comparison with the noise, irritation, and wandering of intellect that is forced on the attention. Also I have known a sane person who became insane, owing to a great calamity of grief, overwhelmed with weeping while the sanity remained, but perfectly and persistently tearless when the insanity was manifested, a result that may appear natural when the physiology of weeping is properly understood.

Tears are the result of a nervous storm in the central nervous system, under which there is such a change in the vascular terminals of the tear-secreting glands that excretion of water from the glands is profuse. Some excretion is always in process in order that the surface of the eye may be laved and cleared of foreign matters which may come in contact with it; but the controlling centre is at a distance. As the muscular power that extends or flexes a finger is at a distance from the part moved, so the excitement to tears is from an irritation in a distant nervous centre, and is removed when the nervous centre is either soothed or exhausted. The persons who weep say that tears afford relief. Nothing is more perfectly true, nothing more clear when the facts are understood. The relief comes, not from the mere escape of tears, which is only a symptom, but from the cessation of the storm in the nervous chain. If the storm be calmed by soothing measures, as when we soothe a child that is weeping from fear, annoyance, or injury, we quiet the nervous centres, upon which the effect ceases. In children the soothing method succeeds, and sometimes it succeeds in adults, although in adults the cessation of tears is more commonly due to actual exhaustion following a period of nervous activity. In grief, the afflicted weep until they can weep no more; then they become calm, or, like children, cry themselves to sleep. Thus tears indicate relief, and that the nervous system has fallen into the repose of weariness. Persons subjected to many and repeated griefs shed in time fewer tears, and the aged compared with the younger are almost tearless. The poor insane patient who ceases to weep becomes griefless; under the continued excitement the grief centre fails or dies. If this were not the case tears would flow in such a person so long as life lasted. Tears have their value in the life of mankind; they are of value not as tears, although their actual flow gives relief, but as signs that the grief centres are being relieved of their sensibility, and that the nervous organisation is being fitted to bear up against sorrow.

Respecting the nervous excitation which calls forth tears, I have noticed how little it is due to physical pain. It is called forth by fear, by anxiety, by affection, by grief, but not even by pain extending to agony. In the days preceding the use of anæsthetics I have seen patients who were undergoing surgical operations faint; I have heard them cry out and scream until they made the bystanders sick and pale, but they rarely, if ever, shed tears. The parturient woman in the acme of her "great pain and peril" may suffer the extremest physical agony, under which her cries are piercing, but she rarely sheds tears. Indeed, I never recollect seeing the most nervous of her class, under such circumstances, shedding a tear. Strangely, however, during the sleep induced by an anæsthetic like chloroform or ether, I have seen profuse tears, not from suffering, but from some emotional dream induced by the narcotic.

A very slight emotional disturbance will induce the nervous irritation leading to tears in susceptible subjects, and this although the catastrophe has nothing to do, intrinsically, with the person affected. Hence the commotion of tears conjured up in a play. Hamlet, it will be remembered, seizes aptly this point when the player weeps. "What's Hecuba to him, or he to Hecuba?" Of course nothing, yet the player weeps, and maybe the audience weeps with the player. By art another remembrance may be used to call forth tears on the proper occasion. A well-known player was asked how he managed to weep when he willed. He replied, "I call up the remembrance of my dear father, who is dead." On the other hand, anything that produces diversion of mind, when the disturbance is not severe, may keep back the outbreak. John Hunter tells us that once when he went to the play to see Mrs. Siddons perform, in a moving exposition of her great powers, he could not join the rest of the house in their tears "because he had forgotten his pocket-handkerchief"; and a friend of my own, an emotional man, told me that at a funeral, where he expected to be overwhelmed with tears, he was completely checked by an absurd reading which the parish clerk gave to a sentence of the service. In these facts there is nothing incompatible, because the more intense the nervous vibrations the more easy is the diversion of impulse from one centre to another.

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* Extracted from an article in the *Asclepiad* by Dr. B. W. Richardson.

As a rule, the escape, and free escape, of tears, relieves the heart, and saves the body from the shock of grief. Tears are the natural outlets of emotional tension. But there are exceptions to this rule, and I have more than once seen uncontrollable weeping followed by serious systemic disturbance, affecting principally the heart and circulation. I have known intermittency of the heart induced in this way, and assume the most serious character.

Change of scene, mental diversion, and outdoor life are the best remedies for the tearful, but an opiate judiciously prescribed is often the sovereign remedy. Other narcotics are injurious. Alcohol, so often resorted to, is fearfully injurious. It disturbs and unbalances the nervous system, keeps up a maudlin and pitiful sentimentality, and sustains the evil. Alcohol is the mother of sorrow. There are other narcotics which are similar in effect, notably chloral; but an opiate given at night-time, under necessity, not only soothes, but controls, and when prescribed so that the use of it shall not pass into habit, is a divine remedy.

It is one of the most curious of natural phenomena that mere imagination can excite the nervous system into the production of tears, without any external aid or reflex. The readers of a pathetic chapter of a fiction may weep over the pages without wonder, because the cause of tears has been raised before the mind; but is it not strange that the writer who made the fiction may be enforced to weep over it, and cannot, in fact, expect anyone else to weep over it unless he is himself affected by the picture he has drawn? Such facts place mind or the immaterial essence of humanity over and above, and over and preceding, our material nature and all its functions. They lead us to the suspicion that we might exist, think, and feel, without this mortal coil at all; or, as if, at best, the mortal coil were nothing more than an instrument, doing the bidding of the *ego*, clumsily or refinedly, according to its form, and no more; as if there might be material forms of finer build; angelic forms, as the old books have it, amongst whom tears are unknown.

I have often wondered whether the lower animals shed tears as men and women and children do? It is in the order of physiology to suppose that every animal that secretes a fluid for the laving of the fore part of the eyeball might, under emotion, throw out an excess of secretion, and shed tears; and I have often heard sympathetic people and children say of animals they were fond of, that such animals wept on the loss of those to whom they were attached, on deprivation of some pleasure, or on receipt of punishment. This statement is made most frequently in regard to dogs, but I could never, in my own observation, arrive at evidence sufficient to confirm it. Animals cry, men weep, would be my interpretation of the argument; and well it is so, for if animals wept at the harsh treatment they are subjected to by nature, as well as man, there would soon be none to weep. That some of them have emotions and moments of sorrow cannot be doubted; but they have no continued memory of the emotion—no recurring pictures that recall it. They forget even their offspring after the briefest periods, and they do not weep from physical pain. The picture of the tear in the eye of the hunted deer is pathetic, and by the reflex may make some weep. But the tear is the sweat of fatigue, not the sign of emotion.

As tears are secreted by glands which lie between their nervous centre and the mucous surface of the eyeball; as they have two functions or duties—one the function of relieving nervous tension, the other of laving the eyeball—so these functions may be called into overaction by internal nervous impulses or vibrations, and by external excitations or what are sometimes called reflex actions. The first is seen in the act of weeping under emotion, the vibration starting in the nervous centres, and extending to the gland from behind, urging it to action; the second is seen in the act of shedding tears from direct irritation of the mucous surface of the eyeball, as when an irritating substance "gets into the eye," and the vibration extends from the mucous surface back to the gland, exciting it to action and causing emotionless tears. In these ways tears afford a good illustration of the mode in which the nervous fibres are capable of conveying to a secreting organ exciting impulses from both sides of a gland lying in their course, and having in connection with it afferent and efferent communications. In both cases the exciting impulse is a vibration; and as when the impulse sets forth from a mere external irritation, as from a particle of dust on the conjunctiva, the effect is in the truest sense mechanical, so, probably, in the case of the emotional irritation, which calls forth tears, the process is as purely mechanical.

In the human animal tears are most easily wrought where the sympathetic nervous system is most developed and most impressionable, and when the three great emotions—fear, grief, and joy—are most active. Hence women are generally more given to tears than men, and under the peculiar state called hysteria, in which the nervous system is at highest tension, are often seen moved to tears by the three emotions, in turn, during one paroxysm.

It has been a matter for discussion why tears are always being secreted in health for the lubrication and laving of the eyeball. That this constant process is active is shown by the copious loss of tears over the cheek whenever the lachrymal duct, by which the secretion is naturally borne away from the conjunctival surface to the nasal cavity, and so to the throat, is closed up. But what keeps up the secretion? I suspect the small trace of saline substance that is present in the tears is the cause. The salt keeps up just a sufficient irritation to give an impulse back to the gland, a reflex, sufficient to sustain the necessary function. During sleep, when the eyes are closed, and there is little evaporation from the conjunctival surface, this irritation will be subdued, and tears will cease like other functions. So sleep cures tears, as it "knits up the ravelled sleeve of care."

USEFUL AND SCIENTIFIC NOTES.

THE best illustrated catalogue of conjuring tricks we have seen this season is that issued by W. and F. Hamley, of 231, High Holborn, W.C. A vast number of elegant and ingenious apparatus are figured and described, and the amateur and professional will alike find the list indispensable.

PARLIAMENTARY notice has been given by a new and independent company of its intention to promote a Bill in the next session of Parliament for powers to construct an electrical underground railway, commencing by a junction with the Great Northern Railway at Finsbury Park, and terminating in the City about the centre of Finsbury-pavement. Powers will also be sought to run into and use the Finsbury Park Station of the Great Northern Railway Company.

New Fluid for Natural History and Microscope Work.—Mr. A. Haly, of the Colombo Museum, has been experimenting with carbolicised cocoanut oil as a preservative. His experience, he states, seems to show (it does not do to speak too confidently in a climate like that of Ceylon) that it is one of the most perfect preservatives known, both for form and colour. Cocoanut oil and carbolic acid freely mix in all proportions. The mixtures at present under trial are oil raised to the specific gravity of 10° and 29° below proof spirit by the addition of acid. While the gum and glycerine process is absolutely useless for any animals except certain families of fish, this mixture is good for every kind of vertebrate. The most delicate frogs are quite uninjured by it, and snakes undergo no change. The delicate plum-like bloom on the geckoes, the fugitive reddish tint on such snakes as *Alabes humberti*, are beautifully preserved by it. Another most important use is in the preservation of large fish skins, which can be packed away in it for an indefinite period, and mounted when wanted. These skins do not require varnishing, neither do they turn brown; but, although, of course, they do not preserve their sheen like fish in the oil itself, they always maintain a silvery and natural appearance, quite different from that of ordinary museum specimens. Species prepared in this way would form a most effective exhibition. It appears, also, to be a most excellent preservative for crustacea and the higher orders of arachnids, and also for centipedes; but it has proved a failure for marine invertebrates in general. Its absolutely unevaporable nature makes it invaluable in a tropical climate, quite apart from its other qualities. The acid also enables cocoanut oil and turpentine to be mixed together, forming a splendid microscopic fluid, in which objects may be allowed to soak without any previous preparation, and in which they become very transparent. A minute species of crustacean, of the order Copepoda, and the leg of a fly, simply laid on a slide in a drop of this fluid, and covered with an ordinary covering glass, without any cell being made or cement employed, have lain on Mr. Haly's table unaltered for ten months.

SCIENTIFIC NEWS.

THE position of Wolf's comet on Christmas day, at Berlin midnight, will be R.A. 4h. 14m. 33s., S. Dec. 14° 41·1'; brightness 4·35, as compared with unity at time of rediscovery.

From the observations of Prof. Tacchini, carried on at the Observatory of the Roman College during July to September, it appears that solar activity considerably increased above that witnessed during the preceding quarter, the number of prominences recorded being much greater. The minimum of faculæ was coincident with a maximum of spots.

The death is announced of Sir Andrew Crombie Ramsay, LL.D., F.R.S., for many years director-general of the Geological Survey of Great Britain, to which post he was appointed in 1845. He retired in 1881, and received the honour of knighthood. Sir Andrew was the author of several important papers on geological subjects, most of which have been translated into German and Italian. As the chief study of the departed geologist was glacial phenomena, he was known to students mainly by his work on "The Physical Geology and Geography of Great Britain." Prof. Ramsay was born in Glasgow in 1814, and retired, from declining health, to Beaumaris about ten years ago.

The eminent Belgian chemist Prof. Stas died on Monday, aged 78. He had the honour of receiving one of the medals of the Royal Society for his researches into atomic weights, and was well known as a learned toxicologist.

Another of the original railway men of this country has joined the majority, in the person of Mr. Richard B. Grantham, M.I.C.E., who was born in 1805. He worked in early life under his father, Mr. John Grantham, but subsequently became resident engineer under Brunel on various parts of the Great Western Railway. In later years he devoted his attention mainly to sanitary engineering and land drainage, and in 1876 he reclaimed Brading Harbour (I.W.) He was one of the Senior Fellows of the Geological Society, and up to within a few weeks of his death took an active part in his professional work.

Another of the Great Western engineers who worked under Brunel died the other day at an advanced age. Mr. John Taylor, of late years well known as engineer to several water companies, was born in Sunderland, and in 1836 was in charge of a section of the works of the Great Western Railway, but left railway for water work. Up to last year he was consulting engineer of the New River Company.

The following arrangements have been made at the Royal Institution for the lectures before Easter:—Prof. John G. McKendrick, six Christmas lectures to juveniles, on "Life in Motion, or the Animal Machine"; Prof. Victor Horsley, twelve lectures on "The Structure and Functions of the Nervous System—the Brain"; Mr. A. S. Murray, three lectures on "Some Aspects of Greek Sculpture in Relief"; Prof. E. Ray Lankester, three lectures on "Some Recent Biological Discoveries"; Prof. W. P. Ker, three lectures on "The Progress of Romance in the Middle Ages"; Dr. B. Arthur Whitelegge, three lectures on "Epidemic Waves"; Prof. J. A. Fleming, three lectures on "The Induction Coil and Transformer"; the Right Hon. Lord Rayleigh, six lectures on "Matter: at Rest and in Motion"; Prof. J. F. Bridge, three lectures on "Dramatic Music, from Shakespeare to Dryden—the Play, the Masque, and the Opera—with illustrations." The Friday evening meetings will begin on January 22nd, when a discourse will be given by the Right Hon. Lord Rayleigh on the "Composition of Water"; succeeding discourses will probably be given by Sir George Douglas, Bart.; Prof. Roberts-Austen, C.B.; Mr. G. J. Symons, Prof. Percy F. Frankland, Sir David Salomons, Bart., Prof. L. C. Miall, Prof. Oliver Lodge, Mr. George du Maurier, Mr. John Evans, Mr. F. T. Piggott, Prof. W. E. Ayrton, and others.

At a recent meeting of the Berlin Medical Society, Dr. Schleich, of Berlin, reported on a new method of producing local anæsthesia. The observation that even a 0·02 per cent. solution of cocaine had an anæsthetic effect induced Schleich to try pure water instead. The experiment was surprisingly successful, but Dr. Schleich prefers the 0·02 solution of cocaine to water. He injects the fluid gradually through the tissues which are to be cut through or removed—as, for example, first the superficial layers of the skin, then the deeper layers, then the subcutaneous cellular tissue, the adipose tissue, &c. He showed a large number of patients on whom operations had been painlessly performed by this method. Dr. Schleich's communication was received with great scepticism.

The chloride of gold cure for dipsomania has recently attracted some attention in the United States; but a patient, who recently published an enthusiastic article about it in one of the reviews, died the other day in a drunken fit at New York. An American paper says:—"It is absurd to suppose that a hypodermic injection of bichloride of gold, or any other substance, could accomplish such a change in a man's moral and mental nature as is necessitated by the cure of a confirmed inebriate; and the undeserved attention that has been paid to the matter illustrates the unscientific habits of thought, and the childish faith in the powers of 'medicine' which so widely prevail."

The following paragraph gives a good idea of modern views of the power of electricity:—The question of sterilising water for the supply of cities by means of electricity has again cropped up in a paper by Mr. R. Meade Bache, recently read before the American Philosophical Society. Mr. Bache has made a number of experiments, which go to prove that a current of electricity sent through water destroys bacteria; but, as in prior experiments by others, it is still doubtful whether the liberated oxygen or the electricity itself kills the germs.

An electric locomotive is to be tried on the railway between Paris and Saint Denis, and perhaps subsequently between Paris and Calais. It is supposed that on falling gradients the momentum of the train will drive dynamos, and so generate current for recharging accumulators that have been exhausted in supplying the current on rising gradients or on the level.

It is proposed to build an electric railway between Budapest and Vienna, a distance of about 150 miles. There will be two main-power stations, with 100 sub-stations, but only three or four stopping-places. The cars will be about 130ft. long, and will be fitted with four bogie trucks. At each end there will be two large electric motors, to which the current will be transmitted by contact wheels running on conductor rails. The speed which it is proposed to attain in regular working is about 120 miles per hour, and, in order to diminish the air resistance, the ends of the cars will be shaped like ships' bows. The distance between Vienna and Budapest is to be covered in 75 minutes, and cars are to be run at quarter-hour intervals. Permission to build the road has not yet been granted by the authorities.

At Glasgow it has been decided by a large majority of the Town Council to proceed with the low-pressure scheme of electrical distribution; at Nottingham the Town Council has empowered a special committee to spend as much as £30,000 in lighting a portion of the borough by electricity.

At Leeds a telephone company complained that the electric tramway interfered with the action of their instruments; but the committee of the Corporation decided to leave the two companies to settle their differences themselves. Similar disputes have arisen in the United States.

An experiment in telephony has been made in Melbourne. The Postmaster-Generals of Victoria and South Australia, with their principal executive officers, succeeded in establishing conversation between Melbourne and Adelaide, a distance of 500 miles. The governments of the two colonies have erected a copper wire (No. 12, or rather more than ⅛in. in thickness), which is to be used for a new quadruplex telegraph instrument, and it was determined to see what could be done with the telephone over the wire. For over an hour an animated conversation was carried on, and the chimes of the Adelaide Post Office clock were distinctly heard in Melbourne, and *vice versâ*. The instruments used at Melbourne were the Hunning, Berthon, Berliner, and the Blake, and the two former were found most effective.

The Belgian State railways are to adopt, from May 1 next, Greenwich instead of Brussels time. The latter is about 17½ minutes fast.

The Board of Trade has undertaken to appoint a committee to consider what the standard of light for testing the gas supply of London should be, the present candle standard having been found to be untrustworthy. The South Metropolitan Gas Company, of which Mr. G. Livesey is chairman, have undertaken to pay the whole of the expenses, and the committee will shortly be formed. It will consist of two members nominated by the County Council, one by the City Corporation, three by the London gas companies, together with the three gas referees, and two independent scientific men. Dr. E. Frankland, F.R.S., and Mr. Dibdin, the Council's chemist, will represent the London County Council. Pending the report of this committee, the Council has deferred action in the direction of obtaining legislation for a more exact standard of light.

A correspondent calls our attention to the statement that a six-wheel coupled engine and tender have been built in ten working hours at the Stratford Works of the Great Eastern Railway. Similar achievements have been effected in the United States, but it is not known whether the locomotives were any the better because they were "erected" so quickly.

With reference to the Channel Tunnel, a Bill will be presented to Parliament in which power is sought to execute further experimental works, vesting in the Lords of the Treasury the sole right of determining the expediency of continuing such works, subject to such conditions, restrictions, and requirements as they may prescribe. It is also provided that in the event of such experimental works proving successful, the Channel Tunnel Company may be required within ten years to sell them to the Lords of the Treasury. The Bill also provides for the South-Eastern and London, Chatham, and Dover Railway Companies participating in the execution of the work, whether experimental or permanent.

The moon is responsible for a good many things, but it seems now that, according to a doctor of the Argentine fleet, M. Segers, mussels are rarely injurious at their maximum time of growth, which corresponds with full moon; but when the moon wanes, they become poor, and often poisonous. The poisonous quality apparently results from the death of a large number at this time, and the putrefaction of their bodies yielding ptomaïnes, which are absorbed by the surviving molluscs. The Fuegians are often attacked by a liver complaint, consisting in atrophy of the organ, with jaundiced colour of the skin, and tendency to hæmorrhage; and M. Segers believes this is due to mussel poisoning!

It is stated that an order for five hundred tons of aluminium has been given to a Pittsburgh firm from Germany, and the following comments are made: "The Emperor desires the canteens (Feldflasche) of his soldiers to be made of aluminium. There are two reasons for this—viz., its lightness and cleanliness. It will be used also for buckles, and it may be brought into use in the manufacture of cartridge shells. The new smokeless powder cartridges have brought about a demand for aluminium, and other European powers are also considering the advisability of using it."

The Royal Danish Academy of Sciences at Copenhagen offers two prizes of 400 and 600 kronen respectively, for investigations on the exact nature and proportions of the more important carbo-hydrates present, at different stages of maturity, in the cereals in most general use; and for investigations on the *Phytoptus* galls found in Denmark, with a monograph on the insects producing them. The prizes are to be awarded in October, 1893.

Referring to the note on p. 348 about the works of C. G. J. Jacobi, the Rev. A. Freeman informs us that a supplementary volume was published in 1884, containing such of the Vorlesungenüber Dynamik as had not been published in Vol. V. Another supplementary volume may also be expected.

One or more belts running independently on the top of another will add much to the transmission of power.

Patent Spring Hook.—Messrs. Beeching and Goose, of Mareham-le-Fen, Lincoln, send a new spring hook, in which the spring is entirely inclosed, and is practically unbreakable. It seems to be a useful device, as the old pattern springs are often broken by the rough usage to which spring hooks are often subjected.

LETTERS TO THE EDITOR.

◆

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, *832, Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

◆

THE OBSERVATION OF STATIONARY RADIANT POINTS.

[32988.]—I think the suggestion of Mr. Milligan (32942) as to watching the western sky for meteor showers might be usefully carried out, and that it would probably settle the question as to stationary radiants. For some years I have been intending to observe the south-western region before midnight, with the view of ascertaining whether the same apparent radiants are visible as in the preceding months in the eastern quarter. I believe the positions of the principal showers between Andromeda and Auriga have been well determined for the period including the months of July, August, September, and October. We now want later observations for comparison. The constellations Aries, Perseus, Taurus, Camelopardus, and Auriga require thorough watching in the months of January and February, and it would then be discerned whether the undermentioned radiants, well visible from July to October, are still active in play.

27° + 71°	61° + 49°
30 + 36½	64 + 22
32½ + 18	73 + 41
47 + 44	74 + 14½
54 + 71	77 + 32
61 + 37	77 + 56½

Several of these have been seen in November and December; are they further prolonged through January and February? The question can only be conclusively settled by an observer who will undertake to maintain lengthy observations at the periods alluded to. Whenever my inclinations lead me to resume meteor work, I shall make an especial effort to obtain evidence as to the southern and westerly radiants. They are undoubtedly feeble, but many of them are capable of satisfactory determination.

Bristol, Dec. 11. **W. F. Denning.**

θ ORIONIS.

[32989.]—In reply to Mr. Sadler (letter No. 32964), I have turned to one of my old observing books, and find that in January, 1864, the four stars in the Trapezium of θ Orionis were distinctly seen with the 2in. object-glass, 36in. focus, power 80. They were so easily visible in this instrument that I distinctly remember showing them to some friends very soon after sunset, and in broad twilight, before the stars in Orion's belt could be seen to the naked eye. **G. Grover.**

Rousdon Observatory, Lyme Regis, Dorset,
November 13th.

A BRILLIANT METEOR.

[32990.]—On Sunday night, Dec. 13, about 9.20, a brilliant meteor was seen at Oxford. It appeared about midway between the zenith and the N.N.E. horizon, and disappeared about 20° above the N.N.W. horizon, the path being about 40° long. As it was very cloudy, no stars were visible, so the exact path could not be seen. It appeared elliptical in shape, the major axis being about 10′. It was very bright, the colour being blue, and was seen through some light clouds, the moon shining at the time. Its duration was one or two seconds, and it left a faint tail, which vanished almost immediately. It seemed very much like the meteor seen here on Nov. 4, 1889 (see *Knowledge* for December, 1889). **W. Leillen.**

THERMOSTATS.

[32991.]—In the correspondence on Incubators I see revived for the twentieth time a form of thermostat which is sure to lead to failure. I think it must be 30 or 40 years ago since a similar system was described in the *Annales de Physique et de Chemie*, and the inherent error of any such system escaped notice. Not long since a kindred contrivance for regulating the heat of conservatories was publicly exhibited. For such a purpose, when the safe limits of heat are very wide, the plan might have answered, but for any nice regulation of heat it is wholly inapplicable. The radical error in all such systems is this—the regulation depends on the action of an *air* thermometer. It is quite true that air, and all other gases, expand with heat and contract with cold; but heat and cold are not the only agencies which cause change of volume in gases. The volume is also dependent on *pressure*, and, as the pressure of the atmosphere varies, so would the bulk of the air, although there may be no change in the heat.

For example, if a bulb contains 30c.in. of air when the barometer is at 30" pressure, the same weight of air would expand to $\frac{30}{28}$ × 30 = 32·14, or over 14 per cent., although no change of temperature had taken place, and the fall in pressure would cut off the supply of gas, and so cool the incubator.

On the other hand—the volume of air (under constant pressure) varies directly as its absolute temperature = degrees Fahr. + 461. Take 99 Fahr. = 560, absolute, each degree causes change of volume of $\frac{1}{560}$ of bulk. The 30c.in. would therefore expand only $\frac{30}{560}$ = or ·053 of a cubic inch. Let us divide the expansion caused by decreased pressure = 2·14c.in., by this, ·053c.in., and we get over 40. Hence it follows that, with an air thermometer, the column would require 40° F. to make it expand as much as it would under a full barometric pressure of 2in. Such a variation would be enough to parboil the eggs, instead of hatching them. If an air thermometer were inclosed in a strong hermetically-sealed glass, and, thus protected from variations of pressure, its indications would, of course, be unaffected by the atmosphere; but, under these circumstances, it would be necessary to employ some electric, or magnetic, contrivance to convey the effect to the source of heat. Such an arrangement would be complicated, and could be easily avoided by a very simple modification which I used over a quarter of a century ago.

Instead of *air*, I used *alcohol* in the bulb above the mercury, and by increasing the capacity of the bulb any desired sensibility can be secured. The bulk of all liquids is affected to the extent of two or three millionths by any change in atmospheric pressure, while the volume of alcohol increases about 1 per cent. for 20° Fahr., an expansion quite sufficient to regulate the flow of gas, and the resulting heat in the apparatus described by your correspondent "Incubans." The apparatus can be much simplified, and a second tube and burner are unnecessary if a small by-pass be used.

P.S.—I may add that the volume of all gases is a function of two variables—viz., temperature and pressure. Now, if the variation of one of these is annulled, the air thermometer becomes a correct measure of the other. In the case of the bulb being inclosed in a sealed tube, the instrument is a most correct thermometer, for the barometric pressure is annulled. On the other hand, if the temperature be kept *constant*, but the instrument be exposed to atmospheric changes, it becomes a very sensitive barometer. In the sympiezometer the heat change is balanced by the shifting of the scale, which indicates the pressure.

72, South Mall, Cork. **Denny Lane.**

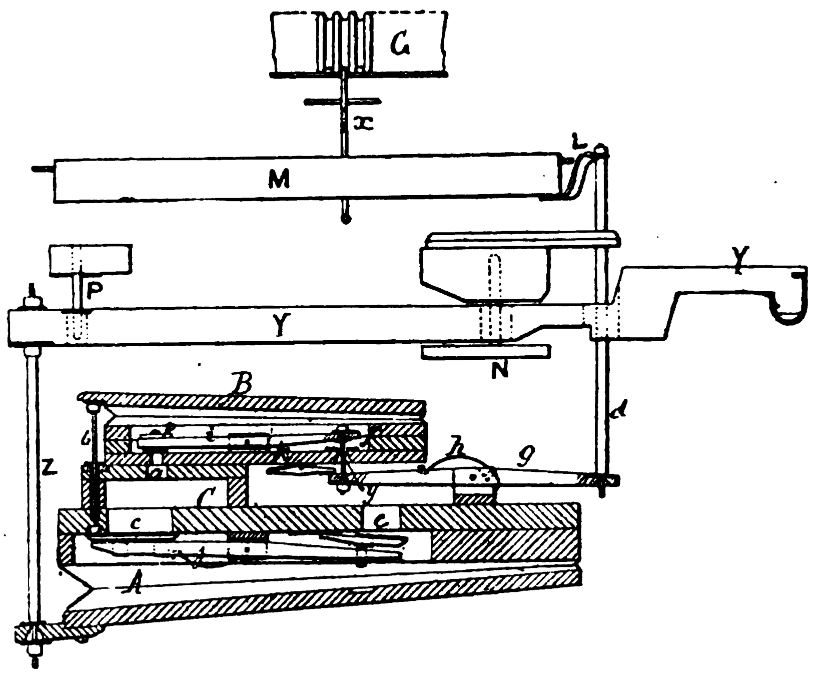
ORGANETTES (AND PIANISTAS).—XII.

[32992.]—We come next to what is probably the most perfect form of pianista that has yet been introduced—viz., the pneumatic instrument patented by Thibouville-Lamy in 1881, and in an improved form in 1884. This is, indeed (so far as I know), the *only* one on the pneumatic principle. The first pattern was, I think, illustrated in the "E. M.," but I have not the vol. here to refer to. The principle may be seen by referring to Fig. 18 in letter VII.; and assuming the stickers to be used to depress a piano-key instead of to open the pallet. The small bellows there marked B were arranged in tiers, and were in number 37 in the small pattern, and 54 in the larger one, and the general arrangement is much the same in the more modern form.

The great point of difference is in the valve arrangement. In the original instrument, the levers that entered the perforations in the tune-band were connected directly to the valves, as in Fig. 18; but in the improved form the levers work a set of *small* valves only, which control a *small* pair of bellows; these, in their turn, open the *large* valves of the *large* bellows that actuate the hammers for striking the keys. By thus giving the levers little work to do, it is possible to use a comparatively thin tune-band instead of one made of thick millboard.

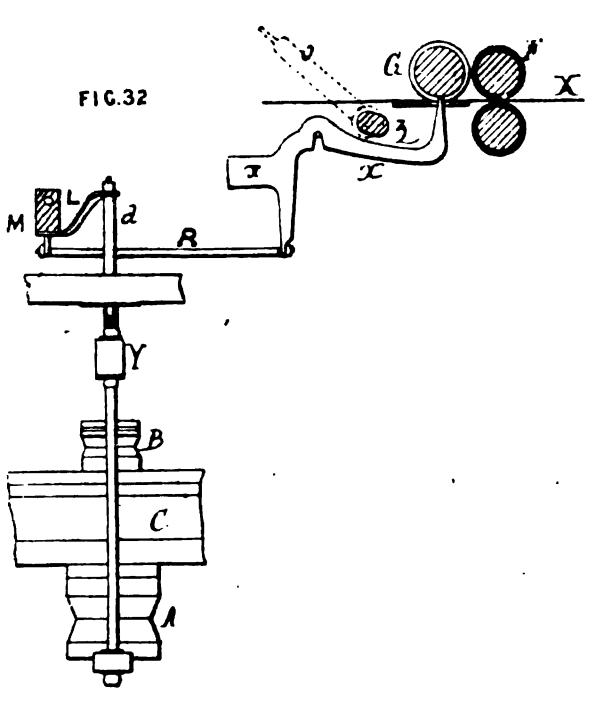
The pianista, as at present constructed, will be understood from Figs. 31 and 32, of which the former is a section from front to back, and the latter is a longitudinal elevation of the levers, &c., but, of course, showing the feed and presser rollers in section. It should be premised that the pneumatic action is on the exhaust system, and that the main bellows ("exhausters") are not shown, but are in communication with the channel C.

FIG. 31



A is the bellows whose collapse pushes up the sticker Z, and by raising the left-hand end of the hammer-lever Y, forces the right-hand end down on the key. The lever itself is pivoted at N on one pin and guided by another at P. B is the small bellows whose duty it is to actuate the valves of the large bellows A by means of the sticker-wire *b*. These valves are so arranged that, as one is opened, as at *e*, the other is closed, as at *c*, this being effected by the lever *j*. The valve at *c* is *attached* to this lever; but the other valve is a hinged one, and the lever-end merely *presses* it up to close the opening *e*. The small bellows B likewise contains a rocking lever *i*, carrying reversing valves having the same office as those at *c* and *e*; but the arrangement is a little different, and there is a third valve at *k*, the object being to partially equalise the air pressure, and render the working easier. The system of valves belonging to B is worked by the lever *g* (with its spring *h*) through the medium of the sticker *d*, which is very ingeniously passed through a slot in the hammer-lever Y.

FIG. 32



This sticker at its upper end has a wire passing through an arm, L, carried at the end of a bar, M, which bar has pivots at each end as shown (most plainly in Fig. 31), and on which it can rock. Projecting from the under side of M is a stud (see Fig. 32), which is connected by means of the horizontal sticker (or tracker) R to the tail of the lever *x x*. This lever is the one whose point enters the perforations in the tune-band X, being urged to do so by the reaction of the spring *h*. The lever *x* is made also of such a form that the left-hand projecting portion by its weight helps to raise the point into the perforations. G is the presser-roller, and F the feeder-rollers. The action is as follows:—When the point of *x* enters a perforation, its tail end pulls the tracker R to the right, and by means of the stud causes M to rock on its pivots. This rocking causes the arm L to pull up *d*, and thus, by means of the lever *g*, to close the valves at *y* and *k*, and open that at *a*. The bellows B being thus put in communication with the channel C, exhaustion takes place and B collapses, and, in collapsing, opens the valve *c* and closes the valve *e* of the large bellows A. The same result as before occurs: A in its turn collapses, forces up Z, and causes the hammer-lever Y to push down the key of the piano. In order to introduce a tune-band, there is an arm, *o*, and cam-bar, *z*, to depress all the lever points simultaneously, and at the same time ease the pressure of the roller G.

There is an arrangement for producing piano and forte effects, as well as pedals for depressing the piano pedals, but neither of these can be shown in the Figs., nor is it necessary to give an illustration of the outside case, which is very like that of a small harmonium. I may, however, mention that the tune-band for the 54-note pianista is only about

8⅝in. wide (including the margins outside the perforations), so good work and close packing are needed everywhere.

Though the narrowness of the tune-band (if the present widths were retained) would necessite making the air-holes in the "bridge" very small and very close together, I do not think it would be impossible to employ some such contrivance as that shown in Fig. 12 of letter V. to actuate the small set of valves inside B (Fig. 31), and so do away with the levers *x* and their connections. If so, thin paper on rollers would serve instead of the present much stouter material with its zigzag folding.

The dimensions of the pneumatic action are as follows: The small bellows B are 5¾in. long by 1in. broad and open $\frac{5}{16}$in. The bellows A are 9½in. long by 1½in. broad, and open ¾in.; but as the leverage is about as 5 to 3, the effective pressure exerted on the piano-key is increased in that proportion, and the "stroke" correspondingly diminished. The main bellows consists of two double-action "exhausters" side by side, each 27in. long by 4½in. wide, and opening 1½in. These are surmounted by a single "equaliser," 22in. long by 8in. wide, and opening ¾in.

The last form of pianista to be described is the electro-magnetic one. At the time when the "E.M." was in Vol. I., I was designing a method of using electro-magnets to act on the pallets of a small automatic organ. The arrangement will be easily understood if we suppose the electro-magnet of an electric bell to cause its hammer to push down the sticker of the pallet, instead of striking the bell. The great cost of the magnets, and the expense and mess of the battery when in work, put me out of conceit with the scheme, and I dropped it soon afterwards. Some years later, Sir H. Bishop patented his very ingenious applications of the principle, both in a simple form and in combination with a particular kind of pneumatic action, and I remember an organ so constructed at the Polytechnic, though I am ignorant of the precise details.

Since then a patent has been taken out by a Spaniard, for applying the principle to a pianista. He shows the electro-magnets just as I had arranged them, but the sticker has to press down the piano-key, instead of opening the organ pallet. He has also a contrivance for throwing in extra cells of the battery, in order to increase the force of the push on the key—a device, I think, of very doubtful utility, as, provided the electro-magnet can depress the key *at all*, it is sure to depress it sharply and suddenly the moment connection is made. This notion of an electric pianista (which I had not thought about originally) rather interested me, as I saw by the letters it had interested other readers of the "E. M.," and I had an experimental magnet made and fitted with the arm for acting on the sticker. The result is right enough in some respects; but I found it needed a strong current to get enough power out of the magnet, which is about 2½in. high, and of $\frac{7}{16}$in. iron. I also discovered anew that £ s. d. was an important factor in the matter. Each magnet costs 9s. complete, and mounted on a continuous supporting bar carrying one row of them (two or more rows, one above the other, are necessary, as a magnet is wider than a piano-key), so that 54 would cost over £24. The battery would come to £5 more, and we have yet to allow for the connections, the levers, the feed-rollers, &c., and the case. Altogether, I suppose such a pianista would cost 50 per cent. more than the pneumatic one last described, and then there would be, in addition, the cost of charging the battery at frequent intervals, and the trouble and nuisance of doing so.

I am, in fact, reminded of those very ingenious correspondents of the "E. M." who design elaborate contrivances for making a clock ring an electric bell, when, for half the money, they could buy a common alarm-clock to stand by their bedsides. Perhaps the electric-light current could be used instead of a battery.

If, notwithstanding these objections, any reader of this desires to make an electric pianista, I will help him in the matter of arranging the connections (which require some care), and in any other details he may require. I suppose one could make a musical-box work the pianista, and so play the piano, if the mechanical parts could be made with sufficient accuracy—and, with this "Jack-the-Giant-Killer" suggestion, I leave this form of instrument.

The magnets might also be used to bring plungers under an oscillating bar, and much less power would be necessary to do this than to depress the plungers; but the system could not compare with that of Mr. Wenham, and it is useless to go into any details.

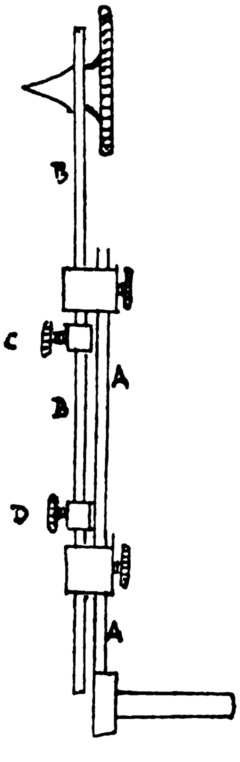
I hope in my next letter to describe and illustrate the way the tune-bands are marked and punched.

A. S. L.

LATHE INDEX.

[32993.]—That of which N. D. La Touche sends sketch, is similar in its action to the index of, I believe, the late much despised, but clever mechanic, Gilray, except that as designed by him it became an automatic counter. A is the flat part of spring, attached as usual, which carries two sockets in which B can slide up and down. On this are two adjustable stops, C, D, which are to be fixed at such a distance apart as to touch one or other of the sockets at each up and down motion. The lower socket was, if I recollect rightly, itself adjustable on A.

The stops on B were so adjusted as to allow the required number of holes to be passed over, so that on raising B by the milled head till the upper stop touched the top socket, and dropping the point into a hole, and then pulling round the pulley till the other stop touched, the holes were practically counted at each movement. If the lower socket is adjustable as a stop, only one is needed on the part B. My sketch is very rough, but the principle will be understood readily enough.



There is probably no more simple design of a counting index; but it would, I think, be found to work too loosely. It seems to me that a second ordinary index would be needed to hold the pulley after this affair had automatically done its duty as a ready-reckoner. In a lathe with traversing mandrel, it seems to me that a much larger division-plate might be fitted to take on and off at pleasure, overlapping the bed. Such would allow the numbers to be printed so as to be much more legible. This index I find was designed by Holtzapffel.

O. J. L.

INDEX FOR LATHE.—TO "F. A. M."

[32994.]—No; certainly not. If "O. J. L.'s" drawing gives an impression of instability, it is not meant to do so. The size of pillar, and of the rest of the concern, will depend on the uses to which it is to be put; but strength is readily to be obtained without departing from the design. I am only glad if any suggestions of mine stir up the inventive faculties of the readers of the English Mechanic.

In reply to "J. S. T.," I had hunted for that very index, but not in Holtzapffel's Vol. IV., as I fancied it was one that I had in an old mechanical notebook. I hunted Vol. V., and, not finding it there, gave up the search. It is a very good one—very simple, and so forth; but what I aimed at in the ratchet idea was a plan to need *no* looking at the plate at all: just the pulling over a handle and pushing it back each time a given distance. Evans does just this, and has also a visible pointer. I only wish, as many others do, I had money to spend on these lathe luxuries. As to writing down ideas, I wish "F. A. M." and everyone else would do so as often as an idea strikes them. We want to ventilate all such subjects, and to keep the thing going.

O. J. L.

VIOLIN MATTERS.

[32995.]—Having been much out of London recently, I have neglected to keep up my "file" of the English Mechanic, and have only just completed it. This must be my excuse for not having previously replied to two or three queries which I had not seen.

Fiddle Backs.—In reply to Mr. John Rae (75428), there is no rule that the figure in quarter-cut backs shall slope in any particular direction. It was, no doubt, from fancy that some of the old makers joined their backs with the figure sloping upwards from the centre. It may in some instances have been determined by the dimensions of the wood. In the diagram alluded to I purposely drew the figure sloping upward, because I much prefer to see it so, and consider it adds a certain amount of style to a handsome back. The old workers confined themselves to no fixed plan, and gave no jointed backs with the figure sloping upwards, downwards, and at right angles, from the central line, and in whole backs they were made with figure sloping from left to right upwards, left to right downwards, or at right angles to the longitudinal axis. As to whether the arrangement has any influence on the tone, I should reply that, as far as I know, it has none whatever.

Scotch Fir ("Fiddler," 75773).—Swiss pine is generally recommended and preferred for violin bellies; but North-country wood was in common use among the English makers a century ago. There is, however, less of suavity and more of hardness in the character of the tone of instruments made with it. If yours is a piece of larch fir, white in appearance, and bate very close together, and of which there is any quantity in the mountainous districts of Scotland, I advise you not to expend time and labour upon it. Your bird's-eye maple should make a good back, and it does not matter a rap whether you make it a jointed back provided the joint is clean and almost invisible, and kept exactly in the centre of the pattern.

Worms ("Henricus," 32981).—I heard the opinion you mention expressed some years ago—viz., that varnish was originally applied to violins as a safeguard against worms—and it was asserted on that occasion in such a positive and dogmatic manner that it would have been sheer waste of time and energy to argue or contradict. I therefore allowed the individual to have his way, and to go his way. At this distance of time it is perhaps difficult to prove that such was or was not the primal function of varnish; but I cannot bring myself to believe that there was any such intention. Even if it were so, the remedy was not by any means a success, and violins, from that remote period to the present, have always been liable to the worm complaint. The little wretches, moreover, pay no respect to authorship or varnish, and the stately "Strad." is as likely to suffer, under suitable conditions, as the humble Klotz. One might imagine that if the prescription included gamboge and aloes, it might have sufficed to keep the instrument in a healthful condition, and would have been somewhat unpalatable; but there is no accounting for peculiarities of taste. I do not know what would be the result in the case of a new instrument being washed with a solution of picric acid. It would, at any rate, give a bright yellow stain—for those who do not object to stains—and the pest in question, which appears to thrive in wood flavoured with aloes and gamboge, might possibly draw the line at picric acid, which I think would try the temper of the most persevering worm. It is much more reasonable to suppose that varnish was introduced with the object of protection from dirt, as well as to add to appearance. What an interesting sight would be, for instance, an unvarnished violin which had been played a few years in a London orchestra!

With reference to the second question of "Henricus," whether the Italian makers rubbed down their varnish, I should say that in most cases they did not; but it was the opinion of the late J. B. Vuillaume that Stradivarius did not varnish his instruments all over, or, if he did, that he certainly afterwards broke up a portion of the varnish, for the sake, no doubt, of picturesque effect.

Double Bass ("Carpenter," 75726).—Following are the body dimensions of a fine, 3-string double-bass, attributed to Vincent Panormo: length, 45in.; shoulders, widest part, 21in.; waist, 15in.; lower portion, 22½in.; depth of ribs at shoulders, 6¾in., widening up to 7⅝in. at the lower end.

W. Pickering.

[32996.]—I have been somewhat surprised several times at what I have seen in the "E.M." about the making of violins, and have very little doubt other practical men have also. My first surprise was that Mr. P. should recommend anyone to make one, or attempt it, during winter evenings, there being so many good reasons against it which I need not mention, as a little thought will present most of them to any thinking mind; and my last surprises were his remarks upon varnishing. Surely he knows better than this? I should say to anyone who has an instrument in the white, and who intends doing it with an oil varnish, by all means leave it till next summer. It will dry best in the open air, or in a current of air before an open window, or, better still, in the sunshine. I, from my limited experience (having made about a score or so), have found this varnishing the most difficult process of all—so much so, in fact, that I think it needless to aggravate the difficulty by doing it when nature or our climate makes it more so. What is the use of his saying never varnish in a room with the temperature below 60°? Just as if the thing was completed when the varnish had been laid on from the brush. I would ask how many of your readers have a room which they could shut up at this time of year, and maintain at this temperature for a month, while five or six coats of varnish dried? I would not undertake to do one with less than five or six coats, and I have two instruments (mentioned below) upon which I laid eleven coats, and this number was necessary in order to get the colour I desired—a deep red—there being so much difficulty in getting an oil varnish to take up colour. I by no means wish to criticise Mr. P.'s articles, as I think one party did, for the sake of finding fault, there being passages in them for which I give him thanks, and which have given me a something to think over and make trial of when the time comes (next summer). At the same time, there are some things which he had better left unsaid, and for which (if he really seriously means them) I feel sorry for him.

To take an instance, he quotes a case of an old English maker, whose "Varnish, although put on a century ago, is hardly dry yet." Surely, Mr. P. knows, or ought to know, that there are such things as elastic varnishes, as well as hard, and although a varnish is still elastic as it was intended to be, and as the very nature of the gums used in making it compel it to be, till they have perished, i.e., lost their virtue, and I think it displays nought but folly or ignorance to assert that it is not yet dry, because it still possesses this elastic peculiarity. I send you, herewith, sir, a small piece of maple, which has had several coats of varnish laid on roughly. This varnish I made and put on during the hot weather (and it was hot) in July, 1887, and you will observe it still possesses this peculiarity. If anything presses against it for an hour or two, it takes the impress; again, if rubbed briskly a few times, as if to polish, you will find when it becomes warm that it readily takes an impress from your thumb-nail. Now, sir, knowing that the lumps of copal were like this before I made the varnish, and that I mixed no harder gums with it to harden it, but purposely selected these lumps from a quantity because they were soft, I should consider myself guilty of folly or falsehood were I to assert that it was not yet dry, because I *know* it is as dry as it will ever become. But I am running on, and have, as yet, said nothing; and I could and would, if space and time permitted, say much, for there is so much to be said that one hardly knows where to begin. However, my opinion is that the whole secret of the violin is contained in the air-mass of the instrument, and I set this fully forth in some letters I wrote some eighteen months ago to the editor of *Musical Opinion*, under the title of "The Making and Choosing of Violins," and which appeared in that journal during the summer of 1890. I was amused at Mr. P.'s method of voicing an instrument (I think that was what he termed it)—viz., his scraping and rasping away at the back after it was strung up. I should not like to serve one of mine like that after spending 60 or 70 hours' work on it, and one result I should expect to see would be the sound-post through the back in consequence. I should feel much against altering the thickness more than a fine sand-paper to finish off would do when I could not take note of the difference with the calipers.

I should like to ask Mr. P., or any other of your readers who may have thought of the matter sufficiently to have formed an opinion—I do not think Mr. P. even mentioned the fact in his articles—Why were many of those grand old instruments built with the ribs narrower in the upper bouts than the lower? You will please note I say many of them, not all. And I believe it is a fact that some are more so than others. My opinion is, and I have found it borne out in practice, that this was one of the methods by the which these makers altered the air-mass of their instruments when necessary that way. I should say from my experience that it is impossible for any maker to produce instruments like the violin time after time, even though he used the same patterns exactly of a like internal capacity, he might get them very near, by chance now and then exactly hit the mark; but the probability is, however (and this I have proved from experience), that he would be a little out more or less one way or the other, and he would then alter it (the size), and bring it to the exact capacity, or as near as he could get it, if not exact. I do not know, Sir, whether you are a violinist or understand anything of the instrument, either as a player or a maker, but have no doubt, as a scientific man, you know it is a peculiar instrument, and one that has given rise to endless discussions, and I would ask you, Mr. P., or any of your many readers to tell me how it is—if this is not thus, as the saying is—possible for anyone to select the best three instruments from, say 12 or 20, even though they were not, and never had been, strung up, or a note played on them? And this, I assert, could be done by anyone, even a deaf person, providing he could feel with his fingers and thumbs. There might, and no doubt would be, certain characteristics of tone peculiar to each of these three instruments, which would be manifest upon trial, for no three violins were ever made exactly alike, any more than are the voices of three individuals alike throughout their compass, and this fact I proved experimentally by spending a lot of time and trying in various ways to make two alike in sound, using wood from the same blocks for backs, bellies, blocks, ribs, and linings, &c., throughout for both of them, only the tools parting the wood, first by working them alike to the greatest accuracy I could in measurement, and after this, when I found it fail, by working them to weight; but in spite of all the time and trouble I spent on them, and although I got a good result in both cases, they were, and are, very dissimilar in tone. I, however, in making and altering them so many times gained that best of all knowledge—viz., experience, which I have turned to good account since, and now find no difficulty in gaining the one result I aim at—viz., the air mass correct.

The Pavement, Merton, S.W. **J. K. Monk.**

VIOLIN MAKING.

[32997.]—I HAVE read with much interest Mr. Pickering's articles. I quite endorse his remarks about the variableness of the works of the old and best masters. I have seen and handled many fine examples of these masters, and have often noticed these slight freaks. A slight difference in the two sides of the waist was noticed in a fine Strad. in the possession of Prof. Huggins, who kindly invited me to see it. Prof. Huggins thought none the less of the gem, for it is a fine example of a good period, and has the favourite red varnish. (I have a Guarnerius which differs in its middle bouts).

Prof. Huggins, as well as on physical astronomy, is a high authority on the subject of violins of the old masters. It is not surprising the capacity of the Joseph Guarnerius was less than the Strad. Mr. Pickering tried. Of course Mr. Pickering knows that a Joseph is often a "small fiddle."

Mr. Wenham is inclined to think the Italians worked on "scientific principles." I have great doubts of this. There is no evidence that they were scientists, but merely intelligent craftsmen.

The life of Stradivarius was spent in experiments, which, in his able hands and long life, led up to the best known results, and he appeared to be guided only by his experience. If these makers worked by a "scientific principle," how could they differ so much among themselves and their own individual productions? None worked on the *best* principles till Stradivarius, and after him many inferior models were still made—some of which we are inclined in our own day to call stupid fiddles. Better artists than some of them there could not be; but I have always inclined to attribute the superior character of these instruments mainly to good material and work, wonderfully helped by *age* and *use*.

There was a time when new Stradivarius instruments were imported into this country: they were not liked because they were too loud and hard in tone; were at that time thought to be too thick in the wood, hence the mistaken preference for the thin and less vigorous tone of the Stainer type.

As an instance of what age and use will do—the violin which Hill and Sons recently disposed of for £2,000, had not been used—the varnish and general appearance was such as if it had recently left the workshop of Stradivarius. In conversation with Mr. Hill on this violin, he remarked, "And what do you think, Mr. Calver? Its tone was like a new fiddle, hard and crude." **No Name.**

[32998.]—THE articles on "How to Make a Violin," by Mr. Pickering, in "Ours," were very excellent for the purpose for which they were written, and I indorse the greater part of Mr. F. H. Wenham's remarks (letter 32982). I am in full accord with him when he says: "I am of opinion that beyond the high excellence of their workmanship the old masters had a defined scientific principle to work upon." I quite agree with him because I know that, as far as the practical handling of the instrument permits, the violin is made strictly in accordance with acoustical principles. I will endeavour to prove this by bringing forward three cases, all of which have more or less bearing upon the subject in question. I am acquainted with several pianoforte makers who, to their honour be it said, tried their best to produce a first-class piano. Knowing, however, no principle to work upon, they proceeded to copy minutely the better class of instruments by other makers. I know for a fact that the material they used and their workmanship was positively superior to that employed in the manufacture of the instruments from which they copied—which, indeed, in these special cases is only natural; but in spite of all this the instruments fell short of the originals. This would tend to show that good material, workmanship, varnish, &c., without the requisite knowledge of how they should be properly utilised, will not make a first-class piano, and this applies with greater force to the violin.

The second case I would mention is that of my late friend, Mr. S. Anderson, of Margaret-street, Cavendish-square. This gentleman had two very fine violins; for a certain reason he was compelled to use a very large chin-rest made of very heavy wood. When he applied this to the one violin it improved its tone wonderfully—in fact, it was then a different instrument; on the other hand, when he applied the same chin-rest to the other violin the difference it made was exceedingly slight; the sound merely appeared to be a little muffled. Now I would ask our violin makers what had the wood, workmanship, and varnish to do with the result? The third case I should like to bring forward shows that a shaving taken off from a certain part will, to a certain extent, muffle a sounding body, whereas an additional shaving or two taken off, and the body will once more acquire its old brilliancy of tone. This is an experiment that I made in 1878, and the result thereof is stated in "Oars" on the 20th Sept. in that year. It is as follows:—"I took a lath of a certain length, thickness, and width, and suspended it by a thin thread. Now when I struck the flat surface of the lath a certain musical note was produced, very clear and bright; this was also the case in a less degree when I struck it on its edge or smaller surface, which tone was a fifth higher than that produced from the flat surface. After this I took a shaving off the smaller edge, when it neither produced a fifth nor a fourth, and the tone was consequently not quite so bright. Then I took another shaving or two from the edge to make it produce a fourth, and the tone from the flat surface again sounded bright."

These facts ought to be sufficient to silence, once and for all, those who talk about varnish and wood as the principal requirements in producing a good violin. Nevertheless, I fear my few remarks will not have that effect. A violin manufacturer has to live, and in order to do business he is obliged to hide his ignorance, and as a reason for the shortcomings of his productions, his lack of the wonderful "Italian varnish" always serves as a very plausible excuse for the inferiority of his instruments.

J. H. Schucht.

[32999.]—I AM glad to find Mr. Wenham among the correspondents on violin-making his remarks are always eminently practical. To my mind, it is an indisputable fact that the old artists "toned" their instruments in some way not at present known. No doubt part of the process consisted in making the back and belly respond to certain notes at a known interval apart before they were joined to the ribs; but I think the final process must have been done on the outside, as Mr. Pickering suggests. It is, I believe, a recognised fact that there should be a *tone* difference between back and belly when finished, the back, I presume, giving the higher note. Will Mr. Pickering, or the omniscient "Scio," tell us how to clamp and vibrate these plates so as to correctly determine their fundamental note?

The man who makes violins to a certain standard form, no matter how carefully he may work, can scarcely be called an artist. A well-made instrument is not necessarily a good one, and if its tone be poor, it is like having a good clock which won't go. The difference between a good instrument and an indifferent one can only be told by the ear, and doubtless all the old famous violin-makers were men with very sensitive musical ears, and did not fail to use them in finishing their best instruments. Doubtless, too, they worked in a true scientific spirit, by noting carefully how each change in curvature and thickness affected the sound. Probably their method of "toning" was a simple one; but it is not the less difficult to discover on that account, just as was their method of making and applying their varnish. I don't remember seeing it stated that they *bought* their varnish, and if each man made his own, it must have been a simple process, for we can hardly suppose him to have had a chemist's laboratory. As to the amber theory, how many men can, even now, with modern chemical appliances, successfully fuse and make amber varnish?

It is generally asserted that each of the great makers had his own special tone character, and that this, to the experienced ear, was quite sufficient to identify the maker of every first-class violin known to have been the work of some one of the four or five famous Italians.

Can Mr. Pickering, or any other correspondent, inform me what are the structural differences in curvature and thickness of back and belly in, say, a Strad., a Stainer, and a Guarnerius, and whether the difference in tone can be ascribed to these variations? **Orderic Vital.**

ESTIMATION OF THE DIATONIC INTERVALS.

[33000.]—ALTHOUGH the intervals between the successive notes of the musical scale must be in reality progressively smaller as we ascend the scale, yet to the musical ear all the whole-tone intervals seem equal, and the semi-tone ones appear equal also, in whatever part of the series they occur. The interval C D is really only half that of C D one octave lower in pitch, yet to the ear the two intervals seem equal. This judgment of equality no doubt arises from the fact that the vibration ratio (or the string-length ratio) between the C and the D is the same in both cases, although no idea of ratio is conveyed to the mind in listening to the consecutive notes and comparing the two intervals, except that of equality. These vibration ratios have, therefore, very properly been used as the basis of measurements of the intervals. But the usual mode of stating these measurements by such fractions as $\frac{9}{8}$, $\frac{10}{9}$, $\frac{16}{15}$, although founded upon the said ratios, does not, I think, give a very clear or correct idea of the relative dimensions of the intervals. To say that a whole-tone is to a semitone interval as $\frac{9}{8}$ is to $\frac{16}{15}$ is equivalent to stating that they are within a very small fraction of being equal, this fraction being only $\frac{7}{120}$, or, say, $\frac{1}{17}$. Even in the harmonic scale, with its large semitone intervals, they cannot be so nearly equal as this; while, with regard to the melodic scale, the statement must be still farther from the truth.

If, however, we give the said fractions the equivalent forms—1·125 and 1·066—I believe we shall find in their decimal portions, that is, the excess above unity in each, something like the true relative measures of the two intervals. In this way we get, in the harmonic scale, C 125 D 111 E 66 F. Here the semitone E—F is more than half the widest whole tone C—D. In the melodic scale the semitone is E 53 F—less than half of a whole tone interval. But perhaps the relative lengths of the intervals may be better appreciated when they are stated according to the plan suggested by Mr. Alexander J. Ellis (see "E. M." Vol. XLI. p. 118), founded on the equal-temperament scale. An octave of that scale he divides into 1,200 equal parts, which he names cents, 100 of these being the measure of each of its 12 semitone intervals, 200 being, of course, that of a whole-tone interval. Upon this basis a few simple calculations enable us to assign to the intervals of any scale the proportional number of cents corresponding to their measures otherwise ascertained, so that the comparison of one scale with another in regard to its intervals becomes easy. The accompanying table shows the intervals of the harmonic and melodic scales translated in this way into cents.

	Harmonic.	Equal temp.	Melodic.
	C	C	C
	205·3	200	204
	D	D	D
	182·5	200	204
	E	E	E
	109·5	100	90·5
	F	F	F
	205·3	200	204
	G	G	G
	182·5	200	204
	A	A	A
	205·3	200	204
	B	B	B
	109·5	100	90·5
	C	C	C
Totals	1199·9	1200	1201

Here it will be seen that the harmonic exceeds the equal temperament semitone by 9½ cents, exactly the amount by which the melodic semitone falls short of it; also that the larger harmonic whole tones are 5⅓ cents greater, and the smaller 7½ cents less than those of the equal temperament scale, while the melodic whole tones are just 4 cents. greater than the equal-temperament ones.

Edinburgh. **Walter M. Hardie.**

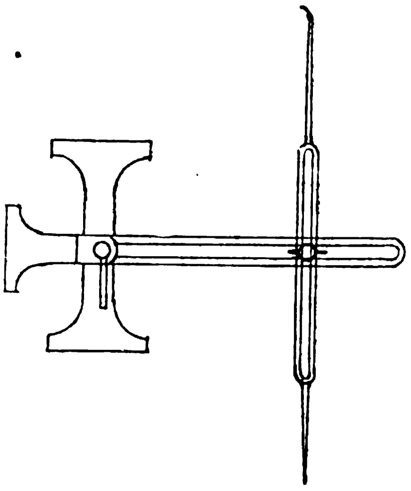
RAIN-BRINGING.

[33001.]—YOUR correspondent "A Fellow of the Royal Astronomical Society," referring to the statement that the rain-bringing experiments in Texas have been successful, says that similar experiments in Madras have failed entirely. He does not say whether the conditions were the same. No one, I suppose, would be so foolish as to expect to draw rain from cloudless skies by the explosion of dynamite rockets or balloons, or anything else of the kind; but the experiment—a truly scientific one—was carried out in Texas to see if it was not possible to compel the moisture-laden clouds to discharge some of the water they contain. There is scarcely a farmer in this country who has not experienced disappointment, when longing for rain on his parched fields, to find the heavily-laden, moisture-filled clouds pass over his "bank" without leaving him even a little deposit. Mere gardeners, who have not time to water their bits of beds with the usual appliances, and who know the value of rain, especially on almost dust-dry earth, have experienced the disappointment. They find one morning the sky clouded over with evidently moisture-laden strata of atmosphere, and they say, "Ah! we shall get some rain to-day;" but the day rolls on, and the night closes without a drop of rain having fallen on the parched fields. Surely, if there is a possibility of compelling the water-carrying clouds to discharge the much-needed rain, it is, at least, worth while trying how best to achieve the desired result. Whether the expense of the dynamite balloons would be too much to make the experiment pay, remains to be proved; but it is, at least, worth while trying, when there is obviously "rain in the clouds"—no one would try it, presumably, in the cloudless skies over the Soudan, for example. Atmospheric conditions are not always the same in even the Eastern and Western counties of England, and they are not quite so far apart as Texas and Madras. Everyone knows that the rainfall in Suffolk and the Eastern counties is much less than it is in, say, Westmoreland (less than a quarter). Surely, if there is a possibility of the farmer getting rain from the clouds he sees rolling by, it might be worth his while to try the experiment, which, whether it failed or succeeded, would, at least, add something to our knowledge.

Hortus.

A SCRIBING BLOCK.

[33002.]—BELOW you will see a rough sketch of a "scribing block" which is infinitely better than the one described in the article of "Fitting." I have used both very often, and can say it with confidence.



G. H. B.

INCUBATORS—PATENT LAW.

[33003.]—IF Mr. Fraser (letter 32978, p. 352) had stated that the specification he received was that of Hearson's patent, I could have told him at once that the patent was still in force, and that all the stamp duties or fees had been paid for the full fourteen years—sufficient proof of the success of the invention. If he had referred to my letter on p. 157 he would have found these words: "Perhaps Hearson's is one of the best incubators in the market, and it is also fitted with a good regulator, which acts automatically." The principal feature in Hearson's specification is, in fact, the closed capsule containing a liquid which expands and contracs within limits of temperature required in incubators; and it is certainly an ingenious device. I am satisfied that Hearson's must be a valid patent, or it would have been contested long ago.

Now, as to Mr. Hearson's question, addressed to me, in which he asks for a "case" confirming the statement I made, that "Anyone may make a patented article for experiment, even if the patent is valid" (that is how I wrote it—not "be valid"). The answer is easily given, and should be well known to all patentees, for anyone may make a patented article for amusement or experiment, but not for "beneficial user." There are many cases: See "Jones v. Pearce," 1, Webster's Reports, 125; "Frearson v. Loe," Law Reports, Chancery Division, 48. Mr. Hearson can find more cases in the manuals, and any patent agent can tell him that the law is as I stated. For obvious reasons, it must be so. The whole essence and spirit of the Patent Law of this country is to encourage invention for the benefit of the public—not the inventor; but the law says to the inventor: If you will publish such a description of your invention that any one conversant with the details (a workman in the trade) could make the machine, or what-not, from the description, then on your paying certain sums of money the patent will be sealed for fourteen years; but if any one infringes it you must defend your rights. The only advantage a patentee gets is the fact that the issue of a patent is *primâ-facie* evidence that he was the original inventor, and the onus of proof to the contrary lies on the infringer. It is clear that any one may make a patented article for experiment; for in the case of many things no one would buy the articles or take out a license to make without first trying, and preferably that by making according to the specification, for if the article could not be made according to the specification, the patent would be void. In many cases, patentees are quite pleased to have amateurs make the invention for amusement or experiment, as that advertises it, and makes it better known.

The law is quite clear on the subject, and cán be found clearly stated in all the manuals relating to patent law, and, so far as I know, the decisions of the judges have invaribly been as I stated—that anyone may make a patented article for experiment, so that, if possible, he may improve it, and so further promote the progress of invention.

Incubans.

REFLECTION OF SHIP 150 MILES DISTANT.

[33004.]—AN instance lately came before my notice which might interest your readers. The officers of the ship *Prince Rupert*, belonging to the Hon. Hudson Bay Company, were engaged "taking the sun" in Hudson's Bay, and they were surprised to perceive a plain reflection of a ship upon the silvered-glass of the instrument. Nothing in the shape of a ship save their own was in sight, "field" ice extended to the horizon. However, noting the time, &c., the *Prince Rupert* proceeded, as well as circumstances permitted. Some 40 hours after a vessel was sighted, and her appearance tallied exactly with the reflection in the sextant. The vessel was spoken, and special inquiry led to the fact that she proved to have been 150 miles distant from the place where the observations were taken on the *Prince Rupert* 40 hours previous.

The captain of the latter vessel ascribed the phenomenon to the presence of the ice. Perhaps some of our able fellow-readers can explain?

Walter Strafford.

100, Balaam-street, Plaistow, E.

OPTICAL ILLUSIONS.

[33005.]—REFERRING to my letter in this week's "E. M.," No. 32,980, p. 353, permit me, in justice to myself, to point out that the illusion No. 1 is, by your compositor, placed upside down. And regarding No. 2, your engraver has broken my square under the band, and distended the lines above it out of the rectangular shape. **T. H. Evans.**

PROJECTILES AND THE ROTATION OF THE EARTH.

[33006.]—I THINK "J. R. C.'s" letter of last week explains the difficulty raised by the letter of "N.S.W. Reserve Rifleman" quoted by "F.R.A.S." But he is in error in supposing that the rotation of the earth has nothing to do with the deviation. The drift of the shot caused by its rotation being much greater than its deviation caused by the rotation of the earth, the actual or nett deviation is always to the right in either hemisphere. From the table given by "J. R. C." I make the drift at 3,500yds. range to be more than 13yds., which is more than the deviation quoted by "F.R.A.S." for 5,600yds. So "N.S.W.R.R." was right in his observations, though he probably did not understand the problem.

I quite agree with "J. R. C." that the explanation of the drift must be found in the theory of the gyroscope, and I feel certain that it might be explained mathematically. Has anyone ever explained the cause of the curved path of a billiard bell with a lot of side on?

In reply to "Kinetic" (Query 76062) if a projectile be shot up vertically into the air, it will fall to the westward, because while in the air it will only travel east at the rate of the surface of the earth from whence it was shot, and to keep vertically over the spot it left, it would have to travel an arc with a radius greater by the average height it maintained while in the air. So the distance it would fall to the westward would be the difference of the arc a point on the surface of the earth would describe while the shot was in the air, and the same arc measured at the average height the shot maintained. For example, supposing a projectile shot up vertically at the equator with a velocity of 2,000ft. per second, neglecting the resistance of the air, the deviation may be found by the formula, $\frac{16\,h\,\pi\,t}{3\,P} = D$. Where h = height to which the shot is projected; t = time of ascent or descent; and P = period of earth's rotation. The shot would ascend for $\frac{2000}{32} = 62{\cdot}5$secs. to a height of $(62{\cdot}5)^2 \times 16 = 62{,}500$ft., and the average height would be two-thirds of this; but we need not concern ourselves with this, as it is included in the 16in. the numerator, and the 3in. of the denominator. The earth's period is a sidereal day, and equals

86,164secs. ; so, taking π as 3·1416, and formulating the values, we have

$$D = \frac{16 \times 62{,}500 \times 3{\cdot}1416 \times 62{\cdot}5}{3 \times 86164}$$

I will leave "Kinetic" to work out the result. I make it 759·59ft. **H. Wake.**

BALANCED SWELL-PEDAL.

[33007.]—In my suggestion for a balanced swell-pedal on p. 335, in answer to "Discere Cupio's" question, No. 75836, I overlooked a fact which Mr. Thomas Elliston has been good enough to call attention to in his reply to "T. A. L.," No. 76031, on p. 358—namely, that the shutters being out of centre causes a variance in the leverage; therefore, for the same reason, a coiled spring would not do either, as the spring would be at its greatest strength when the shutters were closed, whilst the geeatest weight would occur when the shutters were open. I do not understand how his suggestion of having the shutters weighted would answer, either, for I presume he means having weights let into the tops of the shutters, so that the weight would be inside or behind the centre. If that is so, I do not see where the difference lies between having a weight which pulls up in front of centre, and a weight hanging behind the centre; nor would the placing of the shutters perfectly central do, unless you have a weight to counterbalance the weight of the action; nor yet would hanging the shutters behind their centres do, as you again get the variation in the leverage.

The only suggestion I can make is to have vertical shutters, in the use of which I have never found any difficulty in closing the swell, as, when all the action is balanced properly and the pedal balanced a little in advance of the heel, the leg is entirely at rest on the pedal, the movement being from the ankle alone, toe down and heel up—heel down and toe up. With a little practice, this is far more comfortable and steady than when the whole of the leg from the hip downwards is at work, as is the case with the recovering pedal.

The plan which Mr. Elliston suggests on p. 313, reply 75836, for maintaining a recovering pedal in any position, and which he says is his own idea, I consider to be an excellent substitute for, and the next best thing to, a balanced pedal.

I feel sure this will be an interesting subject to most organists, and I would therefore like to see other readers' opinions on the matter. **Leo.**

The New Italian Rifle.—The weapon is 1·2 mètres long, exclusive of the bayonet; and of 6·5 millimètres calibre. The most important factor in connection with the rifle is the smokeless powder cartridge, which, owing to its light weight and small size, permits the number of cartridges carried by the soldier to be augmented to 160. The initial velocity of the bullet is 720 mètres per second, and with regard to its penetrative force, it is said that the ball will pierce two mattresses and two planks 12 centimètres (5in.) thick, at a distance of 1,200 mètres, or 4,000ft. Loading is effected by means of magazines containing five cartridges so arranged that a repeating fire may be maintained until the magazine is exhausted. A few experts who witnessed the experiments assert that the new rifle is too short; but the majority were convinced that the weapon is the best and most destructive at present existing among European armies.

Metallochromy.—Metallochromy is a process of direct polychrome printing upon metallic surfaces recently presented by Mr. Josz, its inventor, to the Society of Encouragement of National Industry. Hitherto, all impressions upon metal have been obtained by the transfer of a freshly-printed sheet, or by the transfer of the impression upon a sheet of rubber to a sheet of metal. To this effect it is necessary to construct special lithographic presses in order to obtain an exact adjustment of the colours forming the subject. In order that the printing may be done directly from a hard surface —that is, the lithographic stone, upon another hard surface—that is, the metal, it is necessary to be able to render the metallic surface elastic enough to take the ink that the stone carries, without impasting or destroying the details of the subject. In order to reach such a result, the process employed is as follows: Upon the metallic surface to be printed there is produced by the mechanical action of very fine sand a fine and close grain, which is diluted and cleaned by immersion in different alkaline solutions. This roughened and velvety surface takes a lithographic impression as well as paper and fabrics do. Immediately after the printing the sheet of metal is submitted to a temperature of 50° in a special stove, the object of which is to cause the ink to enter the pores. The impression is, therefore, no longer superficial, but is printed in the metal itself, whose expansion and contraction it may follow without undergoing any alteration. The metallochromic prints, covered with two coats of varnish, applied hot and fixed in a stove, present the same characters of durability as faience and enamel.—*La Nature.*

REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75683.]—**Astronomical Driving Clock.**—If this querist can refer to *Engineering*, No. 1146, Dec. 16, 1877, and to No. 1165, April 27, 1888, he will find excellent drawings and description of various forms, by Sir Howard Grubb. I have extracts and drawings from one of the publications of the Institution of Mechanical Engineers, but cannot lay my hand upon it. There is an article by Mr. Wenham in Vol. XXXI. "E. M." No. 796. J. C. Linscott.

[75705.]—**Reed Voicing.**—I am glad to have been of some service to "Reeds," and as time slips along and other readers come forward who know not earlier volumes of the "E.M.," it may, perhaps, be useful if I answer the questions of "Reeds," and add some other hints for the benefit of any interested. I am asked first of all if the reeds are actually tested in their own cavity, or can they be sounded any other way to save inconvenience of drawing? It must be understood that reeds cannot be fine-tuned until they are in the positions they are to occupy; then they are evened-up, and the little asperities due to the equal temperament are softened down. In the rough-and-ready way they are filed up a trifle above pitch by trial on a tuning bellows alongside of a corresponding reed, and then "voiced" and tried again. They are then placed in the cavity-board, or tube-board as I call it, and when the instrument is complete are finished by the tuner or regulator. In the high-class factories the voicer has a skeleton organ or action, in the frame of which are two or three holes, which can be stopped with corks. Against the holes he presses a leather-faced block, on which is the reed he wishes to voice, and by touching the corresponding key he soon gets the reed somewhere near what he wants. Two holes are sufficient—one near tenor C, and the other about staff C. One block with slots at each end of different sizes generally suffices, and a set of reeds so prepared is turned out as "voiced and tuned"; but, as mentioned above, they must be fine-tuned and evened-up when in their own tubes and on the wind which is intended to work them. Here let me say: that in fine-tuning it is necessary to work the bellows very steadily, and to keep as near as possible an even pressure—not merely to get the reeds into tune, but to get them to speak with an even voice, for it would be most objectionable to find C with a round tone, D with a reedy tone, and then E with the round tone again. That is "evening-up"—getting the same quality throughout the register. If that is not understood, please put more questions. Now, as to tuning: the simple rule is that fourths below and fifths above should be a trifle flat (which, it will be seen, means that octaves are true), and fifths below and fourths above are a trifle sharp. The principle is the same in all equal-tempered instruments; but in the case of reed instruments blown with a varying pressure of wind, there is a little "give-and-take" allowed by the skilled tuner with a nice ear. Now, as to C—G, as asked by "Reeds," the G being a fifth above C is left about two beats flat in a second—that is, two beats below a perfect fifth. But perhaps I had better give the whole scheme. The "bearings" are always laid in the middle of the register, so we commence by getting staff C true by the tuning-fork, and then make mid C true to that. Now, holding down mid C as far as the key will fall, make G below it two beats flat (that is a fourth below); the fifth above G is D, and that is to be left about a beat and a half flat ("fine-tuning"); then A below the D is left about one beat flat, and the E above about two beats flat. B below the E_2 is left very little flat, and the F sharp below is left also very little flat to the B, while C sharp above is made two beats flat to F sharp, and the G sharp is made almost perfect to the C sharp, but erring on the flat side. Starting again with mid C, make F (a fifth below) two beats sharp, the A sharp above one beat sharp to the F, and the D sharp a trifle sharp to the A sharp. D sharp and G sharp should then be fairly smooth or tolerable to most ears, for few are so acute as to detect the difference of a comma. The octaves are tuned as true as possible to these bearings; but they cannot be absolutely true always, as the varying pressure in the bellows makes a slight difference: they will, however, be true enough for 999 ears out of a thousand. Here are the trial chords:—

E	D	D	E	E	C	D	Efl.	Efl.	Csh.	Dsh.
C	B	A	Csh.	B	A	Ash.	Bfl.	C	Ash.	B
G	G	Fsh.	A	Gsh.	F	F	G	Gsh.	Fsh.	Fsh.

Having got the "bearings" right, the rest is easy; but laying the bearings is not to be acquired at once, and even skilled tuners do not always find their "ear" in good condition. Now as to tools, I use a bit of stay-busk steel for slipping under the vibrators—one end filed down for use under the smaller reeds,—a half smooth file, a pair of pliers with fine beaks, and a bradawl or piece of round steel. The scraper is made by snapping the tip off an old saw-file and grinding an edge on one of the angles. That is used for scraping the reeds —the free end to sharpen, the rivet or fixed end to flatten. I hope these instructions are definite; but if anything requires elucidation, readers have only to ask through the "E. M.," and they will receive all the information I can give them. I thought I had finished; but it occurred to me that some might like to know how to tell when one reed is flat to another. Take the mid C and the G below, press the two keys down full, keep a steady blow with the bellows, and if you hear the two beats, let the C key rise gently under the finger. If the beats seem to vanish or fade away, that is proof that G is flat to C, for by allowing the C key to rise (that is to only partly open its pallet) C is flattened, and then comes into consonance with the G. Similarly by only partly depressing the G key, while keeping C fully down, the beats will become more frequent, and the dissonance more evident. I have known even musical ears deceived by trusting to beats alone. The G, instead of being the two beats flat, has been that much sharp; but if it is remembered that depressing a key only half-way tends to flatten the note, the difference is easily detected. The above remarks apply to all free-reed instruments—but there must be steady blowing. Organon.

[75729.]—**L. and N. W. Locos.**—The querist will probably find the illustration he requires on p. 141, Oct. 11, 1889; but if that is not exactly the same pattern as the one inquired about, no doubt others can be found in back volumes. Would it not pay somebody to bring out a volume of illustrations, giving pictures of the various locomotives on the different lines? I don't know of what use or interest they would be; but there is evidently a desire to have them amongst some people. K. P.

[75740.]—**Bath Heater.**—I should think that "Iona" could get ideas from the illustrations in the catalogues of makers of bath-heating gas stoves—Fletcher's, for instance; but in back numbers there are many devices illustrated. An "ordinary Bunsen burner" is useful, but one is not of much use if the bath is required to be heated quickly, unless it is a very large multiple burner. T. L.

[75745.]—**Wood Bending.**—Would not a length of ordinary piping of the required diameter (18in.) do for this querist? The "pressure" of the steam is not of much moment, except that, if low, it condenses more readily. L. M. P.

[75751.]—**Boiler.**—Condensed steam will accumulate in such an arrangement as suggested. The query is of little interest to any one. B. M.

[75752.]—**Puzzle 48.**—Is this the puzzle of squares on "card," in which the pieces placed one way make more squares than they do the other? If so, the answer is simple—the edges do not fit accurately. The square root of 45 is 6·7082039. Is that what is required? Mathem.

[75757.]—**Motive Power.**—Taking the question as it stands, if the fuel used in both cases is the same, the Dowson water-gas would probably be the most economical. Ex. P. D.

[75765.]—**New G.W.R. Single Locos.**—I believe the length of stroke is 22in., diameter 18in. W. W. K.

[75773.]—**Violin.**—As the wood is old it will probably do well for a violin, as the tone depends much on the age of the instrument, and the wood being old to begin with, the use of the instrument will more quickly bring the molecules into the best position, if the form of the instrument is suitable. The parts should be put together in a mould. Joining the back does not interfere with the sounding properties of the violin, no more than varnish of any kind improves them. Get the loan of a hundred low-priced violins from a wholesale dealer, try them, and learn something. Schwartzwald.

[75774.]—**Cheese-Making.**—I do not think there is any practical work on the making of cheese. There are several which describe the processes, but none giving those "tips" (to use an expressive word) which are to be had only from experienced hands. Useful hints might be found in some of the books published by Lockwood and other firms on dairy farming; but the art of cheese-making in best style is acquired only by practice. Those who wish to pursue it as a business should take a few lessons at a dairy school. Nantwich.

[75776.]—**Formula.**—It seems that an ordinary work on arithmetic is what this querist requires; but probably he will find the special information needed in Britten's "Watch and Clockmaker's Handbook." At any rate, Mr. Britten can tell him, if he addresses a note to that gentleman at the Horological Institute, Northampton-square, E.C. Nun. Dor.

[75778.]—**Cement.**—Perhaps plaster of Paris would suit this querist. X.

[75780.] — **Electrical.** — The capacity and potential of the *n* jars are equal to the number of jars and their size and charge. Querist says, "Details wanted." What "details" can be given? There are no data to work on. S. P. T.

[75783.]—**Frictionless Pendulum Gear.**—This querist had better consult Lord Grimthorpe's (Sir E. Beckett's) "Clocks, Watches, and Bells." A "frictionless gear" is not known. W. M.

[75789.]—**Heating Room.**—Make the heating pipes practically a part of the boiler; but have a tap to shut off steam when not required in pipes. The inlet should be in steam space, and the return should enter the boiler in the water space, the pipes being laid so that any condensed steam (water) will find its way to the lowest part, or to a position where it can be readily blown through by admitting steam. Nun. Dor.

[75791.]—**Cycle Brazing.**—The brazing of parts of cycles does not differ from any other kind of brazing. The parts to be joined must be filed clean, be covered with a mixture of fine spelter and borax paste, be tied together with iron wire, and be placed in a clear fire until the brass runs. There is not likely to be any book on the subject, but the details are given in many, and many times in the back numbers of this paper. Nun Dor.

[75792.]—**Workshop Floor.**—As there is abundance of clay, burn enough to make a basis 6in. thick all over the floor, mixed with lime or Portland cement. Then float that with about a ¼in. of Portland cement and washed sand about one to three. Or use, say, ¾in. of the asphalte. The broken brick will do for the lowest layer. Nun. Dor.

[75793.]—**Heating Room from Fire Below.**—Several devices for heating rooms by means of one fire have been illustrated in back volumes. There is the simple plan of heating the fresh air and discharging it into the house; the various stoves, and a device for radiating much of the heat passing up the main chimney, by placing radiators in front of the chimney as it passes through the rooms—that is, letting thin ornamental brasses into the front, and compelling the hot gases to pass close to their backs. Nun. Dor.

[75797.]—**Violin Queries.**—The players do not use a pad on the chest, but some use a chin-rest, as illustrated in Spohr's work, or in one of the improved forms. 2. The marks are not binding: it rests with the player; but the teacher would explain why, if there is any necessity for playing according to the markings. 3. No book at all. That is just where all the books fail: they do not give information that is really wanted. Those hints must be obtained from the teacher.

Stradcrem.

[75882.]—**Steam Steering Gear** is usually made with a fixed eccentric for each cylinder. Starting and reversing is effected by another slide-valve, worked by the steering wheel, which changes the steam passages to exhaust, and *vice versâ*. There is a screw hunting gear between the wheel and valve, which I am sorry I am not able to explain, as it is a most interesting piece of mechanism. London River.

[75884.]—**Electrical Nomenclature.**—Correction.—For "armature," read "external circuit," in second line under Fig. 1. A. D. S.

[75899.]—**Compressed Air.**—For rough calculations, the weight of a cubic foot of air near sea-level may be taken at one ounce and a quarter. There are 437½ grains in one ounce, so that the difference between 565·4 grains and 12¾ ounces is 5034·6 grains. Has not Mr. Fletcher unaccountably neglected a decimal point? H. B. F.

[75899.]—**Compressed Air.**—Permit me to point out to Mr. T. Fletcher that 564·5 grains is not 12¾oz., as he states on p. 354. That number of grains is not quite 2oz. Miller gives the weight of a cubic foot of air at 30in. and 60° Fahr. as 538·569 grains—which is about 1¼oz. avoirdupois.

Wm. John Grey, F.C.S.,
Newcastle-on-Tyne. Analytical Chemist.

[75899.]—**Compressed Air.**—The different values given by "B. F." may be both correct. But as the weight of air (or any gas) depends on (1) the temperature at time of observation and (2) the barometer pressure, if these conditions are not mentioned, uncertainty is sure to result. The weight of one cubic foot of dry air under a pressure of 30in. bar. and temp. 60° Fahr. is 538·569 grains. Iota Dash.

[75899.]—**Compressed Air.**—I find, after all, that I have been caught napping, through missing a decimal point, and therefore my last letter is nonsense. The weight of a cubic foot of air at 32° is ·0807lb., not ·807, which will, of course, make it one-tenth of what I stated, and I must ask your correspondent's pardon for correcting him when I stood in need of correction myself.

Thos. Fletcher.

[75899.]—**Compressed Air.**—Mr. Thomas Fletcher identifies himself with "999," and it is truly pleasant to meet "a foe, so worthy of one's steel"-pen. Is it possible that Mr. Fletcher can believe that a cubic foot of air weighs ¾lb. avoirdupois? I avoid temperature or fractions, and put the 12oz. in another form. It is surely "a very curious mistake." I at first took it to be a printer's error, but the exact fraction being given, showed me what Mr. F. now confirms, and which he also explains by his having trusted to his memory. My age warns me never to do so. I avoid "catching Mr. F. in figures"—'twould be too bad! B. F.

[75899.]—**Compressed Air.**—Mr. Thos. Fletcher is pleased to be sarcastic and facetious, but is not he for once "caught in figures"? Has he not made an error in a decimal place, or taken 700 grains to the pound instead of 7,000? 565·4 grains = 1·292oz. avoirdupois. Kohlrausch, in his "Physical Measurements," gives, from Regnault's observations, that the sp.gr. of air at 0° C. and 760mm. barometer, is 0 001293 compared with water at 4° C. From this, a cubic foot of dry air at 0° C. and 760mm. barometer would weigh 565 grains almost exactly. The 527 grains given by Molesworth is probably the weight at 60° or 62° F.

X.

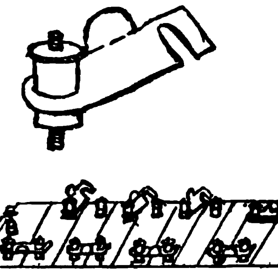
[75899.]—**Compressed Air.**—I am astonished that any "F.C.S." should entertain for a moment the idea that a cubic foot of ordinary air weighs ¾lb. Mr. Thomas Box and his "Treatise on Heat" are not, perhaps, to the front as classical authorities; but any penny book on arithmetic will inform Mr. Fletcher that 565·4 grains do not make 12¾oz. either troy or avoirdupois. The weight of the unit volume of air at standard temperature and pressure is a "constant" constantly to be remembered by every chemist and physicist. On the metric system there is the following *mem. tech.* for it: One litre of air at 0° C. and 760mm. pressure weighs 1·293grms. The sum of the two last figures make up the two first, taken as one numeral—thus, 9 + 3 = 12.

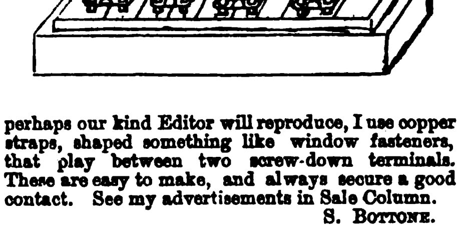
F. C. S.

[75899.]—**Compressed Air.**—Whatever is the matter with our valued correspondent, Mr. Thomas Fletcher, that he still sticks to his amazing blunder? He may not be "often caught in figures"; but he has certainly made up for all deficiencies this time. If he really does think that 565·4 grains make 12¾oz., he must have been inventing a new system of weights to suit his own ideas. If he will take the trouble to divide 565·4 by the number of grains which an ounce is usually supposed to contain—viz., 437·5, he may find that it is not "B. F." but "T. F." who has put his foot in it, and that 1·29oz. is a good deal nearer the mark than 12¾oz. Possibly it was the decimal point which bothered him; but one would have thought that any man with the smallest practical experience with gases would have been preserved by his own observations from such a "curious mistake." At all events, 1·29oz. per cubic foot is so univerally known as the weight of air, that any appeal to "authority" is absurd and unnecessary.

Bristol. C. E. Frank.

[75902.]—**Adjustable Resistance.**—If you want accuracy and constancy, you must have coils. It is not absolutely necessary to have plugs; in my £2 sets, as illustrated in inclosed photograph, which perhaps our kind Editor will reproduce, I use copper straps, shaped something like window fasteners, that play between two screw-down terminals. These are easy to make, and always secure a good contact. See my advertisements in Sale Column.





S. Bottone.

[75943.]—**Brick.**—I beg to offer my thanks for the replies. I have a patent machine for forming brick, but would like to know if a double-knife mixer between rolls and machine is superior to a 7ft. horizontal pug mill? Tough, plastic clay; it requires well manipulating. Output 10,000 per day. Brick.

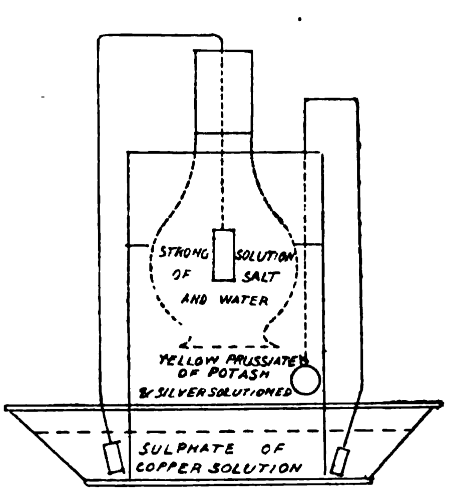
[75955.]—**"Greater Britain."**—I suppose that the best locomotive is the one which works at the least cost per train mile—not necessarily at a high speed, for in the short distances in this country a few miles an hour extra does not make much difference to the majority of the travelling public. Why I asked whether there was a better locomotive than "Greater Britain" was to obtain information. What weight can she haul at a fair express speed? The other night I saw a Midland express with two locos.—one a single the other a four-coupled, and yet there were only seven vehicles on, though certainly three were long doubles, and one a Pullman; but what was the actual resistance? Why run a single and a coupled engine together? Nun. Dor.

[75959.]—**Telescope.**—Your best plan would be to write to the supposed makers, Cooke and Sons, of York, and ask them if they would test the o.g. or telescope for you. Their little book just published is an excellent manual to those who know something of optics; but I fear it would be too difficult for you.

Ramsgate. J. C. Linscott.

[75965.]—**Precipitating Gold.**—I omitted some words in my reply to this query on p. 356. As my answer did not at first appear, I sent you the following correction—viz., to insert "and then pour into water" after the word "flux." I am sorry for my original error, and also that my correction was too late. Z. Y. X.

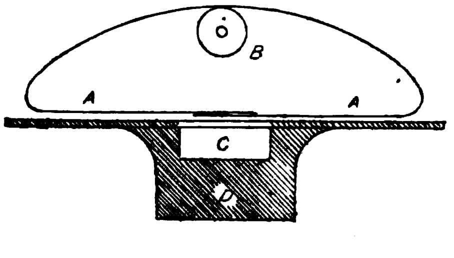
[75965.]—**Precipitating Gold.**—I herewith send drawing and particulars for plating in silver.


STRONG SOLUTION OF SALT AND WATER
YELLOW PRUSSIATE OF POTASH & SILVER SOLUTIONED
SULPHATE OF COPPER SOLUTION

Firstly, procure ½oz. of good old silver, cut up into small pieces, and place in a jar with 3oz. of strong nitric acid; place in a suitable position near the chimney, so that the fumes shall pass away without annoying the operator, as the fumes are not good to be in contact with. After the silver is dissolved, fill up with about a quart of water, and throw into this solution a good handful of salt; this will precipitate it into chloride of silver. After the chloride gets settled, which is easy to see, as it is a fine white powder, strain off the liquid and throw it away; repeat this for three or four times, to get rid of the salt and acid. Secondly, get 4oz. of yellow prussiate of potash and put into a large-mouthed jar that will hold about four quarts of water; put the chloride of silver into this, then place the jar upon an oven-plate upon a good fire, and simmer for about three-quarters of an hour. This jar will answer for the one you see in the drawing when cold. Thirdly, get 4oz. of sulphate of copper; dissolve and place in large dish, as per drawing, with sufficient water, say about three pints. Fourthly, suspend a paraffin-lamp chimney, as per drawing, and put into this a strong solution of salt and water after having tied a piece of bladder round the bottom securely. You are then ready to commence plating. After placing, as per drawing, you will perceive the two copper wires are attached to two pieces of copper and placed in the copper solution in dirt at bottom of drawing; you will then perceive that at the other end of one is a strip of zinc which goes into the strong solution of salt and water in the lamp chimney, and at the other end of the other copper wire is a watch, or any other article you wish to plate. Fifthly, for success you must always be careful to have your article well cleaned; it is best after the article has been in a few minutes to take it out and polish with brush and fine powder. It is then ready to receive any desired thickness you wish. About six hours will give a plate that will last years if you have all things made in accordance with those. H. F. A.

[75978.]—**Locomotive Queries.**—In reply to "Leo," there was a b.g. engine built in the way he says by Messrs. Hawthorn, with 10ft. driving-wheel. It was named "The Hurricane." The largest driving-wheel now in use is on the L. and N.W., named "Cornwall," No. 173, with 8ft. 6in. driving-wheel. In the *English Illustrated Magazine* for October there is a good article, with splendid pictures, on broad-gauge engines. Sexon.

[75974.]—**Band Saws.**—If you have any quantity to braze, I should recommend you to get a casting made like the drawing I send. Fasten the



casting in the vice at D; clamp the saw to casting at A A by any convenient means; let the joint overlap at C. When the joint is ready for brazing, heat a pair of thick tongs to a white heat; grip the joint with the tongs in the aperture C, and you will get a perfect joint. B is a piece of ⅜in. iron driven into the wall over the vice, carrying a wooden reel to support the saw overhead.

Acomb. J. S. B.

[75980.]—**Soldering: Erratum.**—The last time the word "borax" appears in my reply, it should have been printed "storax." I meant to say that I have found the resin storax somewhat better than the common resin for soldering.

W. Hutchinson.

[75982.]—**Interest.**—I agree with neither correspondent in their replies to this question. If the accounts are made up half-yearly, rebate being allowed when payments are made, and the interest becoming compound when payments cease, I think £161 6s. (or thereabouts) would be the amount owing on June 24 last. The balances at the end of each half-year would be as follows:—

		£	s.	d.
1888.	June 24	178	5	0
1888.	Dec. 24	158	8	0
1889.	June 24	153	1	0
1889.	Dec. 24	147	13	0
1890.	June 24	152	1	0
1890.	Dec. 24	156	12	0
1891.	June 24	161	6	0

The rebate being 5s., 4s., and 2s. in the first three half-years respectively, it follows that if rebate be not allowed, the amount owing on June 24, 1891, will be 11s. more than above, or £161 17s. M. S.

[75983.]—**Kiln.**—I would feel greatly obliged by the fulfilment of promise. I would like as small a kiln as possible to test the bricks and tiles in, as the clay lies in 3in. and 4in. veins. One vein will stand a much greater heat than the other before being deformed in shape or colour. If properly burnt, it will be red, white, and black, as the colour is in the raw state in the veins. Experiment.

[76013.]—**Stove Draught.**—I am sorry to say I cannot tell you how to increase the draught without lengthening the piping. I have studied stoves in their various forms now for over 18 years, and consider one made as suggested by Williams, Fig. 41, p. 71, in his book, "Combustion," undoubtedly the best for general heating purposes. I have tried letting the air up the upright pipe, similar to his flue, Fig. 88, sketched on p. 125; but I do not find it any advantage—rather the reverse. All said in this book, though, is not true, because I have a stove at the present time with hollow fire-bars, constructed exactly similar in all other respects to Fig. 41, before referred to, that is heating a shop 60ft. by 30ft., and I never could get one before that would do it. The stove is Cornforth's patent, and is about 2ft. long by 12 wide by 10 deep. The patentee told me I could get better results from it if I had an upright pipe. At present the pipe has two right-angle bends in it. It burns its own smoke after having been lit about 12 minutes, and maintains a good regular heat if fed with coal and slack at intervals. Total length of pipe 20ft. As to slow-combustion stoves, so called, I would not be bothered with them at any price. I had three in the shop mentioned, and my men used (after the fires had been burning some hours) to amuse themselves by tying newspapers round the stoves (frequently holding them there with their hands) to see if the heat was sufficient to singe or discolour the paper. I finally gave them away to some poor chapel people, assuring them they would not want the place insured, or be burdened with debt for coke bills. I know I am treading on dangerous ground in thus referring to slow-combustion stoves; but perhaps some of their advocates will state clearly their construction, and the principles they act on, because, to get a good heat, powerful draught is essential, or good coal. Cornforth's hollow-bar stoves do not burn slack well, the fire-bar spaces having to be wide enough to let a sufficiency of air into the fire-chamber to mingle with the smoke to be burned. Can anyone suggest a bottom to the stove that would let the air in, and at same time prevent the slack falling through? After all, much depends upon the firing with any stove, and the advice given by my friend Michael Reynolds is perfectly correct, "fire little at a time, and often." L. A. I. E. E.

[76020.]—**Phonograph.**—The speed you mention is too high for the motor. It was due to a mistake of mine in calculating the sizes of the wheels. The small intermediate wheels next to the motor should not be in the train when the main-shaft is running at 60 revolutions per minute. The band from motor should run direct on the wheel of 3⅛in. diameter on the counter-shaft, using in this case the top pulley on the motor; and if a regulator is used, making use of the bottom motor pulley to drive it. By all means put in the small intermediate wheels, however, as for purposes of experiment it will be wanted when running the main shaft at different speeds, having, of course, two sets of bands to meet the requirements. W. Gillett.

[76028.]—**Ellipse.**—Seeing the two answers to this query in our last number, it seemed to me that both had got a bit mixed between the formulæ for circumference and area. So referring to one of my school-books of 45 years ago—viz., Bonnycastle's "Mensuration"—find there that the rule for circumference of ellipse is, "Multiply the square root of half the sum of the squares of the two dias. by π." Now, taking "Vector's" given dias. we get

$$\left(\frac{12^2 + 5^2}{2}\right) \tfrac{1}{2} \times 3\cdot1416$$

or— $9\cdot1923 \times 3\cdot1416 = 28\cdot8785.$

F. G. Ll.

[76028.]—**Ellipse.**—The formula for the periphery of ellipse, by taking the arithmetic mean of the axes $\left(\frac{a+b}{2}\right)\pi$ is very rough, especially if the ellipse be of much eccentricity, as in the example given. Ingram gives—

$$\pi\left(\frac{a+b}{4} + \tfrac{1}{2}\sqrt{\frac{a^2+b^2}{2}}\right)$$

which when $a = 12$, $b = 5$in., gives periphery $= 27\cdot79116$in. See Ingram's "Mathematics," p. 240, where the analysis of the formula is shown at length.

Liverpool, Dec. 12. W. S.

[76039.]—**Bunsen Burner: Substitute for.**—You can use wood naphtha; but why not use methylated spirit? That can be got as low as 6d. a pint. S. Bottone.

[76039.]—**Bunsen Burner: Substitute for.**—I can advise a Defries safety stove (Vagner's patent) for burning petroleum. Although these have a short iron chimney, he can get an intense heat to boil anything above it, and the flame produces absolutely no smoke or soot. I have burnt one of these stoves for months together with absolutely no deposit of soot in the chimney.

Another J. H. B.

[76039.]—**Bunsen Burner: Substitute for.**—I think you will have to seek a long while to find a more convenient source of heat, gas not being available, than methylated spirit, which can be got in London for 5d. a pint. Why do you not try vaporising the naphtha in a separate vessel, and connecting to your Bunsen? If this arrangement were worked with sufficient pressure to carry the air up the tube, I do not see why it should not answer; but I have not tried it. A. E. B.

[76041.]—**Softening Cast Metal.**—With a drill made of the right steel, and of the proper angle of cutting power, I was seldom defeated in boring. The first cut is the worst, owing to the sandy nature of the skin. I have softened refractory pieces by inclosing them in metal boxes with lime, heavily smeared with clay, and put into a furnace for some time. This deprives the pieces of their carbon, and turns them into malleable castings.

Eos.

[76041.]—**Softening Cast Metal.**—Presuming cast iron or steel is the metal, make the piece red hot, and place an iron ferrule such as is used for tool-handles, of about diameter of hole required, upright on red-hot piece; then drop inside the ferrule a piece of brimstone the size of a pea (for a ¼in. hole), and leave till cold, when it is said that the iron will be quite soft. Not having had occasion to try the above process, the writer would advise an experiment on a waste piece first. If successful, kindly say so in "E.M."

Choke-bore.

[76043.]—**Separating the Joints of Cast-iron Hot-water Pipes.**—I do not know of any preparation for getting these joints apart only by chipping the joint partly out; then it will sometimes shake the rest. I have broken a great many by doing the above. E. J. W.

[76045.]—**Chemical.**—To Mr. Grey or "J. T. M." —There is no such compound as $HNaCO_2$; but the querist probably means $HNaCO_3$. Two molecules of this salt, weighing 168, require one molecule of H_2SO_4, weighing 98, for decomposition. Water takes no chemical part in the action, but merely acts as a solvent. Roughly speaking, 1oz. of hydric sodic carbonate needs ¾oz. of sulphuric acid.

Wm. John Grey, F.C.S.,
Newcastle-on-Tyne. Analytical Chemist.

[76046.]—**Feed-Water Heater.**—Why not use an injector? It would keep the boiler supplied with water at a very high temperature—in fact, nearly boiling.

Brighton. T. C. Smith.

[76046.]—**Feed-Water Heater.**—"Lever" does not mention how the water is injected into the boiler. As the query stands, the tank would actually become part of the boiler, as the water from tank would gravitate, and the steam would only form above the level of water, wherever that might be. I should advise the use of a small injector, by means of which the water-level could be maintained at any point, and the engine kept moving. W. Strafford.

[76047.]—**Light Obtainable from ½H.P. Water Motor.**—1H.P. is equal to about 12 lamps of 16c.p. If your dynamo is well made, and your engine really giving ½H.P., you should get five lamps of 16c.p. well lighted. This would require a ring armature dynamo (either Gramme or Manchester pattern) with armature 4½in. diam. by 3in. deep; or else a drum armature machine with armature 3in. diameter, 8in. long. Cost, about £5.

S. Bottone.

[76048.]—**Engine for Lathe.**—What sort of work do you intend to use lathe for? Your engine might "drive" a 6in. lathe if there was no work in it. You will only be able to do small work—viz., light cuts—with so small an engine.

Brighton. T. C. Smith.

[76049.]—**Electro-Motor.**—A motor with ring armature 2in. diam., 2in. deep, wound with 3lb. No. 16 wire, field-magnets 7¾in. high, including pole-pieces, with 3lb. No. 14 in series, will run well in your 45 volts 6 ampère circuit. You will find full description of the type of machine you require at § 36 of my book, "Electro-Motors," and details as to winding at §§ 27, *et seq.*, of the same book.

S. Bottone.

[76050.]—**Hook-and-Eye to Gut Band.**—Thin the end of gut band so as to just enter the hook or eye, and screw it well in. See that a thread is in them when you purchase. E. J. W.

[76050.]—**Hook-and-Eye to Gut Band.**—Pare the end and screw the hook on tight. There should be no difficulty. No heat is required. Perhaps band is greasy; if so, clean it thoroughly. Or another fault may be headstock and flywheel not being opposite? Duffer.

[76050.]—**Hook-and-Eye to Gut Band.**—I have about 20 of these gut bands running daily about nine hours per day. My method is to file the ends of gut band slightly taper a little beyond the required length of hook or eye (the file must be sharp). Clean the thread in hook-and-eye with a fine point, such as an old pen-nib. Now insert a piece of iron in eye to act as a lever; insert the prepared end of gut into thread of eye, and firmly screw on. The hook-and-eye must not be put on hot or even warm, if you want a good lasting job. I have got hooks-and-eyes that have been on for over three years, and to all appearances will keep on as long as the band will last, and these bands get some nasty jerks at times. Do not have the hook-and-eye too small.

S. Robert Bonney, Electroplater.

[76051.]—**Chemical Laboratory.**—I have found Jones's "Junior Course of Practical Chemistry" a good book; it is published by Macmillan and Co. at 2s. 6d. "Quantitative Analysis," 3s., and "Qualitative Analysis," 3s. 6d., by Prof. A. H. Sexton, might suit you (Griffin); but why not write for a catalogue? Most of the balances I have seen are made by Oertling. I have not the list by me, so am not certain of the name, but any chemical dealer will tell you. A. D. S.

[76051.]—**Chemical Laboratory.**—(1) For gentle heating, spirit is the best, although expensive. For more intense heat, as for ignitions, a patent benzoline blowpipe is both serviceable and inexpensive after primary outlay. (2) For a given price, Sartorius's balances are far and away the best. I have one which cost me £8 2s. 6d., which, both in finish, durability, and sensitiveness, excels some at 12 guineas. (3) Qualitative: "Practical Chemistry," by F. Clowes. Quantitative: "Quantitative Analysis," by Thorpe. Director R.B.L.

[76052.]—**Solution of Dextrine.**—All organic matters in contact with, or solution within, water have a tendency to change; but this can by certain precautions be counteracted. You do not state if you have taken any such precautions. I should advise you to try a few drops of oil of cloves, or about a quarter of a teaspoonful of powdered alum to the half-pint of dextrine solution. A. E. B.

[76054.]—**Electric Light.**—The best battery for lighting is (as often stated in the "E.M.") the bichromate or chromic-acid type, the E.M.F. of which is, roughly speaking, 2 volts. To make an 8c.p. 15-volt lamp properly incandescent, you will want about eight cells connected in series. For pocket accumulators see back numbers, or Mr. Bottone's "Electric Instrument Making."

Brighton. T. C. Smith.

[76054.]—**Electric Light.**—Double-fluid bichromate cells most suitable. Number according to lamp voltage, each cell giving 1·50 volt. You can construct a pocket accumulator from ebonite or guttapercha, the latter being better suited to amateur construction. Make a cell about 2½in. square and 4in. long, with partition, and place two pasted lead plates in each compartment, and charge the cells with acidulated water, 1 in 9. They can be charged with current from a small dynamo or three-celled bichromate battery. Methods of making the plates, &c., have frequently been given, and I must refer you back for further information on the subject. F. Askew.

[76054.]—**Electric Light.**—Procure a 15-volt 8c.p. lamp. Make up eight cells of double carbon single zinc elements. The zincs should hang between the carbon plates, at a distance of about ¼in., sandwich fashion. Plates 3in. by 6in. will do very well. Ordinary Weston salt jars will do nicely to contain them. The elements should be supported by a transverse bar, so that they can be all lifted from the solution when not in use. To charge the battery, use chromic acid 3oz., sulphuric acid 3oz., water 1 pint. The cells must be coupled in series—that is to say, the carbons of the first cell to the zinc of the next, and so on. You will find full description and cuts how to make such a battery at p. 152 of my "Electrical Inst. for Amateurs," and at p. 166 a full account of the mode of making a small accumulator for scarfpin. S. Bottone.

[76055.]—**Steam-Boiler Safety-Valve.**—The weight of the lever itself acts as its centre of gravity, which, if the lever were uniform, would be at its centre. Therefore, the pressure on the valve would be (without the weight):—

$$\frac{11\frac{1}{4} \times 20\frac{1}{4}}{3\frac{3}{4}} + 2\text{lb. } 6\text{oz.} = 63\text{lb. } 2\text{oz.}$$

Area of valve = $2\frac{1}{4} \times 2\frac{1}{4} \times 3{\cdot}15 = 15\frac{3}{4}$sq.in.;
Pressure per square inch on valve = 63lb. 2oz., $\div\, 15\frac{3}{4}$ = 4lb. nearly.

For every lb. per square inch the pressure at which the valve blows off is increased, 15¾lb. more must be put on it. To obtain this pressure, the weight must be put $\frac{15\frac{3}{4} \times 3\frac{3}{4}}{55} = 1\frac{13}{176}$, or about $1\frac{1}{13}$in. from the fulcrum. Thus, to obtain a 26lb. per square inch pressure, 4lb. is supplied by the weight of lever and valve; multiply $1\frac{13}{176}$ by the remaining 22, which gives 23⅝in. from the fulcrum. H. L. M.

[76055.]—**Steam-Boiler Safety-Valve.**—Let the distance from centre of valve to fulcrum be called $k = 3\frac{3}{4}$in. Let the distance at which the weight is placed upon the lever from fulcrum be called l. The length of the lever $= m = 40\frac{1}{2}$in. The weight $= w = 11\frac{1}{4}$lb. The weight to slide on lever $= W = 55$lb. The effect of the lever at centre of valve-seat, including the weight of the valve $= p$. The upward pressure of the steam against the valve $= P =$ say for 15lb. per square inch, 15 × 15·9 (area of valve-seat) = 238·5lb. The effect of the lever at centre of valve-seat may be correctly enough found for all practical purposes by dividing its total length by the distance between centre of valve-seat and fulcrum, and multiplying the quotient by half the weight of the lever, thus:

$$\frac{m}{k} \times \frac{w}{2} = \frac{40{\cdot}5}{3{\cdot}75} \times \frac{11{\cdot}25}{2} = 60{\cdot}25\text{lb.}$$

$$\text{Add weight of valve} = \underline{2{\cdot}375\text{lb.}}$$

$$62{\cdot}625\text{lb.} = p.$$

Then for distance of weight (W) from fulcrum—

$$\frac{(P - p) \times k}{W} = l;$$

or for actual case, given a working pressure assumed—

$$\frac{(238{\cdot}5 - 62{\cdot}625) \times 3{\cdot}75}{55} = 12\text{in., nearly.}$$

It is evident that the greatest working pressure which the given conditions permit will be found by the formula—

$$\frac{W \times l}{k} + p = P,$$

or—

$$\frac{55 \times 40{\cdot}5}{3{\cdot}75} + 62{\cdot}625 = 656{\cdot}625\text{lb.},$$

and as the valve-seat has a clear area of 15·9sq.in. (square of radius multiplied by 3·1416), the highest attainable steam pressure per square inch will be $\frac{656{\cdot}625}{15{\cdot}9} = 41{\cdot}3$lb., and the whole is probably arranged for a working pressure of 40lb. The effect of the lever may practically be found by balancing it in a horizontal position on a knife-edge. Measure the distance from fulcrum to this point of equilibrium, and divide it by the distance from fulcrum to centre of valve-seat. The quotient multiplied by the total weight of the lever represents its effect in pounds on the valve, to which the weight of the valve must be added. This should give about the same result as before—viz., 62·625lb.

Marienberg.

[76059.]—**Reflector.**—There is ample information in the back volumes of this journal to answer your query. If you have a speculum 8½in. diam., we assume you will require a 10in. tube to mount it in. The half of this is 5in., and if we assume the stop between the two lenses of an Huyghenian eyepiece to be 3in. from the outside of tube, the flat mirror must be placed 5 + 3 = 8in., or, say, 8½in. within the cone of rays formed by the speculum when exposed to parallel rays. If you desire further information write again.

J. C. Linscott.

[76059.]—**Silvering Metallic Mirrors—Focus of 8½ Mirror.**—As I am so often applied to, both by amateurs and tradesmen, to silver metallic mirrors, I thought it would be well to answer this question of "A. E. W." Metallic mirrors cannot, of course, be silvered by our silver solution process, as nitrate of silver would attack the metal. "Acide" can find the focus of his 8½in. mirror by tacking on the end of a plank at right angles to its length a piece of card about 5in. high, placing the plank in the direction of the sun and nearly the same angle of elevation, throwing the image of the sun on the card, and moving it to or from card till he gets the smallest and sharpest image. The plane should be placed at a distance half-diameter of the tube and the end of eyepiece tube, less by, say, 1½in., according to the different eyepieces he uses. If the focus is 6ft. and half the diameter of tube, and length of eye-tube is 12in., place plane 10½in. inside focus of mirror. G. Calver.

[76060.]—**Dynamo.**—Fifty volts and 3 or 4 ampères, at 2,000 revs. per minute, should run three lamps of 16c.p. each requiring 48 volts.

F. Askew.

[76060.]—**Dynamo: what Output?**—A dynamo having a ring armature 5in. in diameter wound with 2¾lb. of No. 18, and running in field wound with 12lb. No. 20, should, if well made, light 5 lamps of 16c.p. 48 volts 1 ampère each, if driven at 2,500 revs per minute. S. Bottone.

[76065.]—**Smoky Chimney.**—If the querist can refer to your back volumes (several years ago) he will find that someone patented the method of curing a smoky chimney by putting a bladder (loosely held) in the chimneypot, or just below it. If I recollect, it was a copper or other metal ball of oval shape, and I daresay the idea was very old. The way to cure a smoky chimney is to put something on the pot—Boyle's cap, for instance—which will always insure an up-draught. As to the phrase "I am become like a bottle in the smoke," I suspect it means that the speaker had become "dried," as a leather wine-skin would if exposed to smoke. Nun. Dor.

[76069.]—**Lathe.**—The V-groove of a mandrel pulley is better than a round groove. It should not slip off if you have the belt that will suit the size of the grooves; or perhaps your flywheel is not in line with the other pulley. E. J. W.

[76069.]—**Lathe.**—"A Constant Reader" may reduce the slip of his lathe-belt by sprinkling with powdered rosin; at the same time he should not try to take too large a cut, or he will assuredly place too great a resistance on the overcoming powers of belt. W. Strafford.

[76069.]—**Lathe.**—V-shaped grooves are certainly better than round, and I should advise the querist to have the pulley re-turned. As to belt, I prefer a leather strap, similar to those on sewing machines, to the gut bands for small lathes. With a strap of this sort I can turn in my 2½in. lathe a piece of iron 5in. diameter without much trouble.

Major.

[76069.]—**Lathe.**—For small lathes, round gut band is the proper thing to use. If the grooves on pulley are turned to exactly fit the band, you should not have any difficulty from slip; but I think the V-groove is the best. Rosin, applied to band, causes it to grip more; but it makes both band and wheel very dirty.

Brighton. T. C. Smith.

[76070.]—**Electrical.**—To Mr. Bottone.—The proportions your friend gave you are quite correct. The defect is in your lamp—or, to speak more exactly, in the proportion of cells to the voltage of your lamp. Get an 8-volt lamp, and you will be all right with your cells; or else add another cell or two and use your present lamp. You must not expect to get more than three hours' light with once charging. S. Bottone.

[76072.]—**Wood-Bending.**—Did the querist get the wood thoroughly pliable before bending, and take the bend by degrees? The process must be repeated for sharp bends. L. M.

[76072.]—**Wood-Bending.**—I once successfully bent a walking-stick by boiling the part to be bent for several hours. Perhaps you did not boil your stick long enough. Major.

[76075.]—**Siemens Dynamo, to give Shocks.**—To Mr. Bottone.—Any device by which the current can be rapidly interrupted will cause the machine to give shocks. Perhaps the neatest way is that suggested by our friend G. Bowman, who simply widens the slit of the commutator. With regard to the best battery for lighting an 8c.p. lamp, see my reply to query 76054, in this same number. S. Bottone.

[76076.]—**Brass Colour for Solder.**—Prepare a saturated aqueous solution of sulphate of copper (blue vitriol or bluestone), and apply a little to the solder. On touching this with a steel or iron wire a precipitation of metallic copper will be produced, and by each repetition of the process the deposit will become thicker and darker. Next mix a saturated aqueous solution of sulphate of copper with half its weight of a similar solution of sulphate of zinc (white vitriol). Apply to the coppered spot with a zinc rod, and a deposit of brass will be the result. P. W. Stanley, Analytical Chemist.

Billson-street, Poplar, London.

[76076.]—**Brass Colour for Solder.**—Why not use yellow solder? Spon gives a yellow solder for brass or copper:—1. Copper 1lb., zinc 1lb. 2. (Stronger) Copper 32lb., zinc 29lb., tin 1lb. Or you can colour soft solder—according to the same author—by preparing a saturated solution of copper sulphate (bluestone) in water, and applying some of this on the end of a stick to the solder. On touching it with a steel or iron wire it becomes coppered, and by repeating the experiment the deposit of copper may be made thicker and darker. To give the solder a yellow colour, mix 1 part of a saturated solution of zinc sulphate with 2 of copper sulphate. Apply this to the coppered spot, and rub it with a zinc rod. The colour can be still further improved by applying gilt powder and polishing.

S. H. C.

[76076.]—**Brass Colour for Solder.**—I believe a yellow solder has not been discovered, though a good reward was offered for the same. I always colour any white metal in the following manner: Put a bit of gamboge in a small stoppered bottle, fill it up with methylated spirit and a small piece of pale shellac. This is No. 1. In another bottle make a solution of pale lac in spirits. Keep in a warm room, frequently shaking the bottles. The contents should be ready in 24 hours. Place your work before a fire, till the metal is raised to blood-heat; then with a very soft brush apply No. 1 till you have the right colour; when quite dry, and still warm, give a thin, smooth coating of No. 2, and a second one in two or three hours if you like. I use this process for my artificial baits, and find it stands well, even in water. Eos.

[76077.]—**Silvering.**—The querist will find ample information in back volumes; he may also, with advantage, procure a book for 1s. from Messrs. Horne, Thornthwaite, and Wood, of 416, Strand, giving several formulæ for silvering glass mirrors. This book is called "Hints on Refracting and Reflecting Telescopes," and is advertised on p. ix. of the "E. M." for Dec. 4th. J. C. Linscott.

[76077.]—**Silvering Solution for Glass.**—To Mr. Bottone.—Make your glass scrupulously clean by rubbing over with a cork dipped in strong nitric acid, and then rinse in plenty of distilled water. Stand up to drain, and as soon as drained lay on the surface of a bath composed as below, the glass being supported by its corners, just on the surface of the fluid, by four glass or earthenware stands. The solution is composed of—nitrate of silver 1½ part, water 12 parts, liquor ammoniæ 8 parts, pure caustic soda 1 part, water 70 parts. Mix these together. Just before placing in the glass to be silvered, add 10 parts of a solution of ½ part sugar of milk in 9½ parts of water (distilled) and ½ part of pure alcohol. Under the influence of daylight, the immersed surface of the glass will be seen to become first yellow, then brown, and in five minutes will be uniformly silvered; in 10 to 15 minutes the coating will be thick enough. Must be well washed in plenty of water, reared up to dry, and polished, if desired, with a chamois leather and finest rouge.

S. Bottone.

[76078.]—**Boring Square Hole.**—Is not this on the same principle as cutting a square hole in a sheet of metal? of course, easy enough.

Duffer.

[76078.]—**Boring Square Hole, &c.**—This is a "catch." If a thin piece of board be firmly fixed in a vice between two fairly thick pieces; if now a hole be bored edgeways by means of a brace and bit, it will appear as if it were possible to bore a square hole by means of a round bit. It is simply a trick. Iota Dash.

[76078.]—**Boring Square Hole.**—If "Old Subscriber" will refer to his number containing p. 86 of the last volume, he will find illustrated a method of drilling square holes, and, I think, a reference to a method of doing it patented some years ago, by means of what may be described as a wobbling bit, or cutter. It was illustrated, if I remember correctly, in Sept. 27, 1878.

Nun. Dor.

[76078.]—**Boring Square Hole.**—Let the cutting edges of drill form a right angle with each other; then take a piece of brown paper, double it, and place it between two pieces of iron, double edge of paper being exactly level with surfaces of iron. Now drill exactly upon the seam into iron until shoulder of drill is precisely level with surface. Then separate pieces of iron, take out, and open brown paper; a square hole will be seen at place where paper was doubled.

W. Strafford.

[76079.]—**Battery for Electric Light.**—A battery of accumulators, the plates of which were of the size you name, would be completely run down if 1 ampère were drawn off in an hour. The voltage, when freshly charged, would be about 44, so that you might just keep one of the Beaumont arc lamps going for, say, half an hour. This would give about 100 c.p. You could charge them, if coupled in series, on the circuit you specify, without injury.

S. Bottone.

[76081.]—**Motor for Boat.**—Since I wrote respecting the above (75420), I have made further experiments with oil as a motive power, with such good results that I think, in fairness to myself, I ought not yet to make my ideas public.

Brighton. T. C. Smith.

[76082.]—**Electric Lighting.**—Four double-fluid bichromate cells, quart size, will do what you require, but will want charging after 12 hours' work.

F. Askew.

[76082.]—**Electric Lighting.**—If you mean two lamps of about four volts, 1c.p. each, you would best do this with four Fuller cells of about one quart capacity.

S. Bottone.

[76085.] — **Voltmeter.**—Please refer to reply 72440, p. 150, of English Mechanic, Vol. LII., which is the No. 1333 for Oct. 10, 1890. There you will find sketch and full description of how to make such a voltmeter. The only difference you need make in your case is to wind the bobbin with ½oz. No. 38 copper wire, instead of the German silver.

S. Bottone.

[76086.]—**Re-silvering Reflector.**—Your Gregorian telescope speculum is made of speculum metal, and cannot be silvered as glass is; and if you could have it electroplated, the figure would be spoiled. It can only be re-polished by persons who know how to do it.

Ramsgate. J. C. Linscott.

[76087.]—**Formula Wanted.** — The simplest method is to reckon 6d. as interest on every pound for one year, which would be ½d. for one month.

H. L. M.

[76087.]—**Formula Wanted.**—The interest is found for a rate of 2½ per cent. by multiplying the capital by the number of days, and dividing the product by 14,000. For 3 per cent., by 12,000; for 3½ per cent., by 10,286; for 4 per cent, by 9,000; for 4½ per cent., by 8,000; and for 5 per cent., by 7,200. The year being assumed at 360 days.

Marienberg.

[76087.]—**Formula Wanted for Interest.**—As 2½ per cent. per annum is 6d. per year, that is one halfpenny for every month for every complete £1, I should think "Inquirer No. 1" could work out for himself what he desires to know.

J. C. Linscott.

[76088.]—**Electric Light Installation.**—To Messrs. Bottone or Allsop.—A two man-power engine will light four or five lamps of 8c.p. 25 volts. The cost of setting up engine and dynamo, and fitting lamps, wires in casings, and switchboard would come approximately to £5. This, of course, is exclusive of actual cost of engine and dynamo. This latter would cost £4 to £5, the former £8 to £15, according to maker. There would be no absolute necessity for voltmeter or ammeter.

S. Bottone.

[76089.]—**Brass Melting.**—If you use clean metal to begin with, you need not use borax at all. In fact, I always find I can make a much better casting without using borax. The brass casting "trade" in Birmingham—probably the largest in the world—do not use anything of the sort, and it is only among amateurs and in amateur books that one finds the use of borax mentioned. The proper use of borax is for cleansing dirty metal; this is run into ingot and remelted without borax for casting. As to (3) the only burning that takes place is that of the zinc, and the only preventive is to remove the crucible from the fire when the white fumes of burning zinc appear. The metal is then ready for pouring.

Brum.

[76093.]—**Relacquering Chandeliers.** — Lay some scraps of sheet iron in your trough, and fill with water; then add a little weak dipping acid, and let it stand for about half an hour. Dip the brass into your acid and then into the trough for a few seconds. When taken out it will be a bright copper colour. Dry off in sawdust in the usual way, and finish with light gold lacquer. Am sorry I cannot give you the steel bronze; but you will find the "Brass Founders' Manual," by W. Graham, price 2s., a great help; order it from any bookseller.

Aqua.

[76091.] — **Boiler.** — What sort of "flues" through a barrel only 6in. in diameter? It seems to be only a sort of "model," and is, I should think quite unable to generate steam sufficient to work an engine capable of driving a saw to cut wood 4in. thick. "More trouble than it is worth" would, I fancy, be the verdict of practical men.

X. T.

[76094.]—**Coil Construction.**—To Mr. Bottone.—The results would be far inferior in every way. First, the resistance of the secondary would be greatly increased by the increase of length, without any increase in induction, which takes place in the direction of the length of the coils, and not across. The tendency to leakage through the primary would also be greatly increased.

S. Bottone.

[76095.] — **Physiological.**—1. You could not make Marey's instruments as cheaply as you can buy them. I do not know the prices in London; but speak of the price in Paris. In my opinion it is utterly useless to attempt to study physiology in this country, owing to the success of the anti-vivisectionists. You must go abroad, as I did, to Vienna, Paris, and Strasburg. 2. Yes, you require a license from one of H.M. Secretaries of State, and you must, further, obtain a certificate from one of the scientific bodies mentioned in section 11 of the (Vivisection) Act, 39 and 40 Vict. c. 77. The penalty for making a physiological experiment under this Act without a license is £50 for the first offence, and £100 or three months' imprisonment for second offence.

Plymouth. B.Sc.

[76096.]—**Atmolysis.**—This term is given to the separation of gases by means of diffusion—e.g., if an explosive mixture of H and O be slowly passed through a porous cylinder, a great quantity of the H gas will pass out through the side of the cylinder. If the mixed gas be now tested, it will be found that it will be no longer an explosive mixture.

Iota Dash.

[76096.]—**Atmolysis.**—This word is a Greek compound, and signifies "vapour" and "I loosen." It is a means of separating two gases from each other by taking advantage of their different diffusive powers. The rate at which a gas diffuses varies inversely as the square root of its density—for instance, hydrogen will diffuse four times as fast as oxygen, and nearly six times as fast as chlorine. A common long churchwarden tobacco-pipe serves very well for showing the action. If a mixture of detonating gas (two vols. hydrogen and one vol. oxygen) be allowed to traverse the pipe slowly, the gas which emerges will consist chiefly of oxygen, the hydrogen having escaped through the pipe. Deville proved the dissociation of ammonic chloride as vapour by atmolysis, and the method is sometimes useful in gas analysis.

Wm. John Grey, F.C.S., Analytical Chemist.

[76098.]—**Rouge.**—It seems to me that the answer to this query is given on the next page in Answers to Correspondents to Arthur Wilson. It is cheaper to buy rouge than to make it. V. S.

[76098.]—**Rouge.**—Put 2oz. or 3oz. of sulphate of iron into an ordinary open clay crucible, and heat it in a good fire for about three hours. At first the crystals will split up and fall to a white powder, and then be gradually converted by the action of the heat into rouge. Endeavour to prevent cinders falling in, but do not cover the top of the crucible. The rouge is then to be mixed with water, and allowed to settle. The coarser particles may be used for polishing steel or hard metals, and the finer for silver, &c. H. L. M.

[76098.]—**Rouge.**—Make a solution of sulphate of iron with boiling water; filter, and add a strong solution of oxalic acid until there is no further precipitation. When cold, well wash with hot water until the acid is quite removed—i.e., until the washing water gives no action on litmus-paper. Well drain the precipitate, and heat in an iron ladle until decomposition takes place (about 395° Fahr.) By this process oxide is obtained in a very fine state of division. Unless "S. P." uses a great quantity of rouge, he will, I think, not find the "game worth the candle."

Brighton. T. C. Smith.

[76099.]—**Gauge-glass Washers.**—I do not think there is much harm is using the grey rubber washers, as they are used by the score in the mail-steamer boilers; but when we run out, we used to pick the asbestos packing to pieces and make that into washers, or a thread of sailmaker's twine made into a washer with a little grease, and I have seen them stand a whole voyage of two or three months at a stretch.

Birmingham. W. J.

UNANSWERED QUERIES.

◆

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75467.	Continental Trains, p. 163.
75471.	Self-Toning Photo. Paper, 163
75475.	Diffraction Spectroscope, 163.
75478.	Tea Culture, 163.
75481.	Reversing Gear, 163.
75485.	Byng Coil, 163.
75494.	Glass-blowing with Oil-lamp, 163.
75501.	Hydraulic Pump or Ram, 163.
75509.	Telescope Optics, 164.
75513.	South-Eastern Railway, 164.
75521.	G.N.S.R. Locomotives, 164.
75528.	Taking Out Quantities, 164.

75730.	Electric Organ, p. 250.
75738.	Testing Rennet, 250.
75739.	Fan, 250.
75750.	Tests for Tin, 250.
75756.	Self-acting Railway Carriage Coupling, 251.
75759.	Question in Arithmetic, 251.
75760.	Law, 251.
75767.	Dry Plate Developer, 251.
75768.	Hysteresis—To "Sigma," 251.
75779.	Atomic and Molecular Volumes, 251.
75781.	Horological History, 251.
75785.	Sun Transits, 251.
75787.	Curves, 251.
75799.	Repoussé Work, 251.

QUERIES.

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[76101.]—**Balance Swell Pedals.**—The writer will be deeply obliged to "Leo" if he will give the design for the balanced action for the vertical swell for the organ, and thanks him for the horizontal swell design he gave in the No. for Dec. 4 inst.—Efil.

[76102.]—**Paraffin Oil**—What is the explanation of the following report, and how are the analyses performed? "Flashing point is 75°—Abel test"; burning point, 119°—American test." Does the report indicate a safe oil?—Antares.

[76103.]—**Soldering Cast Iron.**—Will Mr. Thos. Fletcher be kind enough to tell those who are ignorant, like myself, how to make the sodium amalgam he recommends in his reply to query 75980 on p. 356—C. E. F.

[76104.]—**Condensers for Biunial.**—I have a biunial lantern fitted with 3¼in. condensers which are excellent, but scarcely show right to the extreme corners of Wilson's cushion mat slides. Circular pictures come out as well as could be wished for, being splendidly illuminated, but do not look as well on the screen as the cushion shape mat. The portion of slide so cut off is very slight, but can be distinctly noticed. Will any reader kindly tell me if I can in any way alter the position of the condensers to fully light up the cushion mat slides? A week or two ago I noticed a reply to query *re* condensers which advocated 3½in. condensers for the optical lantern, and I shall feel greatly obliged if the same correspondent will give me any hints on the subject. Failing being able to make 3½in. condensers light up the slide properly, how shall I go about fitting 4in. condensers? The lantern front is plenty wide enough for 4in. condensers.—Biunial.

[76105.]—**Siphon.**—What is the largest diameter of pipe that can be made to siphon water, and whether the difference in heads of water has much to do with the velocity of the water passing into the pipe, or in keeping column of water (in pipe) intact, so as to avoid having to recharge it? I may say that where I have a 2½in. pipe working satisfactorily I cannot get a 3½in. to work at all, and it is this that I want explained.—Siphon.

[76106.]—**Problem.**—What is the meaning of $a^{\cdot}$ in the following equation?—

$$x = a^{\cdot}\ \frac{a^3}{b^3 - a^3}$$

where $a^3 = 27{,}000$,
and $b^3 = 29{,}791$.

What is the answer?—Puzzled.

[76107.]—**Moles.**—Will some reader kindly let me know how to remove moles by electricity, and what kind of apparatus I shall require?—A New Reader.

[76108.]—**Series Dynamo.**—I have a series dynamo, four-pole, two sets brushes, flat ring armature, wound with about No. 11, and fields with 4-18 about. Stated to give 160 ampères at 50 volts, 800 revs. When put into circuit with one arc lamp it excites readily enough, but does not build up to form perfect arc. At 100 revs., when short-circuited between terminals, for an instant it makes a very near approach to lighting the lamp, but does not do more than spark when short-circuited in the same way at 800 or 900 revs.; insulation is good. What is the fault, and how remedied?—Dundas.

[76109.]—**Steam-Pump.**—I have a Worthington steam pump pumping hot water, and cannot keep the glands from leaking at the pump end. Can some kind reader tell me the proper packing to use for hot water, and oblige?—Ignorant.

[76110.]—**Electric Lighting.**—I would like to know probable cost of gas-engine, dynamo, and fittings to light one or two powerful arc lights and incandescent lamps to light about six rooms. What power of engine would be required and size of dynamo? The arc light is intended for outside light, and the rest to take the place of regenerative gas-lights, which are objectionable on account of the great heat evolved. Any other information will oblige.—Retlaw.

[76111.] — **Glass and Caoutchouc Tubing Joints.**—When caoutchouc tubing is put over a glass tube in connection with a very highly exhausted vessel, how is the connection made air-tight?—A. T.

[76112.]—**Organ.**—To "Organon" and Others.—A friend is desirous of adding to his American organ (Bell's) two octaves of either musical tubes or tuned bells; he has an idea that electricity might be made to do the job. Is it practicable, and would it be "the thing" from a musical point of view? What alterations or additions to the action would be required, and how would you propose striking the bells or tubes—with a hammer, as in a piano? He is prepared to enlarge the case if necessary. What about cost?—Musfaer.

[76113.]—**Thirty-Light Dynamo.**—Will some kind reader tell me the amount and size of wire to put on armature and field-magnets of dynamo to light about 30 16c.p. lamps? F.M. cores wrought iron, 4in. diam. and 9in. long. Yoke and pole pieces cast iron. Tunnel for armature 7in. long, 7½in. diam. Armature to be a Gramme ring 36 sections. I have about 3½H.P. at my disposal. Will this be enough to drive it?—R. H. W.

[76114.]—**Press Tools.**—I am desirous of turning out some small brass plates by means of a press tool. Can any of "Ours" give me any information on the working of these, or refer me to a good publication on the subject?—Ulyc.

[76115.]—**Riveting Felt on Piano Hammer.**—To Mr. Bottone.—In letter No. 32921 you remark that good pianos have felt on hammers riveted. Any information on the subject would be welcome.—J. R.

[76116.]—**Carbon.**—I have heard it stated that after being in use for a comparatively short time the incandescent electric lamps are quite useless by reason of the carbon burners becoming worn away. Will some correspondent say if this is correct, and kindly send a drawing of the above-named lamps, explaining the various parts in detail. I hope that this question will not be overlooked, as I am very anxious to know.—W. E. S.

[76117.]—**Strophanthus.**—Would any of your correspondents give a description of this plant, where it grows, and its use as a medical drug?—A. Losea.

[76118.]—**Accumulator.**—How can I make an accumulator giving either 5 volts and 2 ampères, or 4 volt and 3 ampères?—Watt.

[76119.]—**Fixative.**—I want a good fixative for chalk and charcoal drawings, one that will fix the drawings well, and do away with the necessity of having to go over the drawings several times before they are fixed? Must be cheap. The recipe I am using is 8oz. methylated spirits to 1 drachm of gum mastic, which has the faults I have stated.—A. W. L. Dixon.

[76120.]—**Greenhouse Boilers.**—Can anyone tell me if there is a simple cure for incrustation in greenhouse boiler and pipes short of pulling to pieces?—A. G.

[76121.]—**Anti-Freezing Liquid.**—I would like to know the chemical used as an anti-freezing liquid for charging high-pressure ¾in. water pipes, and in what proportion mixed with water.—Frost.

[76122.]—**Marble Slab.**—Will any kind friend tell me the best way to take about ¼in. off marble slab so as to fit tip-up basins which are not exactly round, and will not go into hole in slab.—Amateur.

[76123.]—**Greater Britain.**—Will Mr. Stretton (p. 355) reconcile his statement that 81 miles per hour is the greatest speed ever run on rails, and that this will never be surpassed by a "compound" with that of the *Engineer* of March 7. 1890? In an article on Worsdell's new compound, N.E.R., it gives diagrams taken at 86 miles per hour, and also says that this speed was most carefully measured? It seems that the "Webb" engine is nowhere in the running with the "Worsdell," and also that a compound loco. can run as fast as a high-pressure one.—Speed.

[76124.]—**Photography.**—I would feel much obliged for a formula for making up hydrokinone developer.—H. S. M.

[76125.]—**To Mr. Bottone.**—I saw some time ago at the Inventions Exhibition a small water-motor and dynamo combined driving ten 20-volt lamps. The dynamo was very small, also the motor, and the whole concern only supposed to weigh 12lb. The dynamo stood about 6in high by 3in. wide and 4in. long; the motor seemed to be a row of spoon-shaped fans about six in number, with the same amount of jets above them, and the dynamo was driven direct. Can you give me any information as to whether such a small arrangement could be made to drive off the ordinary house-tap connected with main? Any suggestions would be most thankfully received by—N. C.

[76126.]—**Clock Battery.**—Will Mr. Bottone kindly inform one who is in a fix to keep an electric clock going with a battery suited for such a clock? The clock is named Alexr. Bain's Patent Electric Clock, Edinburgh. Also, is there such a battery called an earth battery suited for this kind of clock?—Electric Clock.

[76127.]—**Gas Photometer.**—I should be grateful for a description of a simple form of gas photometer which would give me the candle-power within a margin of a candle. I am acquainted with the elaborate apparatus in use in large gas-houses, but for my purpose do not require such accuracy.—Rosicrucian.

[76128.]—**Battersea Enamel.**—Can anyone inform me the best way to repair a Battersea enamel snuffbox chipped at the edges, and cracked across the cover. Would it be best to fill the cracks up with plaster of Paris, and paint over, or is there a better cement, or a better way of doing it? The ground of the box is white, painted with different coloured flowers. Or does any reader know of a book on repairing enamel or china?—Painter.

[76129.]—**Piano-Tuning.**—Will one of your musical readers tell me how to set about tuning my piano (a bi-chord)? There is some dodge about flattening one of the a ... I believe. I can get the open keys right but the black keys won't bear playing in.—Failure.

[76130.]—**Glass Grinding.**—Can anyone give me any practical hints on glass grinding and polishing? Are there any handbooks to be had on the subject? I want to grind and polish glass surfaces both concave and convex up to 12in. in diameter. If possible, would like sketch of grinding apparatus, and full particulars.—Zebra.

[76131.]—**Teeth.**—Through an accident I lost best portion of mine, the remainder, with the exception of two bottom ones, coming out with cause—I must now have a false set top and bottom. Can any of "Ours," by thorough use and experience, inform me what kind—I do not want any makers' names—would give best service, those put in by suction only, or those having in addition a spiral gold spring connecting the back ends? I do not want, if possible, to remove the teeth but once a week, neither do I want the top row falling into the mouth when eating or speaking, or getting down the throat during sleep—two such deaths reported this year. I want a set to eat with, speak with, and sleep with, and which would give comfort to—Working Fitter.

[76132.]—**Plating Dynamo.**—To Mr. Bottone.—I have made a ring armature 6in. diam. wound with 100ft. of No. 12 wire; speed 900. What size wire should I put on F.M. to get best result as a shunt machine?—London.

[76133.]—**To Mr. Allsop or Others.**—In telephones used without a battery, does it matter which end of a magnet the bobbins are fixed on, or if one line wire is connected, one end to commencement of wire wound on bobbin, and the other end to the finishing end of bobbin wire on the other telephone? Also, what No. and yards of wire on bobbin give the best results?—N.

[76134.]—**Magneto Bells.**—To Mr. Bottone, Mr. Allsop, or Others.—I have a good deal of trouble with the above, and shall be glad of your advice. In many I find the armature, instead of remaining against either core, if placed there, will persist in sticking to one, and the ringing is very spasmodic and uncertain. If placed against the other core it flies over to the one that it sticks to. Is it caused by the iron in one core being harder than the other, and is the hard one the one from which it flies? Shall be glad to know the remedy for the above. If possible, without having to soften the hard core, as the core forms part of the bobbins upon which the wire is wound.—An Old Subscriber.

[76135.]—**Pocket Medical Coil.**—I have a pocket medical coil: the case is made out of a block of wood, with three holes drilled for the battery, coil, and handles, and three connections for taking the shocks; it is complete except the coil. Will some reader kindly tell me the size and number of coil for primary and secondary wire, and how to connect it to the battery?—Albion.

[76136.]—**1in. Spark Induction Coil.**—Can any reader kindly help me to understand why the coil which I have just completed according to the undermentioned specification, will only give me a ⅛in. spark, using five freshly-charged bichromate cells? I have been rigidly careful throughout as to insulation, winding, &c., and have followed the instructions given in S. R. Bottone's book, "Electrical Instrument Making for Amateurs." No details are given in the above as to the dimensions, &c., of the contact breaker, and I have fancied that the fault lay in this. Specification.—Core: No. 18 soft iron wires surrounded by brown paper tube 9in. long by ⅞in. diameter; wires protrude ⅝in. towards contact breaker. Primary: Four layers No. 18 double silk covered wire. Inside length between the standards is 8in. Secondary: Between 1lb. and 1½lb. of No 39 double silk covered wire. Insulation: Everything well soaked in hot paraffin separately, and all the layers well basted and separated by paraffined rice paper. Condenser: 9in. by 7in., with 150 alternations most carefully made and insulated, and connected to hammer and spring of contact breaker respectively. Terminals of secondary are fixed on the wood standards at either end of the coil, the last layer terminating at the opposite end to which the first layer began. I should specially like particulars as to dimensions, strength, and material of springs, length, &c., of the contact breaker suitable for the above coil, as with the one I have made there always seems such violent action, and the spark is so powerful that the platinum contacts are quickly burnt away.—Induction.

[76137.]—**Stamping Letters on Wood.**—I want to stamp name and address in small letters on wood. As it must be done lightly and neatly, probably pressure and heat would be best. Can you tell me of such an appliance?—J. Y.

[76138.]—**Calculating H.P. of Gas-Engine.**—I have a 7-horse Crossley gas-engine, and wish to put down several new machines, but am not certain whether the engine will drive them. How can I tell at what H.P. my engine is now running? A reply will much oblige.—A. B. T.

[76139.]—**Air Compressors.**—I require a small air compressor to supply about 60 c.ft. per minute at about 10in. of water pressure. The compressor will be in the form of a cylinder of about 19in. diam by 20in. stroke; piston about 4in. thick (no rings). I should like to know if any reader can inform me what should be the area of the inlet and outlet valves; also the best form of valve to use to get a maximum of efficiency. The cylinder will be a double-acting one. A sketch of the valves would be gratefully received.—W. F. E.

[76140.]—**Great Western (N.G.) and North Stafford Locos.**—Will any of "ours," kindly give me sketch of each of the latest express passenger engines of the above, together with particulars and weights? Also please say if the G.W. saddle tank engines with two domes are broken up, and what their weights were.—Chillington.

[76141.]—**Deafness.**—A working man would be glad of advice for the cure of chronic deafness of left ear. It has been diagnosed by a physician as catarrhal deafness with much nerve weakness. Drums are both healthy. It is worse when I have a cold in my head, and my right ear is not so good as it should be. In left ear I can only hear watch about an inch away. I have been to hospital, but got no better. Perhaps some one who has been a sufferer similar to me can advise—One Almost Despairing.

[76142.]—**Hydrometer.**—A hydrometer floats in a liquid sp.gr. ·9 with 5in. more of its stem above the surface than it would have if placed in water. What point of the stem will be on the surface when it floats in liquid whose sp.gr. is 95? Answer, 27·19in. Will some reader show me how the above is worked out?—W. M.

[76143.]—**Hot-Air Engine.**—Will some practical engineer give a sketch and a few hints on how to make a hot-air engine of about ½H.P., for which I will feel greatly obliged.—J. B.

[76144.]—**Model Electro-motor.**—Will Mr. Bottone describe the four pole motor which he refers to in 75510? I have looked through several volumes of back numbers, and can only find one four-pole motor described, and that was in the articles you gave on "Electro-motors: how Made and how Used." Is this the one he refers to? If so, I have the back number by me.—Multipolar.

[76145.]—**Electro-motor.**—To Mr. Bottone.—For series connection you state that the resistance of field-magnets should be about two-thirds of the armature resistance of the ring type motor. Does this mean that the resistance of fields should be two thirds of all the wire wound on the armature? For instance, in a four-pole motor which I have the armature is wound with 120yds. of 22 s. wire in eight sections, with opposite sides of commutator connected and brushes at right angles. In this case what quantity and size of wire would you advise for field-magnets in series? Also for same in shunt, and what is the object of connecting some motors in series and others in shunt? Which connection will give best results from, say, three or four bichromates? The information will be thankfully received by an—English Mechanic.

[76146.]—**Furnace Casing Mixture.**—To Mr. Fletcher.—If you will kindly give me some information on the following question I shall be very much obliged. I wish to make in a similar material to Fletcher's gas furnace casing an article to be the shape of a gas tee, the hole through it to be about 1in. diam, and to have about 1in. of the material on each side, which will cause the outside diameter to be 3in. and 12in. long. In the branch piece of T I put a Fletcher's injector furnace blowpipe connected to a pair of No. 5 foot-bellows. I want this contrivance, so that I can heat thick wire almost to a white heat as it is passing through the apparatus. I have tried the mixture as advised by you in answer to query 75371. It is the best I have found so far, but it is not sufficiently bound together, and will not stand any hardship, although I have tried mixing it in several proportions. It is very much inferior to a Fletcher's furnace casing which I have in regular use. Do you think using liquid silicate of soda with the mixture you recommended would improve it?—F. T.

[76147.]—**Organ Reeds.**—I have an organ of eight sets, or four rows of reeds, comprising 2ft., 4ft., 8ft., and 16ft. depth. The 16ft. I like to use as an accompaniment; but, starting from the top F downwards for an octave and four notes, the reeds sound very reedy, and almost like a clarionet—what I should term a good accom.; but, as I get lower, the reeds take almost the form of a substantial bass. What shall I do to voice them, or to make them compare on with the above notes, or shall I want a new set of reeds? Also, how can 2ft. reeds be made to sound more like the piccolo of the Great Organ? What can be used to bring an organ back to its natural polish after it has been in a damp place? What is a good thing to clean any sort of organ or piano keys?—T. L. H. T.

[76148.]—**Front Slide-Lathe.**—Could any of your readers oblige by giving the dimensions of a 6in. front slide-lathe? Would the ordinary heads do with the front slide-bed? Also, the weight of a driving wheel for the above.—Lathe Struck.

[76149.]—**Lathe Treadle.**—To "O. J. L."—Is your system of driving the foot-lathe, as on the "Lukin," better than any of the following:—The American "Grasshopper," the "D. H. G.," the London Lathe Co.'s elliptical "Gear."—Lathe Struck.

[76150.]—**Tricycle.**—In my Royal Mail tricycle the left-hand wheel is connected to the shaft by a box containing two bevel wheels gearing into two idle bevel pinions. Will some kind reader explain the object of this? The writer presumes it is for faciliating the turning of corners.—Cyclist.

[76151.]—**Dynamo Sizes.**—Shall be glad of dimensions of Manchester type, field-magnets, core, and armature. Should core as well as pole-pieces be in malleable iron? Current required: about 10 ampères at 35 or 40 volts, shunt wound. Is above type most economical in working, as most writers prefer longer field-magnets.—D. D.

[76152.]—**Lantern.**—Please tell me fault of my lamp, which is a 4 2in. wick Optimus? I use Snowflake oil "paraffin," with a small piece of camphor in, yet it smokes awfully when turned up to a decent light, especially the two centre wicks. If the cause is the oil, please will you tell me other oil to get, and where? Snowflake costs 11d. per gallon?—Smoky.

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ANSWERS TO CORRESPONDENTS.

_ *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

_ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above. which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

CHRISTMAS DAY.

The English Mechanic will have to go to press some hours earlier than usual next week, in order to complete publication before Christmas Day. All advertisements must therefore reach the Office by 5 *p.m. on Tuesday next*, instead of by 1 p.m. on Wednesday, as usual.

The following are the initials, &c., of letters to hand up to Wednesday evening, December 16, and unacknowledged elsewhere:—

Morris Cohen.—Taylor, Taylor, and Hobson.—B. B.—J. Leeson.—T. R. Clapham.—G. Henty.—J. Fraser.—Aqua.—Carlo Bergonzi.—A. B.—Matteist.—F. J. [illegible]—J. H. Nurse.—Athanasius Kirscher.—Machinist.—Shunt.—D. H. Hutchinson.—Exe.—Ferreo.—Samothes.—A Fellow of the Royal Astronomical Society.—Scio, Glasgow.—E. E. B., Leicester.—J. A. Campbell.—Loco. No. 2.

N. H. Patick, Bombay. (The machine for resetting blunt files (*vide* "E. M." Oct. 23rd) is the invention of Julius Erlenwein, Edenkoben, Rhenish Bavaria, who will doubtless be pleased to inform you whether it is on sale yet. This is a little doubtful, as the invention is only about three months old.)—W. H. Gates. (Many thanks for kind offer. It is very seldom possible to reproduce pencil sketches of astronomical subjects, but we would do our best. It would be much better if they were in ink, in line only, with no tints or washes, and drawn about as large again as intended for reproduction.)—J. E. S. (It is doubtful whether a really fossil man has been discovered. As Geikie says, "The proofs of the existence of man in former geological periods are not to be sought for in the occurrence of his own bodily remains, as in the case of other animals. His bones are, indeed, now and then to be found; but in the vast majority of cases his former presence is revealed by the implements he has left behind him." At one of the libraries in Birmingham you can see all the works which bear on the subject.)—H. S. S. (Chapman's "Treatise on Rope-making," E. and F. N. Spon, 3s., is about the only work on the subject, but there are many articles on the details of manufacture in back volumes.)—Evil. (Diatoms are "splitters," microscopic bodies, multiplying by fission, found in damp places and at the bottom of deep seas. The term is also applied to the silicious coverings of the plants. or in full, diatom scales.)—B. H. (Apply to the nearest magistrate; he can advise as to whether the howling dog is a nuisance or not. If that course will not suit, state the circumstances fully in a query to Mr. Wetherfield, legal editor of the *Weekly Times and Echo*, and he will be able to advise the course of action. Those who are deaf to "pleading and beseeching" deserve little consideration.)—K. G. J. (By analysis, or roughly by evaporating 100 parts of water and weighing the residue. 2. Only by consulting booksellers' catalogues. At the British Museum, the Bodleian Library, at Cambridge, and at Dublin the catalogues would contain the titles of books published in the last hundred years.)—J. H. F. A. (Use a little white of egg whisked up with some of the wine. Stir well and allow it to settle.)—Sighs. (Given in this column a few weeks ago, and in many back numbers.)—J. M. (For browning gun-barrels see p. 456, Jan. 23, 1885. Full and explicit directions are given; but the general method has been explained many times.)—Starkie. (The best plan will be to procure some prepared rubber and a vulcaniser from those who supply dentists with the requisite apparatus. The impression is generally taken in plaster of Paris, and the rubber vulcanised in the mould.)—Perplexed. (It is always risky to expose an invention until the seal has been granted to the specification; but so far as the law is concerned, you may show the invention as soon as application has been made. 2. The word "patent" must not be affixed or used until the patent has been granted. It is usual to put "patent applied for." 3. The number remains the same.)—Ghost. (The information you require as to the construction of a phonograph has been given recently, commencing with number for Feb. 2?, 1891.)—L.A.I.E.E. (Charcoal, coke. and anthracite are commonly called "smokeless.")—New Reader. (Answered several times. Rub the aniline violet up with a little spirit, and dilute with water or with glycerine, according to the purpose for which it is to be used.)—Walton. (Perhaps a work reviewed on p. 321 will suit you. 2. The little racks for swing looking-glasses can be obtained of any large ironmonger.)—No Cure, No Pay.—(All information as to licenses can be obtained from the officers of the district. The license to sell patent medicines costs 5s. per annum. 2. The simplest and safest way to send through the post bottles containing liquids is to have pieces of light wood bored with holes of the requisite size to take the bottles.)—Telegraphist. (See many replies in recent numbers. 2. When the source of power cannot be maintained steadily and in excess, it is better to use accumulators than to work the incandescent lamps direct.)—J. Fenner. (Apply to the surveyor of the district. The railway company might object to a telephone wire crossing their lines.)—Alfred Archer. (Impossible to do more than guess without an opportunity of examining the fittings. It might be caused by a slipping belt; but the fact that the lamps do not jump in one room, presumably on the same circuit, negatives the assumption. See the indices, or send more particulars.)—Aspirant. (Have you seen the articles on electic-light fitting in the last and other volumes?)—Castile. (Answered several times. See p. 212, Vol. LII. Oct. 31, 1890.)—G. Morley Sandon. (Britten's "Watch and Clockmaker's Handbook" will probably suit. Apply to Mr. Britten at the Horological Institute, Northampton-square, London, E.C., stating exactly what you require.)—Yorick. (We do not know of such an invention.)—Arcanum. (With the projectile about £100; range about seven miles.)—Telegraph. (All the theory there is about it is that vibrations produce sounds.)—T. S. Barrett, C. G. M. Bennett. (In type.)

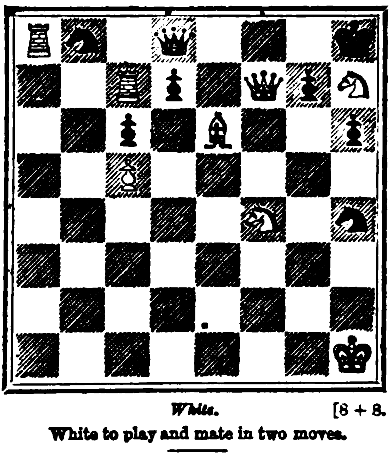
A Little Book of considerable interest to invalids and sufferers is published (gratis) by the Medical Battery Company, Limited, 52, Oxford-street, London, W. It is carefully compiled, and contains much valuable information on "The Remarkable Curative Action of Electricity," with a special chapter on Harness' genuine Electropathic Belt Appliances. Those who cannot call should write at once to the above address before they forget it. A copy, with book of testimonials, will be sent post free on application.

CHESS.

All communications for this column to be sent to the Chess Editor, at the office, 332, Strand.

PROBLEM MCCLXXXV.—By W. T. Hurley.

Black.



White. [8 + 8.

White to play and mate in two moves.

Solution to 1283.

White.	*Black.*
1. Q to Q R sq.	1. Any move.
2. Mates accordingly.	

NOTICES TO CORRESPONDENTS.

Correct solutions to 1283 by H. P. Hosken and A. Anderson; to 1282 by F. H. Guest and Thos. Guest, W. L. Smith, G. H. Inson (very clever), and W. L. Martin.

H. Hilbrand.—Your second attempt at 1282 is also incorrect.

F. H. Guest.—Problems received with thanks.

Thos. Guest.—Ditto.

A. Fellows and A. G. Fellows.—Ditto.

F. W. Roden.—In 1282 if Q to K Kt 5, P covers.

H. P. Hosken.—Duals in twoers do not score.

F. H. Guest and T. Guest.—Solution to 1283 incorrect.

The *British Chess Magazine* for December contains some "Chess Reminiscences" by "Delta." The Rev. W. Wayte continues his careful and thorough review of the new *Handbuch*. It will serve when complete as a comparative analysis of the several new textbooks, and will be a great aid towards perfecting any future editions of same. There is also the usual pabulum of fine games and problems. We notice in future we are promised a greater number of pages, the cost being increased to 7s. a year.

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To Patentees and the Trade.—Mechanical and other Novelties Manufactured throughout in Quantities. Malleable Cast-Iron Work. Hard and Soft Wood Working and Turning. Small Fitting. Spring Making. Press Tool Work. Estimates on application. —THE REASON MANUFACTURING COMPANY, LTD., 111 and 112, Gloucester-road, Brighton.

Holloway's Ointment.—Relaxed and sore throat, diphtheria, quinsey, coughs, bronchitis, and most other pulmonary affections will be relieved by rubbing this cooling Ointment into the skin as near as practicable to the seat of mischief. This treatment, so simple and effective, is admirably adapted for the removal of these diseases during infancy and youth.

OUR EXCHANGE COLUMN.

The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.

Telescope, Equatorial, 6in. aperture, by Sir Howard Grubb, finder, silver circles, driving clock. position circle, slow motions, six eyepieces, illumination, micrometer, photometer. Exchange offers.—Below.

Telescope, Equatorial, 5in. aperture, by Cooke of York, finder, prismatic, illumination, silver circles, slow motions, driving clock, five eyepieces, and accessories, complete. Exchange offers.—Below.

Telescope, Equatorial, 4¼in. aperture, by Alvan Clark, equatorially mounted by Cooke, finder, gunmetal circles, verniers, and microscopes, slow motions, four eyepieces. Exchange offers.—Below.

Telescope, Equatorial, 6½in. reflector, by Horne and Thornthwaite, London, hour and declination circles, slow motions, clamps, finder, six eyepieces, Barlows, solar, diagonal, &c.—Below.

Telescope, 3in., refractor, Unifiler Micrometer, by Grubb; Wedge Photometer, by Hilger. 8½o g., Electric Hand Lamp, two Cameras, pair Telephones, Astronomical Diagrams.—Below.

Microscope, Binocular, large. by Crouch, magnificent instrument; also Monocular by Powell and Lealand. Exchange offers.—Apply Box 20, Post Office, Liversedge. List 3 stamps.

2in. bore **Beam Engine,** 1½ horizontal, in good working order. What offer?—W. Garwell, New-street, Sleaford.

Convertible **Tandem Tricycle,** by Rudge, Coventry, in perfect order, with ball bearings. Exchange offers.—R. Gornall, Damside, Pilling, via Garstang.

2in. **Spark Coil,** ½in. **Spark Coil, Electric Motor.** Medical Coil. Offer wanted.—Rudge, Peasley-cross, St. Helen's.

Chenies Street Exchange and Purchase of all kinds of Scientific Apparatus on which something can be earned. Description first.—A. Caplatzi.

Statham's Ten Guinea Chemical Laboratory, new. never used, perfect. Photographic, or slide-valve locomotive, or other mechanical exchange to full value.—Box 1, Mallow.

English Mechanic from 1197 to 1300, two numbers missing, in good condition. Will exchange for small Dynamo, something mechanical, or horological literature.—George Friend, Duncombe-street, Kingsbridge.

Phonograph, steel screw, about 100 threads per inch, steel nut, brass cylinder and pulley, steel back shaft, with brass sliding tubes, and two diaphragm boxes.—Jas. Henry, 20, Darwen-street, Weaste, Manchester.

Wanted, small **Punching and Shearing Machine** for power, to shear ⅜ Iron, in good order. Have for exchange one-horse power Gas Engine.—T. Atkinson, Crellin-street, Barrow-in-Furness.

Will exchange **Motor** and **Arc Lamp** for pair model Launch Engines, cylinders 1¼in. bore.—A. S., 4, Broseley-villas, Wood Green, N.

English Mechanics, numbers complete, not soiled, unbound, from March '89 to present date. Offers in camera lens, &c.—W. Wolfe, Milton, Cambs.

Wanted, Microscopical Books and unmounted Parasites of animals and birds in exchange for choice Microscopic Slides of every description.—Suter, 5, Highweek-road, Tottenham.

Waste-Oil Filter (Woodhouse and Rawson's), cost 70s., will filter three quarts daily, nearly new. Will exchange for anything useful.—Godfrey, Adelaide-street, Keighley.

Wanted, good useful **Exchange** and part cash for following goods. Bradford's Vowel Y Washing Machine and Wringer, equal to new.—Below.

Two handsome plated brass **Duplex Lamps.** 29in. high to burners, cut glass vases, never used; Tangye's Pulley Block, 10 cwt., and chains.

Bench Drilling Machine, with 22in. flywheel; welded iron bath boiler, 12in. wide, never used; Mechanical Telephone, and 50 yards wire.

Seventy Magnetic and other **Indicator Movements,** Magic Lantern, 3in. condenser, 59 slides, Mechanical Chromatrope, &c.; portable Electric Bell, ordinary Electric Bell, wire, battery, and push.

Gramme Series Dynamo, 50a. 50v., splendid machine, two double carbon Brush Arc Lamps, hangers and globes, quantity second-hand cable.

2H.P. **Horizontal Engine,** with vertical 3H.P. boiler and all fittings, good maker, in good order guaranteed, four pairs quite new Acme skates.

Flywheel, 5½ft. by 6in. face, with 3in. crank-shaft, &c., cast iron Saddle Boiler, 20in., Kelley's "Engineer's and Iron Trade Directory" 1886.

2H.P. portable **Vertical Engine and Boiler,** Hindley, on four wheels, and shafts, recently overhauled and painted, thorough order.—W. Clifford, Charlbury, Oxfordshire.

Powerful **Lighting Dynamo,** 12in. armature, perfect working order, £10, or part exchange in scientific instruments or tools.—W. Webster, 2, Alexandra-gardens, Folkestone.

Will exchange treadle **Fret-Sawing Machine,** 36 patterns, for hot-air Model Engine, with pump attached, value 15s.—W. Welton, New-street, Woodbridge.

Pair high-class **Opera Glasses,** nickel and gilt, with fashionable long handle and pocket case. Exchange photo apparatus.—C. Thompson, 6, Denman-road, Peckham, London.

Vertical **Engine,** horizontal copper boiler, Bourdon steam water-gauge, man-hole, burns coal, reversing gear, force pump, brass tank. Exchange 3½ Lathe, back gear, gap bed, and fittings, or £12 cash.

Telescope, cost £8. Will exchange to value 8's.; hot-air engines preferred.—Simmonds, 17, Union-street, Reading.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, DECEMBER 25, 1891.

A TOOL-CHEST, AND HOW TO MAKE IT.

A TOOL-CHEST is as much a part of an amateur carpenter's outfit as a professional's, and the accompanying illustration will probably, with its description, be of some use to anyone who is desirous of making a tool-chest. Even assuming the amateur possesses a room set apart solely for his hobby, and which would, therefore, be fitted up with racks and shelves for the various tools, still, there are many tools not in actual daily use that may be stored away with advantage, and where the amateur has not a room solely for his own use, it is almost a necessity to have a proper receptacle for his tools. And "every tool in its place" is an important adaptation of the old saying for every mechanic; for what is more annoying than to be unable to lay one's hand on a certain tool when required, in consequence of not having a proper place for it?

A fair average size for such a chest is as follows:—Length 36in., height 23in., width 20in.—these being outside measurements, including the lid. The wood is common deal, not less than ¾in. when planed up. A plank or deal, 11 by 3 or 9 by 3, with two cuts making three boards, is about the right substance, and I should advise planks 11in. wide being used, which will only necessitate one joint in each of the sides and ends, also the top and bottom. Allowing 3in. for the depth of lid and ¾in. the thickness of the bottom, the sides and ends will be 19¼in. deep, and in preparing the wood, cut the boards fully long—four for the sides and the same number for the ends. For joints, the edges of each board must be shot perfectly true, and use only best glue, and well rub the two edges to be joined together before clamping, so as to exclude all air bubbles—otherwise the joint will be uncertain; but by being careful in this matter, it will be as strong as any part of the whole board. The sides and edges should be devetailed together, the pin-piece being on the sides, the socket-piece on the ends. I hardly know if it is necessary to describe the process of dovetailing; but I will do so as briefly as possible for the benefit of the uninitiated, and by referring to Figs. 3 and 4 my explanation may be more easily understood.

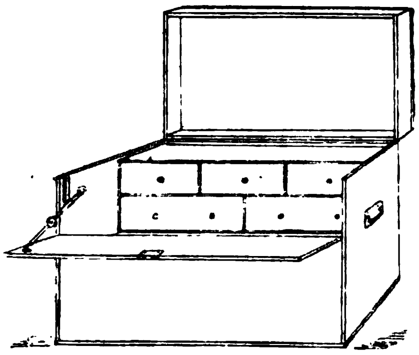


Fig 1

Fig. 3 shows the side, or pin-piece. This having been cut to the proper size—viz., 36in. by 19¼in., a line should be marked on either side and edges rather more than the thickness of the socket part. The pins (any number) are cut out with a tenon saw, the pieces C being removed by a chisel, the end pieces A and B with the saw; then, by laying the pin-piece on to the edge of the socket-piece, the shape of the pin pieces can be marked off on to the socket-piece with a sharp pencil or marking awl, and then saw slightly *inside* the marks, so that when the surplus wood is removed from the socket-piece (Fig. 4), the pins may fit tightly into the sockets and glued. The pins will protrude slightly, and can be finished off when the glue is dry with the smoothing plane. The bottom will also require a join, and cut full long and full wide, and as soon as the ends and sides are fitted together nail on the bottom, as it will insure the box being square, the edges of the bottom being cleaned off flush with the sides and ends after it is fixed. By referring to Fig. 1 it will be noticed part of the front side forms a flap. In the event of this being adopted, the dovetailing must be omitted on the flap and for the same space on the ends, the flap, of course, fitting inside the ends, a small fillet, as shown, being nailed on the ends inside for it to shut against, and what are known as joint-stays, one each end to hold the flap at right angles when open. The advantage of the flap is that the small drawers inside can be more easily got at, and further, it is useful to lay any tools on, or it might be utilised by fixing a rack to it for holding a set of chisels and gouges, and so leave more room in the drawers for other tools. If the flap is desired, the front side will not require a join, an 11in. board forming the lower part, and the width of the flap making up the total width of 19¼in., it being fixed by a pair of brass butts or hinges, 2½in. long.

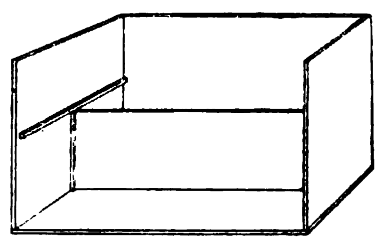


Fig 2

The next part to be considered is the lid, which, including the top, is 3in. deep, the sides and ends being consequently about 2¼in. deep. These are dovetailed (allowing two pins and sockets to each corner), and the top is fixed in like manner to the bottom, and the lid hung with a pair of cast-iron butts 3in. long, the hinges being let into the box, so that when folded they are flush with the edge. An iron chest-lock, say, 3½in., and a pair of strong iron chest-handles will complete the chest itself. I have found the inside of the lid very useful for holding my saws—the hand-saw and half-rip saw—one end of the saws being held by a slip of wood fixed to the lid, the other ends by means of wooden buttons. This is only by way of suggestion.

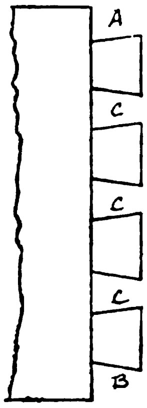


Fig 3

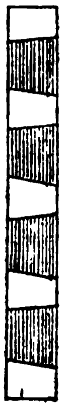


Fig 4.

The inside fittings are simple though useful, and consist of a partition dividing the lower half of the chest, and a portable nest of drawers, occupying half of the upper half of the chest, which slides backwards and forwards on two runners screwed to the ends of the chest. Fig. 2 shows the plan of the lower half. The partition can be made out of a 9in. board, ⅝in. thick. It is a fixture, and secured in its place by two fillets at either end, nailed or screwed to the ends of chest. The runners for the nest of drawers should be 1in. square, screwed to the ends of chest just above the partition, the surface being covered with blacklead to insure the nest of drawers running easily. The box for the drawers is shown in Fig. 5, and measures 9in. high and 8½in. deep. The length must be just slightly less than the inside of the chest; but care must be taken not to allow too much room for the box, or it will get wedged in sliding. The box is made of ½in. stuff throughout, the top, bottom, and ends being dovetailed—the pins on the ends, the sockets on the top and bottom. The centre shelf and the partitions are fixed by being let into grooves and bradded from the outside. It will be seen the space between bottom and centre shelf is 4in., and between the latter and the top 3½in., so that the partitions for the smaller drawers should be cut 4in. long (the grain of the wood being vertical), allowing ¼in. each end for grooving, and 4½in. for the centre partition of the larger drawers. The centre shelf is also let into the ends of box ¼in. either end. A thin back, fixed on with brads or screws, completes the box. The drawers—five in number—should now be made, and the best plan is to cut out all the fronts first, and fit them in their respective places. It is necessary that the drawers should be strong; the fronts, which take the greatest strain, should be of ¾in. stuff, and by bevelling off the fronts (see Fig. 6), they are relieved of their otherwise heavy appearance.

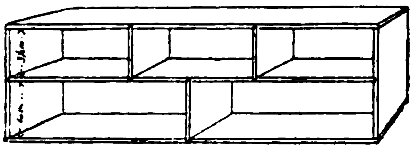


Fig. 5.

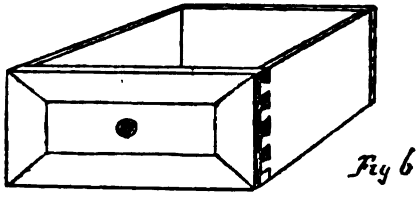


Fig 6

Drawers made properly are not so easily made as many would suppose. A badly-fitting drawer is a nuisance, and I have found a good many amateurs let their drawers slide on the bottoms, whereas the sliding should be on the sides; and another thing—drawers should not be allowed to have too much "play," or they stick when being pushed in, first one side and then the other. This, of course, is more liable in larger drawers than will be required for this tool-chest. Still, I think it is just as well to point out these little details, which, after all, are important items in every kind of work. To proceed, I will describe the making of one drawer; the same will apply equally to all.

The sides and back should be of ½in. wood, the sides being dove-tailed at one end on the front, and as the pins should not appear at the front, mark the wood ½in. from the

VOL. LIV.—No. 1396.

front, and proceed to cut the pins as before described; then lay them on the edge of the front and mark out the shape clearly and cut the sockets out with a small chisel; the back is dovetailed to the sides in the ordinary manner, and before fixing up a $\frac{1}{4}$in. groove should be run on the inside of each side for the bottom to slide into, which is of $\frac{3}{8}$in. wood chamfered at the sides to the width of the grooves, which in these small drawers are $\frac{1}{4}$in. from the bottom. The bottom should protrude slightly beyond the back, which will therefore make the back slightly less in width than sides; then proceed to fix the drawer together, finally sliding the bottom into its grooves, and putting two or three brads through it into the back piece, and it might with advantage be glued into the grooves. The knobs, 1in. oak, can be obtained from any cabinet ironmonger.

This completes the tool-chest. Such a one I have found very useful—moreso than one fitted with trays for screws and nails, and the tools distributed round and about the chest. The chest should be painted or grained according to fancy.

PRACTICAL HINTS IN BOILER DESIGN.—VI.

By W. C. Carter.

Riveted Joints not Exposed to Tension.

THE arrangement of rivets in joints not exposed to tension, such as the circumferential seams, those across the end plates, or the joints of the combustion chamber and furnaces, is determined by practical consideration, and is not subjected to calculation. In the case, however, of boilers of extreme length, the Board of Trade requires, in the circumferential seams, a certain minimum strength of joint, calculated as if the joint were in tension. This is probably required to provide a check upon too great freedom in designing these joints, as there is at least some tension upon them, and owing to sagging of the boiler when full of water, unequal expansion, and other causes, the tension might happen to be considerable. These joints, then, should have, according to Board of Trade rules, a strength of not less than 65 per cent. of plate or rivet, which will be found by formulæ (xviii.) and (xix.)

The riveting of joints such as we are considering is dictated, as stated above, by experience, the pitch being such as to secure tight joints under the required conditions. Joints for low-pressures —say up to 70lb. per square inch., and with light plates, $\frac{3}{8}$in. thick and under—may be single riveted, the pitch being about $2\frac{1}{4}$ times the rivet diameter.

In the case of thicker plates, and where the joints are exposed to the action of the flame, or to some special stress, double riveting is preferable, the pitch being made about four times the rivet diameter.

It will frequently be found that the total length of the joint or line of rivet is not capable of much variation, and when such is the case the best possible pitch must be decided, and such a number of rivets must be chosen as will give a pitch as near as possible to the ideal pitch.

Diameter of Rivets.

The size of rivet is a matter for the judgment of the designer, and consequently the practice is very varied. The rivet, however, should not have a diameter less than the plate thickness. Hutton gives, in his new work on Boilers, the following extremes of practice as found by him in actual use—viz., from Thickness × $1\frac{1}{8}$ to T × 2.

Diagonal Pitch.

The diagonal pitch in zigzag riveting with two or more rows may be—

$$P \times \cdot 6 + D \times \cdot 4.$$

Measurements of Heating Surface.

It will be convenient to give here, before going on to our specimen design, the usual methods of calculating the heating surface of the boiler, as this will be one of the first matters to be considered. First in order come the tubes, the effective surface of which is obtained by multiplying together the outside circumference and the length between the tube plates. Some faddists insist upon measuring the inside of the tube instead of the outside, but as this is usually an odd size, very difficult to manipulate, it is most convenient to take the even dimension outside the tube while the difference is unimportant. The discussion is about as useful as the mediæval one referred to by "F.R.A.S." a few weeks ago as to how many angels could dance on the point of a needle, and here we may say that, inasmuch as the value of any part of the boiler for transmitting heat can never be actually, but only relatively, ascertained, it is impossible to say *exactly* what parts should or should not be included. The value of a fixed rule in the matter is that we can depend upon comparisons made with other boilers similarly measured, and the rules here given are those in general use.

The surface of the furnaces is taken over five-eighths of the circumference of the flue, as the fire lies only in the upper half, the extra eighth being added in order to allow for such evaporation as takes place below the bars, and also in consideration of the high evaporative value of the furnace on account of the radiant heat from the fire. The rule for them is therefore:—Circumference × Length × $\frac{5}{8}$. If the furnaces are corrugated, the result may be multiplied by $1\frac{1}{8}$.

The surface of the internal tube plates should be taken down to a line 1ft. above the bars and parallel to them, and the area of the tube-holes deducted. Owing to their irregular shape, it is convenient to use a planimeter for this purpose.

The combustion chamber tops and sides may be stepped round with dividers set to 6" on the scale of the drawing, using the transverse section for the purpose, starting and finishing at points 1ft. above the level of the bars. This length must then be multiplied by the width of the combustion chamber, or its mean width if sloping. In single-ended boilers, and in a few double-ended boilers, the combustion chambers have back-plates, which must be added, and these are taken in the same way as the internal tube plates, except, of course, that there are no holes to deduct.

In placing upon the drawings the particulars of surface, that of the tubes should be kept separate from the other items, which may be combined in one sum, as the tube surface is the most easily varied in trying out designs.

Weights.

The taking of weights is naturally a process of simple mensuration, but a few hints gained from experience may save labour. It will be found convenient to remember the following data, to avoid the constant repetition of the same calculation in taking the weight of hollow cylinders (shell plating). The weight of a ring of solid plate 1ft. in diameter, 1ft. long, and $\frac{1}{16}$in. thick is, in steel, 8·168lb.; and in wrought iron, 7·854lb. We may call this a unit ring. From these figures we can obtain the weight of any similar ring by multiplying them by the number of times each dimension of the ring contains each respective dimensions of the unit ring.

For example, suppose we have to find the weight of a ring of steel plate 9ft. diam., 6ft. long, and $\frac{3}{4}$in. thick, the weight of the new ring is—

$$8{\cdot}168 \times 9 \times 6 \times 12 \ (\tfrac{12}{16} = \tfrac{3}{4}) = 5{,}292\text{lb}.$$

The weight of rivet heads must be obtained from the practice of the manufacturer and the number of heads counted out, until by experience the draughtsman can approximate the proportion with sufficient accuracy.

The weight of the corrugated portion of corrugated furnaces is to that of a plain surface of equal thickness, and of a diameter equal to the mean of the corrugations as 7 : 6.

In the Purves furnace each ring may be considered as equal to a ring shrunk on of a sectional area of about 1·32sq.in., and the weight of these must be added, taking the rest of the furnace as a plain tube.

The rest of the question of weights is plain sailing, and simply a matter of hard work, practice, and judicious note-taking, always remembering that when factors are detected repeating themselves in a series of calculations, they should be extracted and combined in the form of a constant, leaving the variable quantities to work. Much useless labour may be saved in this way. It is one of the secrets of calculation.

We have now seen sufficient of the subject to commence our design.

Note.—By an oversight the last figure in Art. V. was made "N = 5" instead of "N = 3," which is correct.

FITTING.—XI.

FIG. 59 shows a common force-pump, packed up on blocks for lining out in one of its planes. The first matter is to get the feet A A and the centre line *a* of the bores of the barrel B, and of the valve-chamber C, in parallel planes with the face of the marking-off table. Ordinary cubical packing-blocks, D, and thickness liners are used. As in other examples, in order to get the faces of the feet A to plane up parallel with the bores, mutual adjustments may have to be made. The feet may not only not be parallel, but they may be winding with each other, so that more metal may have to be taken off one end than the other. When adjusted, the centre-line *a* will be scribed all round B, C, E, F, G with the scriber H, vertical lines, *b*, squared up on each flange-face, and circles, *c*, for the bores struck, and witness lines around them, and the stud-holes also marked.

The pump may now be bored, or the remainder of the lining out may be done first. If bored now, the flanges E F G will be also faced at the time of boring, and the dimensions over their faces need not be lined out beyond a centre punch mark upon one side of each flange to guide the turner. If the valve seatings are merely drilled, and there is no appliance available for facing at the same time, or if the flanges have to be planed, then they may be lined-out either before or after boring. In such cases the pump will be turned a quarter round, and re-set and packed up, so that the valve-chamber end C stands vertically upon the table. Then the flanges F and G will be scribed round with lines representing their faced over-all distances.

The centre lines, both vertical, *b*, and horizontal, *a*, are scribed upon the feet while in the position shown in Fig. 59, and the centres of the holes through which the studs or bolts pass are marked at the same setting. The centres of the holes in A A are marked after the pump has been turned a quarter round and the barrel B packed up parallel with the table. The feet may or may not be planed first. If not planed before marking out the holes, then they must be drilled before planing.

Fig. 60—a slide-valve—is an example of work where all faces stand at right angles with one another, and it is in consequence marked out easily. In the first instance, the valve is laid upon the face of the table in the position A. Such adjustment on the blocks D D with wedges or sheet metal as may be necessary to average about equal amounts for the machining off the faces E and F must be made. I say about, because the faces have to stand at certain distances from the centre G of the hole H for the valve-rod, which hole is not always cored exactly true, and, in consequence, a little more may have to be planed off one face than the other, in order to correct the inaccuracy of the cored hole. The lines *a*, *b* are then scribed round the edges of the valve. Next, the vertical centre line J, central with the cored hole H, is scribed up on each end with a square from the face of the table. From these lines, the width, K, of the valve is marked with compasses upon each end, and scribed up. At the same setting, the vertical centre of the valve, lengthwise, will be marked up, as at L. This, however, may have to be corrected subsequently with the centres of the ports. The casting is then removed, and centre popped, and planed on the lined-out faces and edges, and brought back to the table to have the port edges marked, which is done as follows:—

The first thing is to get a centre line round the planed faces and edges of the casting. Its position would be averaged from the cored ports on each face, so that their edges shall all hold up to width, and their bars also be of the right width. There are two ways in which this line and the port edges can be marked: either when the valve is laid upon the planed edges of the strips, as at B, or when stood upon end, as at C. If stood on its edges, as at B, then it will be turned over from edge to face, in order to carry the centre line round on all four faces. If stood as at C, the centre line can be carried round all four faces with the scribing block M, without altering the position of the casting upon the table. If the ends of the casting are planed, even with only a rough cut, then it will stand perpendicularly without any packing up.

It does not matter which plan is followed. If the casting is stood upon end, then the port openings will be marked off in horizontal parallel lines with the scribing block. The distances of

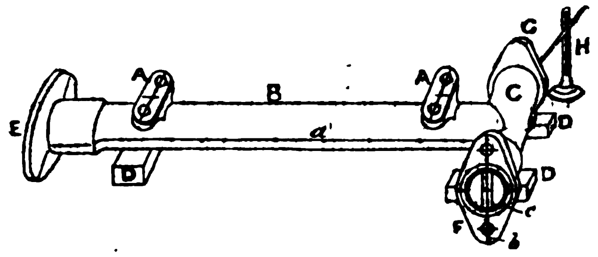


Fig. 59.

their edges from the centre line L will be given either by pricking off with compasses direct, or by transference from another vertical face, according to the method already described in a previous article. If the casting is stood upon edge, as at B, then the port edges will all be marked from the square set upon the face of the table.

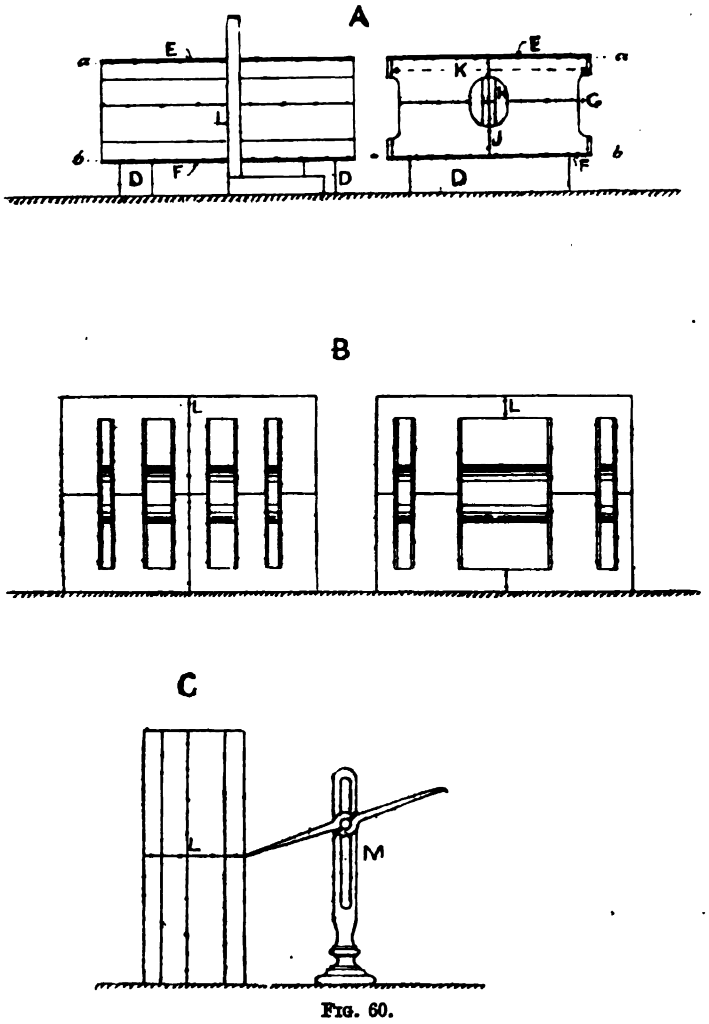


Fig. 60.

Take, now, a piece of work that has no square face to stand upon—the shaft A in Fig. 61. Upon this shaft it is desired to mark key-ways at right or any other angles with each other. For this, the vee blocks B, B are used. Or, in some cases, planer centres* may be substituted, when the chucking centres of the shaft are left in. The shaft being already turned, and supported upon the vee blocks, the required lines, whether at right, or at other angles, are set out upon one end. Say the lines are to be at right angles: then a vertical, *a*, is scribed up through the centre with a square, C, and a horizontal, *b*; also, through the centre, with a scribing block, D. The horizontal is carried round on the side, or sides, of the shaft where the key-way has to be slotted. The width of the key-way, or key-ways, *c*, is then pricked off with dividers, and its edges scribed at the same time. Or a slotted templet is employed for the purpose.

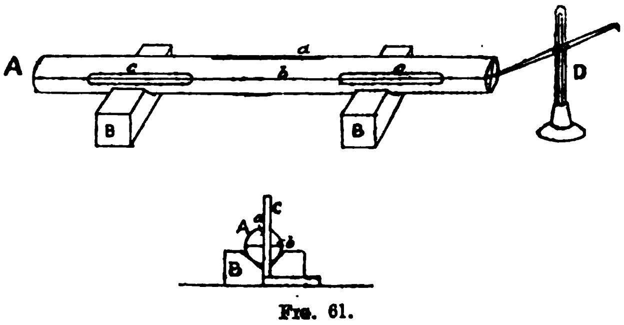


Fig. 61.

The shaft is next rotated upon the vee-blocks, and re-set, with the horizontal line *b* brought into a vertical position, thus bringing the centre line of the key-way, *d*, that was above or below before, to the side, where it is also scribed with horizontal lines.

If the key-ways have to stand at any other angles than right angles, then the angles are first set off upon the ends, and the shaft rotated until their centre lines are successively brought into a horizontal position—that is, in the same horizontal plane with the centre of the shaft.

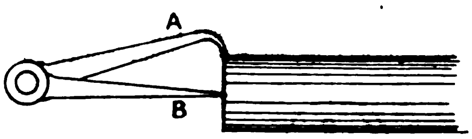


Fig. 62.

In standard work of this character special templets are used for lining out the key-ways. I will, however, describe these in another section, devoted specially to templets.

The planer centres are used for lining off work of this character when no necessity exists for setting off lines from the ends of the shafts. In some cases there is an advantage in using them. When the chucking centres remain in the ends of turned work, they afford a quick and ready method of supporting that work, and it can be turned quickly into any new position required for marking the positions of key-ways, grooves, and flutes.

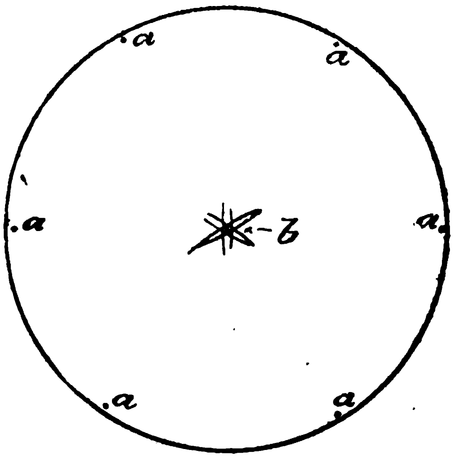


Fig. 63.

To obtain the centres of shafts and of circular work generally, various devices are resorted to. For work of small diameters the compass caliper is commonly employed, in the method shown in Fig. 62. The caliper leg A is held outside of the shaft, and a short line is scribed with the compass leg B upon the end of the shaft. This operation is repeated four or six times at roughly equidistant positions, and the mean of the lines scribed upon the ends is the shaft centre.

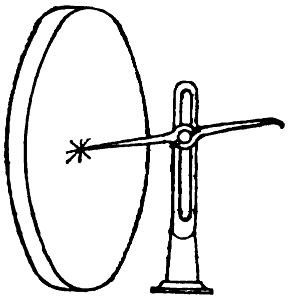


Fig. 64.

Another way is to set the shaft in vee-blocks, set the scriber-point of the block approximately to the centre, and rotating the shaft at intervals through distances equal to about a fourth or a sixth of a circle, scribe short lines on the ends, the mean of which will be the shaft centre.

Other methods are by means of a centre square, or of a bell-centre punch; the latter being adapted for shafts, the former chiefly for discs. The centres of discs, however, are often found by means of compasses, thus, Fig. 63—several centre-pop marks, *a*, are made just inside the edges of the disc. These form centres for one compass-leg, from which the other leg scribes a short radius. The intersections of these radii at *b*, or their mean when they do not quite intersect, is the centre of the disc.

But when the disc has sufficient thickness to stand on edge, the scriber-point is often used in preference (Fig. 64.) The disc may be steadied, if necessary, with wedges, or by the hand, while the successive scriber marks are being made, whose intersection gives the centre.

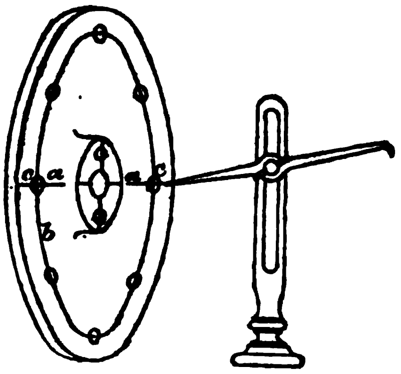


Fig. 65.

To get a centre line across a cylinder or pump-cover, where a straight edge cannot be employed, because a stuffing-box or similar projection stands out in the way, the scribing-block is used, Fig. 65. The cover being set quite vertically upon the table, the line *a* carried across the face of the cover will exactly bisect the circle *b* of the bolt centres; and from the intersections *c c* so obtained, the whole of the bolt-centres can be divided round. J. H.

CHEMISTRY FOR STUDENTS.—V.

By John Mills.

Author of "Alternative Elementary Chemistry," &c.

In our last article we were describing experiments which, if carefully performed by the reader, would enable him to determine for himself the nature of the air we breathe, and practically demonstrate the chief properties of its main constituents. Instead of using phosphorus to remove the oxygen from a confined volume of air, we might have taken a mixture of iron filings and *sal ammoniac* moistened with water; by allowing these to remain for some time under a gas-jar inverted over a shallow dish of water, the iron rusts and so absorbs the oxygen, and a burning taper introduced into the residual gas becomes extinguished as before.

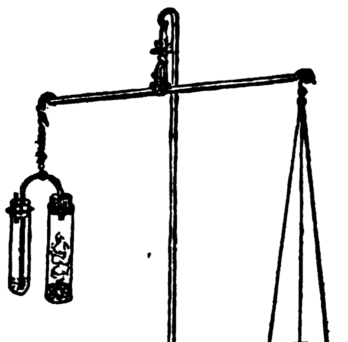


Fig. 35.

We may arrange our apparatus so as to clearly prove that the new body formed by burning phosphorus is heavier than the phosphorus used in the combustion. For this purpose, fit a test-tube with a cork provided with two holes, through one of which one end of a bent tube passes, as shown in Fig. 35; pass the other end of this bent tube through a cork as indicated in the upper end of an open tube of hard glass, in the lower end of which is a plug of *asbestos* supporting a chip of phosphorus. Having adjusted the balance so that all is in equilibrium, apply a spirit flame to the asbestos plug to ignite the phosphorus. By this arrangement air is freely admitted to keep up the flame till the phosphorus is all consumed, and the white oxide (the product of combustion) collects in the tubes, while at the same time an augmentation of weight is evident from the turning of the scale. A small quantity of water is put in the test-tube to dissolve the white fumes, and so prevent their escape. If we simply burnt the phosphorus in a sealed tube, obviously no increase of weight could occur, but a partial vacuum would be formed due to the absorption of oxygen. The external air cannot enter to supply the place of the transformed constituent.

Priestley's Experiment.

If mercury is heated in contact with air for some hours in a long-necked flask, the surface of the metal becomes coated with a brick-red film of powder which may be readily separated from the main body of liquid mercury. This powder is *mercuric oxide*, similar in composition to what is commonly called red precipitate. Priestley, one of the most eminent of English chemists during the latter half of the last, and early part of the present, century, discovered oxygen by heating mercuric oxide. We can repeat his experiment in a modified form by means of the apparatus shown in Fig. 36. The powder is introduced into a test-tube and heated as indicated, by which means a gas is expelled, which may be collected over water. Simultaneously very minute globules of metallic mercury accumulate on the sides of the heated tube. Here we see that oxygen has, in the first instance, been extracted from the air by means of the heated mercury, and in its turn the oxide formed has again been split up into its constituent parts by the agency of heat. Or we may express the same thing in another way, thus: We have first built up (*synthesis*) the *oxide* from mercury and oxygen, and subsequently, by *analysis*, determined its composition.

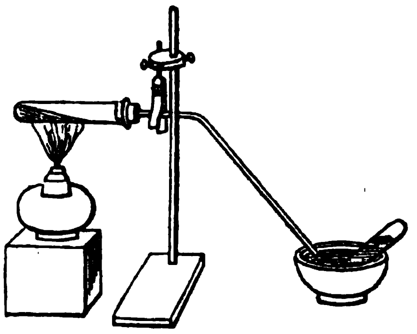


Fig. 36.

We have previously referred to the oxidation or rusting of iron, and the alteration in the weight of the metal, which such a chemical change effects. This oxidation may be brought about rapidly, and in such a way as to leave no doubt as to the truth of what we have just stated, as follows:—Suspend a small horseshoe magnet to one end of a balance, as indicated in Fig. 37, bring iron filings near enough to be attracted by the magnet, and then counterpoise the balance. Under ordinary circumstances equilibrium would be maintained for an indefinite period; but by placing a spirit-flame under the filings, the latter are heated to a temperature which facilitates oxidation; in fact, the filings undergo a slow process of burning, and thus lose their original character. It was by a careful series of ingenious experiments, such as we have described, and conducted so as to leave no possibility of effectual opposition or unbelief that Lavoisier proved to his contemporaries that the combustion of bodies in air consisted essentially in their chemical union with oxygen.

Air is a Mixture, and not a Chemical Compound.

Our experiments and observations up to this point have been such as to furnish us with sufficient authority to now state that the air we breathe consists mainly of two gases—namely, *oxygen* and *nitrogen*, and that, roughly speaking, the former gas constitutes one-fifth and the latter four-fifths of the entire atmospheric envelope. We have, however, not yet explained how a gaseous mixture differs from a chemical combination of gases; nor do we intend in the present article to deal fully with this subject, and shall, therefore, content ourselves by merely indicating at this juncture some of the reasons why air is regarded as a mixture. We noticed that when oxygen was added to nitrogen, obtained in a bell jar by the combustion of phosphorus in confined air, the mixture possessed the same properties as air—that is, it supported the combustion of a taper, and other burning bodies. We might, also, by introducing small animals, easily show that it would sustain respiration. Both the gases in question are slightly, but not equally soluble in water, yet when air is shaken up with that liquid, the gases dissolve in the ratio of their respective individual solubilities—viz., 1·87 : 1. No diminution in volume is observable, and the relative quantities of the two gases are not those in which oxygen and nitrogen are known to usually combine with each other. Further, the gases undergo diffusion at rates corresponding with those of the uncombined elements, and no change in temperature can be detected when the gases are mixed. None of these conditions would obtain if air were a chemical compound consisting of the gases named; but the properties of the nitrogen and oxygen would be entirely suppressed, and the compound body, if such it was, would exhibit characters peculiar to itself. A larger proportion of oxygen is dissolved than is contained in the atmosphere, because oxygen is more soluble in water than is the case with nitrogen; but had air been a chemical compound, the solution would have been effected as a whole—that is, 1 : 4.

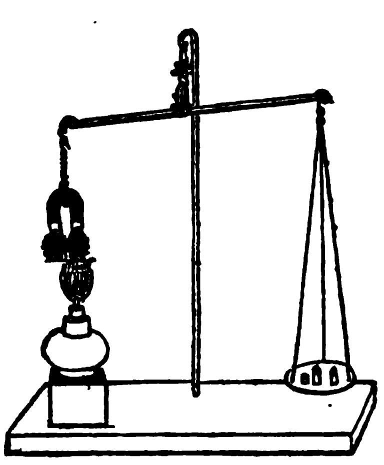


Fig. 37.

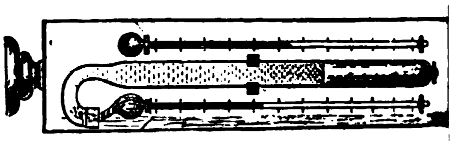


Fig. 38.

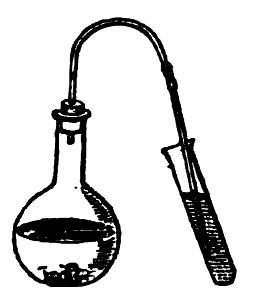


Fig. 39.

Exact Composition of Air.

The composition of the air is not at all times uniform; but, considering that numerous agencies which tend to destroy its homogeneity are constantly at work, the proportions of its components remain remarkably constant. Nevertheless, there is, at various times and in different places, an appreciable irregularity in its composition. By volume, the composition of a hundred parts of air is as follows:—

Nitrogen	77·95
Oxygen	20·61
Aqueous vapour	1·40
Carbon dioxide	·04
	100·00

In addition to these substances, air contains traces of nitric acid, ammonia, sulphuretted hydrogen, sulphur dioxide, and ozone. The last named is found in fresh air, but is usually missing in the air of closely-inhabited places. There are other substances promiscuously mixed in the air, and these are derived from a variety of sources, among which may be mentioned the spontaneous decomposition of animal and vegetable matters.

Detection of Aqueous Vapour and Carbon Dioxide in Air.

A little reflection on certain phenomena of everyday life, such as the deposition of dew, the fall of rain, snow, and hail, will at once lead the reader to infer that watery vapour must be contained in the air; but the fact may be still further impressed on the mind by some familiar and also simple experiments. Break some ice into small pieces, and mix it with an equal weight of common salt; put the mixture into a glass or metal vessel, and observe what happens. *Hoar frost* will form on the outside of the vessel, due to some of the moisture of the air having first condensed thereon and afterwards frozen. The ice and salt form what is called a *freezing mixture.* Again, place about an ounce of *calcium chloride* in a watch-glass, counterpoise on the balance, and leave it alone for some considerable time. The salt will absorb moisture from the air; the deflection of the scale beam, as well as the moist appearance of the substance, affording visible proofs of this.

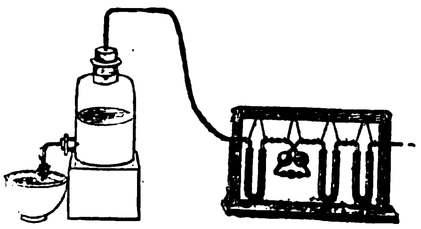


FIG. 40.

Aqueous vapour, although always present in the air, is a very mutable and ever-changing constituent, and the *humidity* of the atmosphere, as it is called, depends upon the temperature, distance from the sea-level, direction of the wind, and the like. Meteorologists, whose business it is to study the atmosphere and its phenomena, make use of an instrument termed the *Hygrometer* for determining the amount of aqueous vapour in the air at any given time, and the results obtained are serviceable in making forecasts of the weather. A simple and reliable form of this piece of apparatus is shown in Fig. 38. Two thermometers, exactly alike, are placed as indicated, side by side, and the bulb of one is kept moist by a covering of muslin saturated with water, and extending downwards so as to dip into a reservoir. The evaporation of this water causes a lowering of the temperature of the inclosed thermometer-bulb, so that the reading is usually below that of the naked thermometer. The greater the difference between the readings of the two thermometers the drier is the air; but if the air is saturated, an event which seldom happens, no evaporation takes place, and the thermometers read alike. Tables have been constructed from a careful series of experiments, so that when the readings of the hygrometer are known the humidity can be readily ascertained.

Air holds most moisture when its temperature is high, and should the atmosphere become cooler small globules of water are deposited, forming a cloud, so that a fall of rain, snow, or hail may follow, according as the temperature is above or below the freezing-point. Hail is probably the result of raindrops, during their descent, passing through a stratum of air of a temperature below the freezing-point of water, and the deposition of dew is brought about by the more rapid cooling of the earth's surface after sunset than the air immediately above ground. A current of warm air heavily laden with moisture, coming from the sea or passing into a higher region of the atmosphere, may be intercepted by air of a lower temperature, and a quantity of aqueous vapour assumes the liquid form and descends as rain.

On inspecting the table showing the composition of the atmosphere, it will be seen that *carbon dioxide*, compared with the gases oxygen and nitrogen, forms but a very small proportion of the air—only about 4 volumes in 10,000. Its presence in the air may be determined by pouring limewater on to a plate, or into a basin, and allowing it to stand exposed to the air for a day. By this means a scum of solid matter is formed, due to the gas *carbon dioxide* from the air having chemically united with the lime in the limewater. This new body may be skimmed off the clear liquid, and, if placed in an evaporating basin and treated with an acid, will be found to fizz or effervesce. The acid decomposes the newly-formed substance, and the fizzing is caused by the vigorous expulsion of the carbon dioxide (*popularly called carbonic acid*).

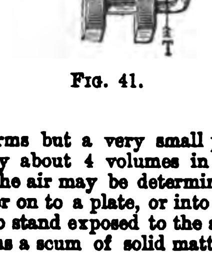


FIG. 41.

Mortar which has been exposed to the air for a long time gives off carbon dioxide when brought in contact with an acid. Thus, place some pieces of old mortar in a small flask, pour on them some dilute hydrochloric acid, attach a cork and delivery tube as shown in Fig. 39, and pass the evolved gas into limewater contained, as indicated, in a test-tube. The lime in the mortar, by long exposure, absorbed carbon dioxide from the air, and thus formed exactly the same kind of new substance as was obtained by subjecting limewater to the action of air, the gas expelled in each case from the resulting *carbonate of lime*, as it is called, being carbonic acid gas, which renders limewater cloudy or milky.

In Fig. 40 is shown an arrangement of apparatus which may be employed for estimating, approximately at least, the amount of aqueous vapour and carbon dioxide in air, the latter being drawn through the U-tubes and potash bulbs by means of an aspirator. For this purpose not less than 20 to 30 litres, or, in plain English, about five gallons of air should be passed through the apparatus. All being in readiness, the screw-clip, shown in detail in Fig. 41, is opened, and water run from the aspirator into the basin, and air is thus drawn through the two U-tubes on the right containing pumice-stone, moistened with *strong sulphuric acid*, which absorbs all the aqueous vapour; moving onwards through the bulbs containing *caustic potash* solution, the air is freed from carbon dioxide, and a third U-tube, similar to the other two, prevents any loss of misture from being carried forward from the potash bulbs. The volume of air used in the experiment being known, as well as the increase in weight of the U-tubes and potash bulbs, the proportion of aqueous vapour and carbon dioxide respectively can be calculated. The tubes and bulbs should be carefully weighed both before and after the experiment, and the more delicate the balance is, the better will be the result obtained. When available, a balance of the kind shown in Fig. 42 should be used, the beam of which will turn with a difference of a thousandth part of a grain in the scale pans. The beam, at the ends, has knife-edges, on which agate planes, bearing the pans, are suspended. The centre of the beam also has a knife-edge, which works on an agate plane so as to eliminate friction as far as possible, and so render the balance extremely sensitive. The beam is divided, and in making the final adjustments for obtaining equilibrium, a sliding weight, called a *rider*, may be pushed along the beam by means of a lever having a cross-piece at its end.

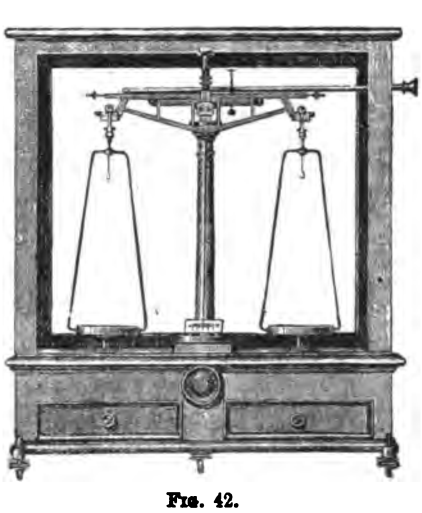


FIG. 42.

It will be well to remember that our object at the present stage, in conducting experiments of the character last described, is merely to obtain results, by the simplest possible means, which will supply evidence enough to inspire confidence in the mind of the student to take "the shadow for the substance," so to speak, until he has acquired by a prolonged experience greater skill in chemical manipulation. For example, in the case in point, it is easy to demonstrate that aqueous vapour is more plentiful in air than carbon dioxide; but some skill and patience would be required to determine the exact amounts.

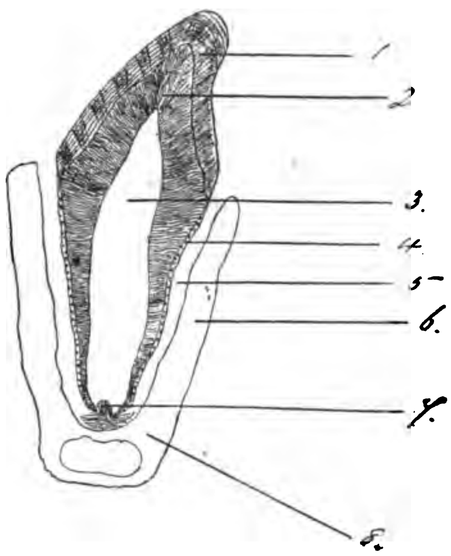
(*To be continued.*)

PRACTICAL MICROSCOPY FOR STUDENTS.—XII.

By Frederick Davis, B.Sc.

In examining "bone" we found it fairly porous; but in reviewing the characters of the "teeth," we shall observe that as far as ossification is concerned—for a large proportion of teeth is merely modified bone—the substance of the tooth is very compact and well defined.

To satisfactorily appreciate the parts of a tooth we will consider it firstly as it appears when inserted in the jaw, and secondly the structure of its parts under the microscope. We have standing out and above the substance of the gum, the "crown" of the tooth; this is covered with an

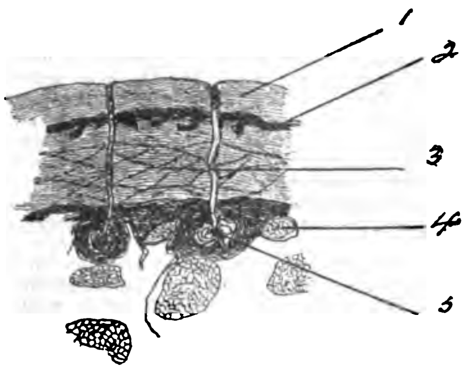


Section of Tooth.

1, Enamel; 2, Dentine; 3, Pulp cavity; 4, Cement covering fang; 5, Periosteum; 6, Alveolar process; 7, Entry of nerve; 8, Alveolar process.

exceedingly hard substance called "enamel," and inserted beneath the gum in the alveolar of the jaw, the "fang," the portion where the "crown" and "fang"; meet, is termed the "neck," so that we see starting from above and travelling downwards, we have the "crown," "neck," and "fang," or "fangs" called sometimes the "root" or "roots."

The "crown," as before stated, is covered entirely with enamel, a very hard, compact, and, if once broken, brittle substance. Now the substance of the tooth is chiefly composed of "dentine," which is really bone, but containing much less animal matter, or tissue, than that substance, the animal matter being replaced by the salts of calcium, consequently making it very much harder. In the centre of the tooth we have the "pulp cavity," and this is filled with the "dental pulp." The pulp cavity communicates with the fangs by little canals, where they congregate, and open at the end, or point, of the fang. The "dental pulp" entirely filling this cavity is composed of highly nervous and vascular tissue, which, permeating through the point of the fang, is continuous with the mucous membrane of the gum beneath. Reverting to the "dentine," we find the canaliculi and lacunæ of bone altogether absent, their place being taken by a vast number of small wavy tubules, branching laterally in every direction. These are termed "dentinal tubules." The "enamel" forming the layer over the crown of the tooth consists of minute, six-sided cells, placed at right-angles to the "dentine," and covers it in its entirety as far as the "neck" or point of union of the crown and fang: at this point it is found to be very thin. Here another substance, termed cement, occurs and covers the whole fang.



Section of Skin.

1, Epidermis; 2, Secondary layer of epidermis; 3, Sudoriparous duct permeating dermis; 4, Fat cell; 5, Sudoriparous gland.

Enamel contains only about 2½ per cent. of animal matter. The "cement" consists of a structure similar to bone itself, but is destitute of "Haversian canals"; it really is constituted of bone matrix, placed in lamellæ and bone corpuscles.

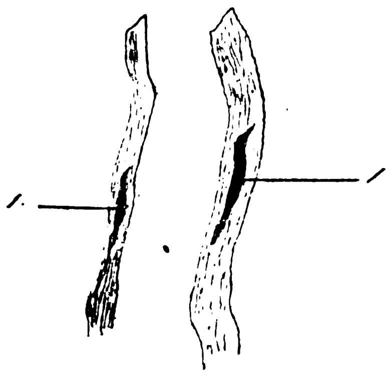
Unstriped Muscle of Artery.

1, Nucleus in natural state; 2, Treated with acetic acid.

The dental pulp is composed of a great number of blood-vessels situated in a matrix similar in cell structure to connective tissue. This is the sensitive portion of the tooth—as we know to our sorrow when, by the removal of the enamel, it becomes exposed, and we suffer with toothache.

Upon the outer layer of this dental pulp, that is internal to the "dentine," we have cells, generally more elongated than the others, almost, and in some cases quite, becoming columnal. These are nucleated, and are called the odontoblasts. In cutting a section of a tooth for microscopical examination, it will be found impossible to saw through the substance, as in bone, because, as previously stated, the enamel is very hard and brittle; the student must therefore use a grindstone, and finish off with fine emery powder, when a sufficiently thin section will be arrived at. The early development of the teeth is very interesting: upon either side of the gum in each jaw a groove becomes apparent, and in each groove five papillæ appear. The walls of the grooves then coalesce and cover in these papillæ, and form the so-called "dental sacs."

Each papilla slowly assumes the shape of the tooth it is to represent—i.e., whether incisor, canine, or molar, and these, by the gradual deposit of the calcium salts, form true teeth, called "milk teeth," a complete set of milk-teeth numbering twenty, their eruption taking place, generally speaking, before the age of seven years. The milk-teeth develop at their basis a little bud or prolongation, similar to that mentioned under "Hair," and this, by becoming calcified, grows, and eventually pushes the milk-tooth from its previous position, and forms the permanent tooth. We thus see how it is the first dentition of childhood occurs, and how and why the milk-teeth are shed. It must be understood that the permanent dentition should consist of thirty-two teeth, whilst the milk-teeth are only twenty; we have, therefore, in adult age twelve more than in infancy. At the time of shedding the milk-teeth the grooves become extended somewhat at the rear, fresh papillæ being formed, and becoming covered in, calcify in the ordinary manner. The last teeth which show themselves are the four occupying the hindmost position in the jaw; these are, therefore, called "wisdom teeth," because they appear at a time when the individual bearing them should have arrived at the age of discretion. These latter teeth generally decay almost as soon as erupted.



Unstriped Muscle,

Treated with acetic acid to show—1, Nucleus.

The muscles of the body are divided into two groups—unstriated, or smooth, and striated, or striped. The former of these consists merely of elongated cells or band-like fibres, with no striations whatever; but the striated variety is peculiar in its structure, and well worthy of the attention of the microscopist: it is composed of long cylindrical fibres, bound together by connective tissue, and these, in their turn, are again bound together by more connective tissue. It may be well to mention all these fibres are arranged parallel to one another.

The striated variety form the greater part of all muscle, and supports the vessels and nerves, &c., of the muscles. Each fibre is inclosed by a covering, termed the sarcolemma, in addition to the connective tissue.

The sarcolemma is not capable of contractility, but simply adapts itself to the contractile substances which it incloses. Striated muscle is voluntary—that is, regulated by the will—but unstriated is involuntary—that is, not under the direct control of the will. Again, if we irritate a striped muscle, we find its contractility immediately evinced, which becomes relaxed as soon as the irritation is removed; but if we irritate unstriped muscle, we find it slowly contracts, and does not cease to do so as soon as the cause of irritation is removed.

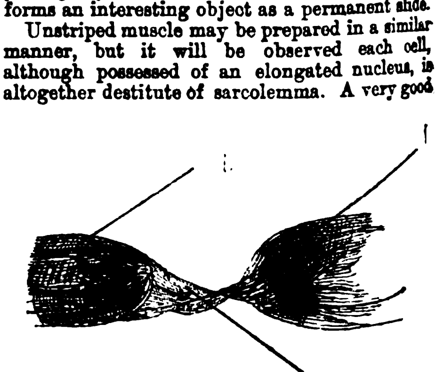
The unstriped muscle in the alimentary canal is arranged in a circular and longitudinal manner—namely, a layer longitudinally and a layer circularly, and these layers, contracting by the irritation produced by the food, &c., passing along, cause the phenomenon known as peristaltic action or movement. All muscle retains its irritability for some time after death; but gradually this ceases, owing to the coagulation of the myosin, and the muscle remains in the position which it occupied at the time of coagulation. This is known as *rigor mortis*, or death stiffening.

Unstriped Muscle from Bladder.

The muscles of the heart are striated, and, as if to prove the exception to every rule, these muscles are *not* voluntary. To prepare a portion of striated muscle for microscopical examination, the student should soak the fibres in dilute hydrochloric acid. This will cause them to separate and break across in a transverse manner and forms discs. Another plan is to take a small piece of beef or mutton, preferably beef, tease it carefully out with a needle upon a glass slip, with a drop of water, and having covered the teased portion with a thin cover-glass, press lightly down and examine with the 1in. objective, and afterwards with the ¼in. object-glass.

The portion described as the sarcolemma may be seen very distinctly by teasing out a very small piece of fresh frog's muscle in a solution of salts, the thin membranous substance projecting beyond the fibres is the sarcolemma, and forms an interesting object as a permanent slide.

Unstriped muscle may be prepared in a similar manner, but it will be observed each cell, although possessed of an elongated nucleus, is altogether destitute of sarcolemma. A very good example may be obtained by treating a portion of the bladder of a frog with a dilute solution of acetic acid (about 3 per cent.). This form of muscle exists as a network and should be preserved as a permanent specimen. The contractile characters of muscle may be observed by operating upon a portion of the thigh of the water beetle, soak for a few minutes in solution of salt, and examine with the ¼in. objective, but be careful *not* to press, or the motion will be stopped; it may, however, be lightly covered with a thin glass. It may be necessary to explain the beetle should be recently killed.



Striated Muscle.

1, Muscle; 2, Sarcolemma.

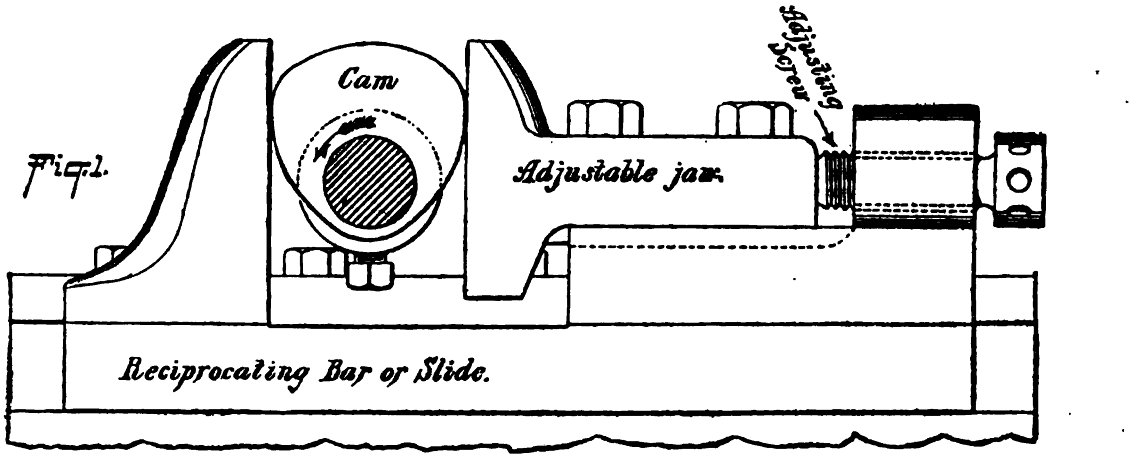


Fig. 1.

THE LARGEST LATHE.

FROM time to time mention has been made of some very large machinery of different descriptions for use by the Government in the construction of large guns or other equipments. One of the largest machines yet made for such use, and the largest of its kind in the world, is the lathe now being built for the naval gun-shops at Washington. This lathe, which will be constructed of bronze, steel, and cast iron, will weigh 500,000lb., and will be 133ft. in length. Its greatest height will be 12ft., its greatest width 10ft. 6in., and its boring capacity 16in. The largest guns that the naval shops can now construct are of 10in. bore, and these are also the largest employed in the service. When the new lathe is completed, however, the navy will be equipped with 16in. bore shooting-irons, more than one-third as big again as the gun now in use.

As soon as the lathe, which will cost 76,000dols., is completed, the company will begin operations upon seven others. These will be only slightly smaller than the former, and will be of 14in. bore. They will be built at a cost in round numbers of 160,000dols., and will be employed for boring and turning the gun-tubes and jackets.

One of the greatest features of the 16in. lathe will be its face-plate. This portion of the lathe is now almost completed. It is constructed throughout of cast steel, and weighs 160,000lb. It is provided with four adjustable steel jaws and a gear-wheel, which has 75 teeth of 4in. pitch and 10½in. face. Skilled workmen have been employed day and night for three weeks in cutting these teeth, and the operation is not yet finished. Fourteen speeds, ranging by exact geometrical progression from 0·4 revolution to 4·3 revolutions per minute, will be obtained, with a cutting pressure on a 50in. diameter of 140,000lb. on the slowest speed. This plate is said to be one of the most perfect and costly steel structures that have ever been built by machinists.

The bed of the lathe is now lying in the company's shops, and it, too, is almost finished. This is built of cast iron, and is 79ft. 19¾in. long, with a width of 9ft. The wide part, or main bed, has four ways, two of which carry the tool-carriage on one side, while the other two serve to hold the steady rests and tail-stock on the other. The middle ways are formed in one section of metal.

The boring arrangement is provided with a 6in. steel screw, which is 62ft. in length. This screw receives both slow and quick motion from a short-gear shaft, connecting it with the proper train of gears on the side of the boring bench. All the parts of the lathe, which include headstocks, tool-carriages, rests, tail-stock, boring arrangement and counters, are built on the same enormous scale, and are perfect examples of the machinist's art.

The 14in. lathes will be constructed upon the same model as the 16in. instrument, but will be slightly smaller throughout. Each bed will be 65ft. in length, and the other parts will be built upon a similar scale.—*Manufacturers' Gazette* (Boston, U.S.)

ONE KIND OF CAM.*

IN modern designing many kinds of movement are desired. The experience of one person familiarises him with one class of motions, and the means by which such motions are got; and another person's line leads him to a knowledge of other classes of movement and their data. The kind of cam here demonstrated is probably the most useful irregular, but positive, mechanical motive, embracing as it does the eccentric cylinder, that is used in practice.

The use of this cam gives a reciprocating motion, that has these peculiarities: A positive action, a rest at the ends of the strokes, which rest may be varied to suit the designer from 0° indefinitely, a quiet and smooth motion, a strong and lasting means to modify movement, and one having the capability of being adjusted for lost motion. This cam may either reciprocate a bar or slide (Fig. 1). It may oscillate a lever (Fig. 2). Or it may produce four motions within a quadrangle; that is, a part of a compound slide or rod (Fig. 3).

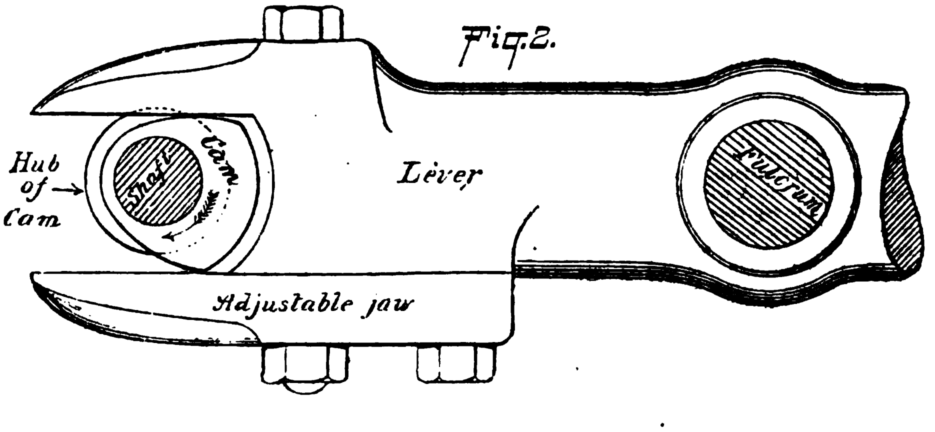


Fig. 2.

If this quadrangle were in the upper of two slides which are arranged at right angles, and in horizontal relations to each other, then this cam would, in revolution, produce the same four motions in every part of the upper slide which the point A indicates in Fig. 3.

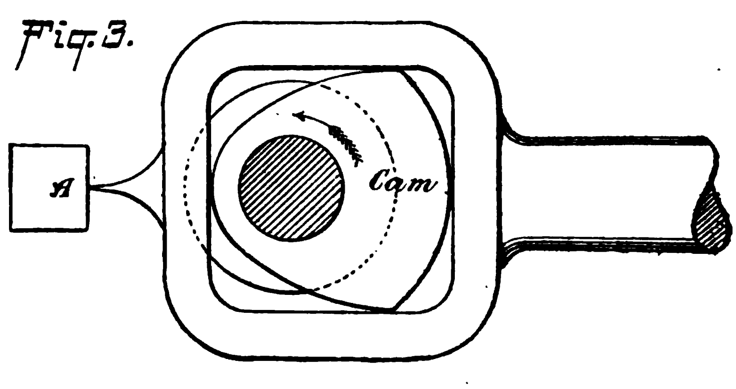


Fig. 3.

This cam, if the angle of rest be 90°, may be the bearing part of a drilling spindle, which will produce a square hole (Fig. 4). The section N is a part of the frame of a drill press. The eccentric cam O is fitted to the square mortise in N, and fits the mortise at four points, whatever part of the revolution it may be at. The mortise in N should be deep enough to control and guide the cam O without lost motion. The cam O may or may not have the interior spindle P. Then, if a tool be placed within the angle B, A, C and the cam O be revolved, the point A will describe the square A, D, E, F; but if the arc M be less than 90°, the corner A, D, E, F will be proportionately rounded. The tool in B, A, C should not exceed 45° angle at its edge, which shall be exactly at A, which is the centre from which the arcs M and L are described. Now the arcs J and K are described from the centres, G and I, and inasmuch as M and L are each 90°, J and K together on one side cannot be more than 90°, and because J has no more length of arc in degrees than K, but the same precisely, then J and K each are 45° of arc. Now if at the centre G there be placed a tool whose edge shall be at the point G, that edge will describe, not a square, but one-half a square, the corners being curved as shown at S. Therefore there can be but one size of square hole made by one shape of cam, in a given mortise; but there may be many cams made to fit this mortise, each of which may make a different size of square hole.

A cam, if constructed thus (Fig. 5) and mounted concentric to its mean centre, will force a lever, or a slide, or slides, or a rod, to reciprocate three times in each direction every time the shaft revolves the cam; but there will be no distinct rests at the ends of strokes. If this cam, then, should be placed on the shafts in either Figs. 1, 2, or 3, it would, if it fitted the devices there shown, act similar to what a regular eccentric would do, should such eccentric be revolved three times as fast as this cam is revolved.

If, again, this cam be mounted eccentric to its mean centre, and at the same time at unequal distances from each of the three centres of construction, then if it were placed in the devices in Figs. 1, 2, 3, there still would be three reciprocating motions in each revolution, but each of the three would be thrown to a different distance. The cam would then be as in Fig. 6.

Should, at any time, the American inventor desire a rotary engine, and not be able, as heretofore, to find a practical one, and get to a point where one that, while it does not exactly rotate about one centre, revolves about three would satisfy him, let him perfect this. I know so little about steam, that I do not feel competent to perfect it myself. Still, I have known it some years, and had reserved it for the future—but? Thus it is in its present form, and if there is any valuable property in it, I present it to the rotary engine men, and everybody else.

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* By A. D. Pentz, in the *Scientific American*.

A is a casting having a central opening to which the piston B is fitted. The corners in A fit the small arcs on the piston B. Through these corners are the ports 1, 2, 3, 4, and valves operated by the rods, 5, 6, 7, 8. The port 1 is closed, but is about to open; 2 is open full and admitting steam; 3 is closed, but is about to exhaust; 4 is open to exhaust. Of course, this valve scheme is not a practical one, but I believe this a new way to make an engine, and that it only needs to have a means to keep it tight, a valve arrangement and the connecting mechanism devised, to make it a good one.

The elements of this cam are: That it shall fit within the four sides of a square or rhombus, and that it shall touch each of these four sides, at some point, at all positions. Of course, then, every point of contact is perpendicular to another point of contact on the opposite side of the inscribing parallelogram. These elements are well indicated in the preceding article on the practical applications of this cam.

The outlines of this cam (Fig. 8) are the abutting arcs F G, H H', and I I', and together they must aggregate exactly 360° of arc. These arcs are those of the sectors A D B', B D A', C E' A, C' E B', B E C, and A' E' C'. These sectors equal four right angles, of course. The inscribed portions of the secants A A', B B' and C C' are equal in length, and it is the intersection of these lines which determines the centres from which the arcs that constitute the outline of this cam are described. The whole difficulty in designing cams of this character lies in locating these points.

To design a cam of this kind that shall give the longest arc of rest possible under the circumstances is very simple, Fig. 9. Having found the size of the shaft on which it is proposed to mount this cam, draw the circle A to represent it; then, if it be practical to have the hub G, the cam can be made as thin at B as strength will permit of; ⅛ the diameter of the shaft A will do. / Describe a circle concentric to D, to represent this thickness B. Now the throw as C being known, then ½ A + B + C is the radius D H. Describe the arc K L 90° long or more, and then through one end of this arc and through the centre D draw the secant E F. Next from L as a centre, and with the radius L M, describe the arc N, touching the arc I at M, and cutting the arc H at K. Then with the same radius, and from K as a centre, describe the arc J, touching the arc I, and ending in L. This completes a cam having the greatest rest possible with the dimensions given. No greater rest is possible without reducing the proportion of C to the radius D H, or elongating D H without elongating C. The angle of rest in any cam of this kind cannot reach 180°.

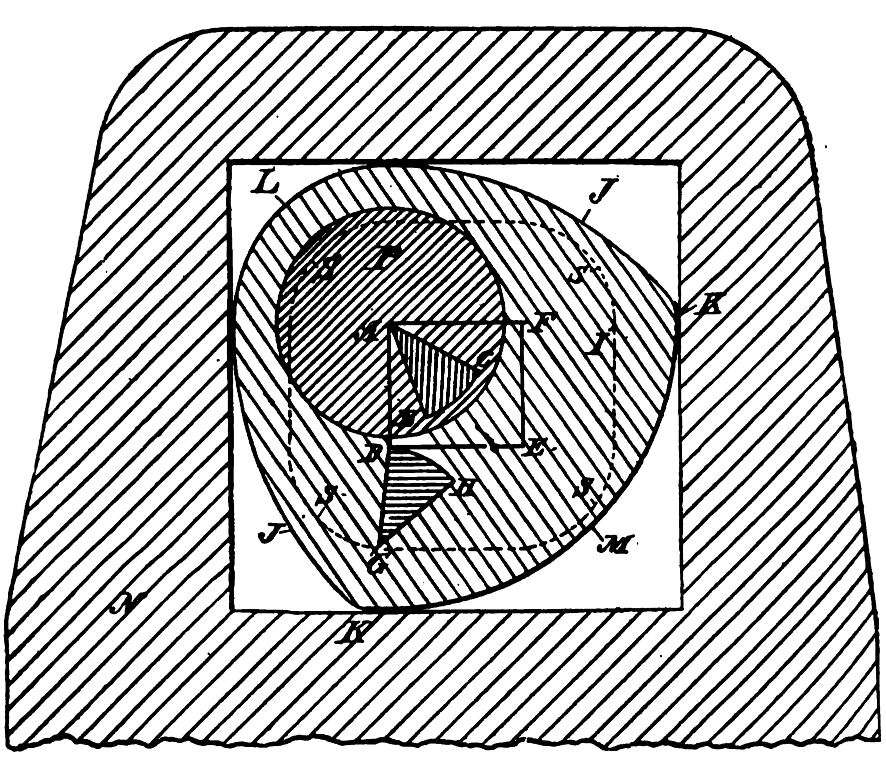
The corners, K and L, in this last construction being angles, are not desirable, because they soon are worn off, resulting in lost motion and noise. This angle becomes sharper as the proportion of C to D H increases, and as this proportion increases, the motion of the cam like this approaches the character of a blow. The arc H in a cam where the arcs J and H are struck from K and L, or points on the arc H, cannot be shorter than 60°.

To overcome this effect of a blow, and at the same time to preserve the amount of throw in proportion to the size of a cam, it is necessary to sacrifice a part of the rest arc, and it always is desirable to reduce this arc as much as practicable, for mechanical economy.

This arc is reducible to 0°. When it is so reduced, this cam becomes an eccentric cylinder. In reducing this arc at all in any case below 60° of angle, the corners K and L become arcs of circles.

It being desirous to make a cam of this character to throw as C, and to have the radius as D A (Fig. 10), the designer, if he desires the greatest possible rest, produces the arcs A and B, and from the points G' and F' describes the arcs N' and O', which by contact and together with the arcs B and A describe the full cam. If he desires to have no rest at all, he describes the circle J from the centre E, which circle has the same size as the cam A N' B and O', and will fill the same parallel spaces as that cam. But if he desires a rest, but less rest than the extreme, he shortens the arc A to the intermediate length H I, and from C' C' as centres describes the arcs G and F and N and O, connecting the arc A with the arc B. Each of these figures will fill the same square or rhombus and operate one as well as the other, but in different times. It is evident, because the circle J is described from E, which point E bisects the combined radii of the arc B and the arc A, that no cam can be described which has an arc whose centre of construction lies between E and D, or further from the arc A to the point E, and not be D. Again, because the chord G' F' equals the radii of A and B combined, no arc can be described that has its centre on the arc A beyond the points G' and F'. Therefore, in this cam, all centres of arcs except the centre D shall lie between the points E and the points G' and F', as C.

Fig. 4.



The four motions produced by the cam and described by the point A. It is supposed that the rod B is pivoted at an infinite distance, otherwise the outlines described by A were angles and curves.

Fig. 5.

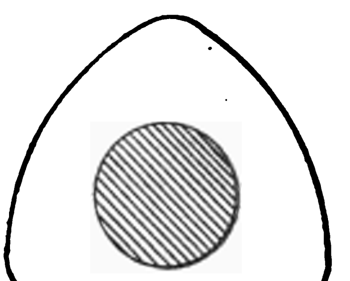


Fig. 6.

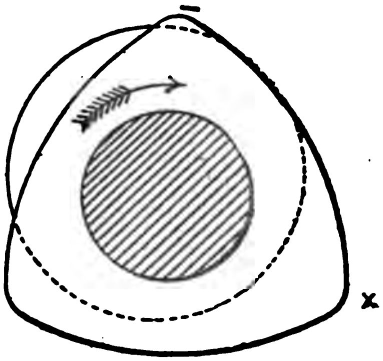
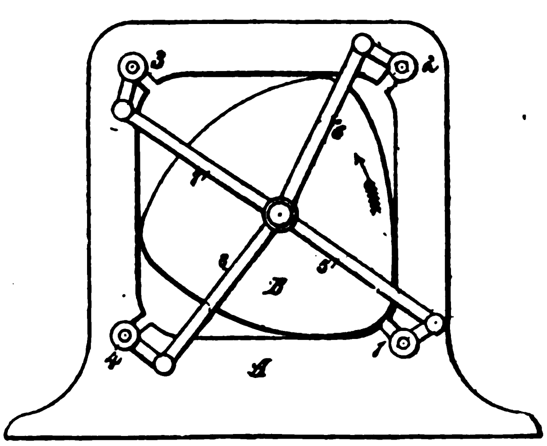


Fig. 7.



In this Fig. 11 it is shown how every cam may have its centres properly located, whether the angle of rest be large or small. I believe this rule to be new, and while it is here indicated by lines, the distances and localities are easily reducible by mathematics. The centres here formed are those of the eccentric arcs. The centre of the concentric arcs requires no calculation to locate it.

The radii, A F and A G, being known, describe the arcs K I and B C. Then through the centre A, and bisecting B C, draw the line G F, and bisect it

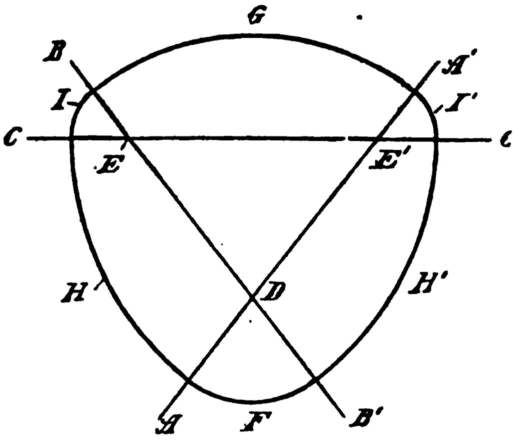


Fig. 8.

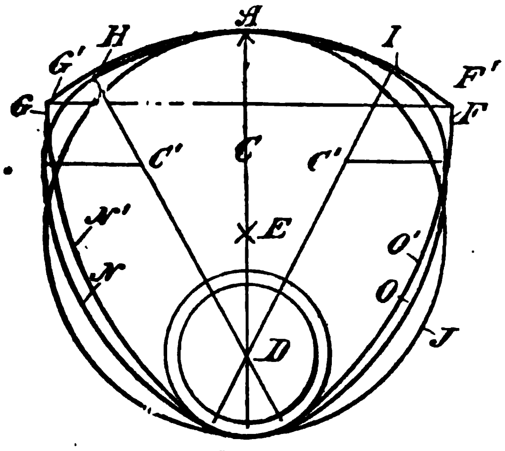


Fig. 10.

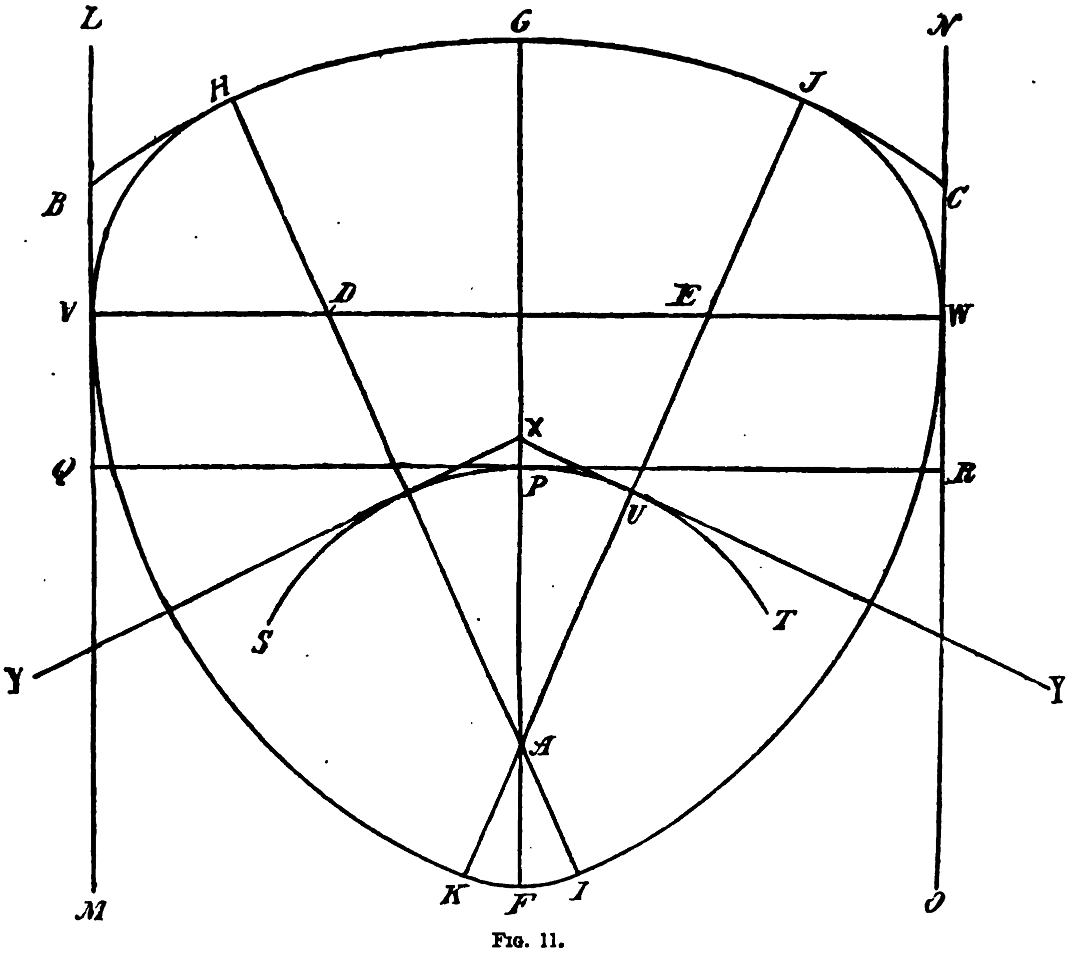


Fig. 11.

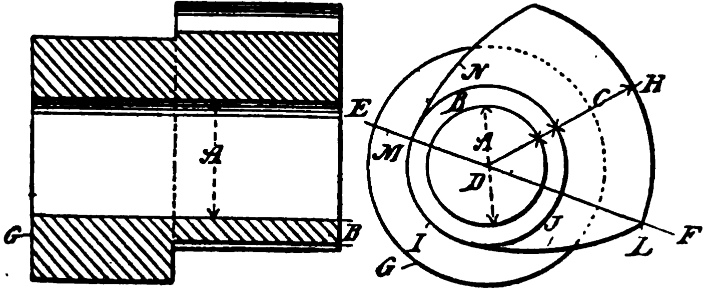


Fig. 9.

at P. Then parallel to G F make the perpendiculars L M and N O, each a distance from G F, equal to the length P G; thus making the length of the line Q R equal to that of G F. Now, knowing the desired arc of rest, locate it on the arc B C, and draw the lines H I and J K, through A, equidistant in angle from the line G F. Now, we know that the centres we seek are on the lines H I and J K, that the one on H I is as far from the arc B G as it is from the line L M, and the one on J K is as far from the arc G C as from the line N O. Again, that these centres are as far from the arc K I as they are respectively from the lines N O and L M. To simplify the problem, we draw the arc S T, intermediate, through the centre A, between the arcs K I and B C. Then we know that these centres are as far on H I and J K from the arc S T as they are perpendicularly from the line G F. Now, if we draw the tangents X Y, we know—because we know the centres we seek are a distance from the line G F equal to their distance from the arc S T—that they are on the line V W, drawn perpendicular to the line G F, and intersecting G F at Z, as far from the point X as the intersection U, of the tangent X Y, is from that point X. Now, therefore, if the centres we seek be on the lines H I and J K, and also on the line V W, then they shall be at the intersections D and E when V W crosses H I and J K.

From the points D and E, therefore, it is possible to draw the arcs V H, J W, V K, and W I, which completes the cam.

RUNNING CIRCULAR SAWS.

I HAVE seen men who, to judge by the intelligence they displayed, had better be running an axe in a woodyard. They would jamb a saw through a board like a man running a beetle and wedge. If the saw choked up and stopped, they pull the board back a foot or two, take a breath themselves, then bring the lumber slap bang against the saw again, stopping it dead. Something has got to slip; the saw belt is the thing that usually does it. The belt can't run off, for it has a cobhouse of edgings around it. Like a horse in a horse power machine, the poor belt can kick as much as it chooses, but must run as long as it holds together. Sometimes a well-regulated saw will bind. It will cut into the work and cut a wider strip than can pass between the saw and fence. Now the average man tries to remedy matters by pulling the work back. The back of the saw cuts itself clear, but there is a spot the width of the saw that has not been touched, so the saw runs in there again and is just where it was before. The trouble is caused by the saw getting hot. It expands and dishes over. The saw always dishes towards the coolest side. The cool side is the sharpest, or may be has a trifle the most set in it.

When a saw acts as above, lift the board up square off the saw. If you have just started into a long board, bear down on your end, and let it swing upon the edge of the table and raise clear of the saw. If nearly through the board, let it swing upon the back of the table, and raise your end of it. Be very careful to keep the band snug against the fence while lowering it back upon the saw. The cool air striking on the saw takes out all the dish, the saw straightens itself up and cuts itself clear as the board is replaced, and will go along all right. There always is one thing to look out for when a saw cuts this caper, and that is to see if the saw does not need setting or filing. Nine times out of ten this is the trouble.

In jointing boards upon a sliding carriage you will sometimes feel the board crawl sidewise as the saw crawls along. When this happens, just take the saw off and play dentist for a few minutes. When a saw smokes (and when a man does also) it is time to quit. Saw the timber, don't burn it off. File a saw before it gets dull. Don't follow the rule one old chap had—viz., "When edgings would slide off the saw without catching, then file the saw." Any saw that can be filed with a three-cornered file should need but three strokes of the file for each tooth, two for the face and one for the back. It does not take long to go around a saw at this rate, and it can be done every time if the saw is filed before it gets too dull.

Sometimes when taking a saw from the arbor, a blue spot is found upon one or both sides of it. Just look that saw over, and see if there is not a spot of gum or dirt close to the blue spot. Glue is bad to get on a saw. Pitch is worse, and there is something in maple sap wood that is worse than either. A spot of gum upon a saw will cause it to heat, and the blue spots tell the story. Take a piece of sandstone or a soft Scotch "rag," wet the saw and scour off all the dirt or gum. Blue spots do not hurt the temper of the saw; but they are apt to spring the saw, and cause it to take a permanent set, and the only cure is hammering.

Hammering a saw is the sawyer's bugbear. Almost every one of them has tried to take a kink out of a saw by hammering, and many have failed in the attempt. The way they did it was to lay the saw on the buzz planer and rounding spot up, then take a 5lb. hammer and attempt to beat down the bent spot. Just like putting a saucer upside-down and trying to hammer it flat. A man might as well attempt to straighten a dent in a tall hat by placing it on the floor and pounding on the top of it with the heel.

Take a straightedge long enough to reach across the saw. Hold the saw nearly plumb upon your finger (if a small saw), and locate the bend. It is generally a little round spot. Lay the saw, rounding place down, upon the anvil. If you cannot afford to own an anvil to true your saws upon, you are too poor to own a saw, and had better sell out. Have a little hammer, not larger than your finger. The face should be round and convex, and not over an inch in diameter. The pene of the hammer should never be used, except in severe cases. Strike one or two blows upon the bent place. Be sure that the saw lays true upon the anvil, or you may hammer until you are tired for all the good it will do. After striking one or two blows, test the saw again with the straightedge. If it shows any improvement, strike a few more blows and test again; if no change is seen, strike a couple of hard blows and make another test.

The principle of the thing is, that the convex side of the saw is larger than the other side, so it puffs out; the hammer blows upon the smaller side stretch the surface, and have a tendency to correct the error by swelling out this side, and, of course, shrinking the other. Sometimes hammering as above only makes the matter worse. In this case mark the place with chalk, or by some other means, and strike several blows in a line extending from centre to circumference through the bent spot. Strike each side of the spot so as to stretch the whole saw to agree with the full place.

The simplest bend to remove is when an arc of the saw is sprung one side and the line of the bend follows the cord of the arc. All that is needed to cure is a number of light blows all in a row upon the hollow side, as above, and right in the hollow or bend. The worst case to deal with is a twist, part of the saw bent one way, part of it another, and the rest of it both ways. In this case go for all the low places on one side first. Get them all out and the saw will dish. It is very easy to deal with a dishing-saw, just hammer the rim. Take the worst saw you ever got hold of, and if you can hammer it so as to be dishing, then the battle is yours. A few good blows at the roots of the teeth, and that saw is good for something.

Once get it through your head where to strike a saw, and you can easily true up a bent one. If you have an old saw that you have always kept to look at, try your hand on that. Pick out a true place in it, and strike there with the hammer, and see what the effect will be. Strike four or five blows in a line, and measure the bend they cause. Now try to straighten the saw back again, always bearing in mind that you cannot drive down a bulging place. You must coax it down. Do it as Paddy coaxed the pig to go ahead, by hitting him on the nose. "If the mountain won't go to Mahomet, then Mahomet must go to the mountain." If a certain part of the saw is too big, stretch the rest of the saw to correspond. It doesn't take much hammering. Have often seen saws hammered too much. It would spring the saw the other way every time, and it would have to be hammered elsewhere to get it back again.

Hammering wants to be done, like filing, "just before it is needed." A small kink needs but three or four taps of the hammer. Let it go, and another kink gets in, the saw springs out of shape, and you may have to get an expert to hammer it in shape again. Do not let a saw run a minute after it needs fixing. It is only a waste of time, power, and elbow-grease. It is ten times as much wear to the machinery, saw, and man. If we could only make the men who tolerate dull, untrue saws, believe the above, they might get rid of lots of hard work and poorly-cut stock.

One day, while passing through a shop, a circular saw was heard making a noise as if it were having an awful hard time. Every time the sawyer forced a board against the saw it would slow down and stop after going eight or ten inches. The countershaft kept right on, and did not care what the saw was doing. Upon going around the saw table, where the belt could be seen, it was found to be sagging badly. It was too loose. The remark was made to the sawyer that "if he took up the saw belt the saw would work better." The sawyer said, "I'll be —— if I take up any belts round this mill unless I have an order." That man cannot be blamed, either. The foreman would fuss and fret around a man every time he found him doing a little repair work, and it shows the foreman does not know his business. The men get so they hate to mend anything. It is hard, in any shop, to make the men "take a stitch in time"; but when the whining boss runs the shop, then every crack goes until it breaks clear off.

Patch up the little breaks as fast as they are found; things will work better. If the corner of a cement joint in a belt starts up, don't let go until the belt breaks; but warm the belt, work in a little cement (one-third fish two-thirds common glue), hammer the parts together and drive in a few pegs. Five minutes will do the job; but it will take half an hour to mend the belt if it runs a week longer without fixing.

Some sawyers raise the table until the saw barely reaches through the work. They claim that the saw cuts better and easier. This is a mistake. It puts double the work on the saw. For example, take an 8in. saw and a pine board. When the board runs close to the collars, the saw cuts nearly square across, and the action of the saw is cut off the grain of the wood and split off the pieces thus cut off. This agrees with the action of cutting tools in general. When the table is raised, the tendency is to split before. This, with the increase of the section upon which the saw acts, which is double, makes it much harder for the saw. The chip is smaller, but does not compensate for the extra section of cut.

Always run the saw as high as possible. If the pulley is small, or the machine is bolted down, raise up the saw until the collars almost project through the table. Keep the saw sharp and true. Use more oil than cuss words. Then your saw will cut a great deal of lumber, and do it easily.—*Tradesman.*

LESSONS IN THE DIFFERENTIAL CALCULUS.—IV.

By Richard A. Proctor, B.A., F.R.A.S.

Author of "Other Worlds than Ours," "Sunviews of the Earth," &c., &c.

I WILL now state the differential coefficients of the few simple functions which remain to be considered. It is not probable that many of those for whom these lessons are intended, will require, at this stage of mathematical reading, to use the following differential coefficients. But it is well for them to notice that every function, however complex, can be differentiated when the following coefficients, and those given in the other lessons, are known, and applied in accordance with the two very simple rules stated in the last lesson. This power of treating any expression whatever is a characteristic feature of the calculus we are dealing with. The integral calculus, which may be regarded as the inverse of the differential, differs from it in this important respect. We can always and easily differentiate, but we cannot always apply the reverse process. So that in the application of the integral calculus to measure the lengths of curved lines, the areas of surfaces bounded by such lines, or the surfaces and volumes of various solids, and still more in the application of that powerful calculus to problems of a physical nature, considerable ingenuity is often required in mastering the analytical difficulties which present themselves, and indeed these difficulties are often only partly superable. On the contrary, the application of the differential calculus to the simpler orders of problems proceeds on sure and easily-mastered principles.

These are the remaining coefficients:—

$$\text{If } y = \log._a x$$

$$\frac{dy}{dx} = \frac{1}{x \log._e a}$$

$$\text{If } y = a^x$$

$$\frac{dy}{dx} = a^x \log._e a$$

Note.—These two results give at once the coefficients of $\log._e x$ and e^x, because $\log._e a$ is unity when $a = e$. Thus the respective differential coefficients of $\log._e x$ and e^x are $\frac{1}{x}$ and e^x.

If $y = \sin.^{-1} x$, that is the angle whose sine is x (said angle being, of course, expressed in arc-measure).

$$\frac{dy}{dx} = \frac{1}{\sqrt{1-x^2}}$$

$$\text{If } y = \cos^{-1} x;\ \frac{dy}{dx} = -\frac{1}{\sqrt{1-x^2}}$$

$$\text{If } y = \tan.^{-1} x;\ \frac{dy}{dx} = \frac{1}{1+x^2}$$

$$\text{If } y = \cot.^{-1} x;\ \frac{dy}{dx} = -\frac{1}{1+x^2}$$

$$\text{If } y = \sec.^{-1} x;\ \frac{dy}{dx} = \frac{1}{x\sqrt{x^2-1}}$$

$$\text{If } y = \text{cosec.}^{-1} x;\ \frac{dy}{dx} = -\frac{1}{x\sqrt{x^2-1}}$$

As respects these last six differential coefficients a few remarks may be made.

First of all, let it be noted that these coefficients may be obtained easily by geometrical construction; and it is well for those who want to become familiar with the principle on which the differential calculus proceeds to obtain the coefficients in this particular way. I give an instance:—

Let y be the angle BAC, whose sine $\frac{\text{CE}}{\text{CA}}$ is equal to x; that is, let $y = \sin.^{1-}x$. For convenience let radius be unity, so that

$$y = \text{BC, and } x = \text{CE,}$$

when x is increased by $\Delta\ x$, equal to DG, let y be increased by the arc DC. Thus—

$$\frac{\Delta y}{\Delta x} = \frac{\text{DC}}{\text{DG}}$$

Now when D G is made indefinitely small, so that D is quite close to C, and is in effect *just upon* C, it is clear that D C G becomes a small triangle shaped like A C E. Hence, when it is in that condition we have (replacing $\Delta\ y$ by dy and $\Delta\ x$ by dx, to show that we have passed to the ultimate condition of these increments).

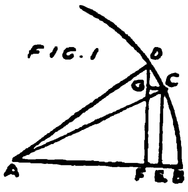


FIG. 1

$$\frac{dy}{dx} = \frac{\text{AC}}{\text{AE}} = \frac{1}{\sqrt{1-x^2}}$$

the value given in the above table.

And in a similar way the other values may be obtained. Their calculation by this method will conduce much to clearness of conception on the part of the student.

But now note this other way of viewing these inverse functions.

$$\text{If } y = \sin.-1\,x,$$
$$x = \sin.\,y$$

and therefore, by what was shown in preceding lesson,

$$\frac{dx}{dy} = \cos.\,y$$

Hence,

$$\frac{dy}{dx} = \frac{1}{\cos.\,y} = \frac{1}{\sqrt{1-\sin.^2 x}} = \frac{1}{\sqrt{1-x^2}}$$

as before

The only objection to this inverse process is that many mathematicians consider that $\frac{dy}{dx}$ should be regarded as a single expression, not admitting of being treated as a fraction. It is a matter to be *proved*, not *assumed*, they reason, that

$$\frac{1}{\frac{dy}{dx}} = \frac{dx}{dy}$$

Other mathematicians, on the other hand, consider themselves free to separate the dx from the dy. So that we find in many treatises that a statement such as

$$\frac{dy}{dx} = \cos.\, x \text{ (where } y = \sin.\, x)$$

is written

$$dy = \cos.\, x \,.\, dx.$$

I mention this lest my readers should light on books in which the latter usage is employed, and be perplexed by it. As regards the question which of these notations is to be preferred, the reader need not at present concern himself. It is certain that both are accurate.

We will now consider a few more applications of the differential calculus to problems of maxima and minima.

A B, Fig. 2, is the section of a plane horizontal

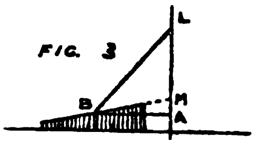


FIG. 3

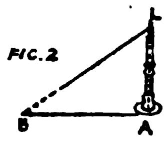


FIG. 2

surface; L, a light vertically above A. If A B = 1ft., at what height should L be, that the illumination at the point B may be as great as possible.

[It is clear there is a maximum here; for if L is in the same level as B, the illumination is zero, and so, also, the illumination is zero if L is at an infinite height.]

Let A L = x. (The light is supposed to be a point, or, at any rate, to act as if collected at a point.)

$$\text{Then B L} = \sqrt{\text{A B}^2 + \text{A L}^2}$$
$$= \sqrt{1 + x^2}$$

And according to the known laws of illumination, the illumination at B varies inversely as the square of the distance B L, and directly as the sine of the angle L B A. Hence, taking m (which will not eventually trouble us) as a suitable constant, we may represent the illumination at B by the expression

$$\frac{m}{(\text{B L})^2} \cdot \frac{\text{A L}}{\text{B L}} = \frac{m \,.\, \text{A L}}{\text{B L}^3}$$

Call this illumination y; then

$$y = \frac{m x}{(1 + x^2)^{\frac{3}{2}}} \quad \ldots\ldots\ldots\ldots\text{(i.)}$$

Now, to differentiate this expression, we take first the differential coefficient of the numerator, and multiply into the denominator. This gives

$$m\,(1 + x^2)^{\frac{3}{2}}$$

Then we take negatively the differential coefficient of the denominator, and multiply it into the numerator. This gives

$$-\frac{3}{2}\,(1 + x^2)^{\frac{1}{2}} \,.\, 2x \times m x, \text{ or } 3\,(1 + x^2)^{\frac{1}{2}}\, m x^2$$

We have only to put the square of the denominator under these two expressions, thus—

$$\frac{m\,(1 + x^2)^{\frac{3}{2}} - 3\,(1 + x^2)^{\frac{1}{2}}\, m x^2}{(1 + x^2)^3}$$

to get the differential coefficient of y, and we could reduce and simplify this expression considerably. But observe, we only want to equate the coefficient to zero (that being, as in former cases, the way of getting the required value of x). So that we have no occasion to write out the differential coefficient as above, or to reduce it. We need only write its *numerator* and equate *that* to zero. This gives

$$m\,(1 + x^2)^{\frac{3}{2}} - 3\,(1 + x^2)^{\frac{1}{2}}\, m x^2 = 0 \;\ldots.\text{(ii.)}$$

or—

$$(1 + x^2) = 3x^2 \text{ [dividing out by } m\,(1 + x^2)^{\frac{1}{2}}]$$

That is
$$2x^2 = 1$$
$$x = \frac{1}{\sqrt{2}}$$

Hence A L should be about 8½in.

If we had taken A B = a instead of 1, we should have obtained the result—

$$a^2 + x^2 = 3x^2$$

i.e.,
$$2x^2 = a^2$$

or,
$$x = \frac{a}{\sqrt{2}}$$

Note that the writing of this problem would be very short in practice. In fact, after expressing y in terms of x, as at (i.), the student would write down equation (ii.) at once; and solve as above.

SCIENTIFIC SOCIETIES.

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ROYAL ASTRONOMICAL SOCIETY.

MR. E. J. STONE, director of the Radcliffe Observatory in the chair. Lord Edward Spencer Churchill, of Castlemead, Windsor, was elected a Fellow of the Society.

Mr. A. M. W. Downing read a paper by the Rev. W. Sidgreaves, on "The Stonyhurst Drawings of Sunspots and Faculæ." Drawings are made on every fine day of the spots, and the faculæ are marked in with red chalk, so that they are at once seen and distinguished from the spot and penumbral markings. On looking over the long series of drawings which are now possessed by Stonyhurst, Father Sidgreaves found that, though faculæ are always attendant upon spots, they seldom precede their formation, but they commence very soon after the birth of a spot.

Mr. Maunder: It seems to me that Prof. Sidgreaves' communication opens up a matter of great interest in solar physics. I have not had time since I first saw it to go thoroughly into the question. I took, however, the minimum year of 1888, and went through the Greenwich observations of that year, with this result—that out of 53 groups of spots, 12 showed faculæ before the spot was seen. Of those 12, four came round the limb, and faculæ preceded the spot; consequently, that was not one of the instances Father Sidgreaves speaks about. Of the other eight groups, seven of them were of one distinct type. They were very small, short-lived groups, and in every one of those seven cases they were revivals of old disturbances. They occurred in parts of the sun where small and transient outbreaks had been observed three or four months earlier, so that in these cases we have no definite proof of faculæ having preceded the outburst of spots. In the 12th case there seems some evidence for thinking that faculæ appeared before the spot; but in that case there was an interval of one day in which neither faculæ nor spot were seen. The next day a penumbral patch appeared, and on the third day a small spot appeared. It is curious how small spots are connected with this intermittent disturbance. Seven of those groups appeared where other groups had been seen a couple of months before. The earlier and later groups lasted only one or two days, and in the interval between, perhaps a day or two before the appearance of the second group of spots, you might have seen the faculæ; so that as far as my observation goes, there is little evidence that faculæ appear before spots.

Mr. Downing then read a paper by Prof. H. C. Vogel, "On the Spectrographic Method of Determining the Velocity of Stars in the Line of Sight." The conclusion come to by Prof. Vogel seems to be that the velocities of stars are much smaller than was expected from the direct observations. The greatest velocity he has measured is that of *a* Tauri. Out of those measured by him, fifteen stars had a positive motion, and thirty-two a negative motion.

Mr. Maunder: I think Prof. Vogel is much to be congratulated upon the skill he has shown in measuring the velocity of stars in the line of sight, and on the success which has attended it so far. The photographic method has several advantages over eye observation. In such work, first of all, the atmosphere and disturbances do not seem to injure the photograph as they certainly embarrass the observer. There is nothing more difficult than to bisect a line in the spectrum of a star if its light is unsteady. The star line frequently goes out, and to retain it sufficiently long in the eye in order to bisect it is very difficult. The photographic method has the advantage that by prolonging the exposure with the same dispersion you can get a better image image than with the eye—just as the image of a star which you cannot see with the telescope, by sufficiently prolonging the exposure can be made visible, so you may render visible on the photograph of the spectrum a line invisible to the eye. Dr. Vogel's aperture is the same as we use at Greenwich; but the length of his spectrum would appear to be three times the length of that we shall have with the new Greenwich telescope. Then there is the further advantage that it is possible for Dr. Vogel to make a comparison—not between one line of the spectrum, but between many comparison lines and many lines of the star spectrum. There are one or two points in Dr. Vogel's paper which I am not inclined to agree with, although it may seem presumptuous for me to say so; but it does not seem to me that it is at all advantageous to take the comparison spectrum across the star spectrum, so that the comparison spectrum obliterates partially or wholly the line you want to measure. Then it struck me it was a complicated way of adjusting the spectroscope—to do it by a measured scale: we can do it much more rapidly directly with the eye at Greenwich.

Mr. Ranyard: I have seen one of these spectrum negatives of Sirius with an iron comparison spectrum, and it was very beautiful and sharp, indeed—better than anything I have seen before. One can only hope that Prof. Vogel has not underestimated the probable error of his determinations of the motion in the line of sight. If we really have such accuracy as he believes that he has attained to, we have a means of estimating the distance as well as the actual motions of stars in the heavens. For, on the average, their motion in the line of sight must be equal to their motion across the line of sight, which we are able to observe as proper motions or change of place, and if we knew the actual motion across the line of sight, as well as the apparent motion, we should know the distance of the stars. I do not quite understand Dr. Vogel's comparison of the hydrogen lines with the absorption lines in the spectrum of the moon. He seems to have assumed that they must agree; but there are many times in the year, and in the month, when the moon is moving away from, or towards, the sun, with a velocity of more than half a mile per second, and also when we are near to our mean distance from the sun, and the radius vector of the earth's orbit is rapidly shortening or lengthening when there ought not to be such a coincidence.

Capt. Noble: I have consulted some comparatively recent observations of Prof. Vogel of Venus in the line of sight, and he found that his measures were within $\frac{4}{10}$ths of a mile. This is a small quantity.

Mr. Maunder: There was one particular observation I noticed with great interest in Dr. Vogel's paper, and that is his observation of the motion of Sirius. It will be within the memory of most of the members of the Society that when I first began to observe at Greenwich I found a displacement toward the red end of the spectrum, and it seemed to decrease year after year until it became a displacement towards the blue end. Prof. Vogel seems to have had the same experience, I think, some years later. In 1878 his photograph showed a displacement towards the red. He published some observations, I think, made in 1889, in which he got practically nil, and his most recent observations show a very distinct displacement towards the blue. It will be very interesting to watch his further observations of this star.

Mr. Ranyard: Do you remember what amount of motion the observations corresponded to?

Mr. Maunder: Yes; about seven or eight miles, as determined by iron and hydrogen lines.

Mr. Ranyard: It can clearly have nothing to do with the companion star we know of, which has a period of 53 years.

Mr. Maunder: No; the period is much shorter.

Mr. H. H. Turner then read a paper on "The Distribution of Temperature in the Transit-circle Room of the Royal Observatory, Greenwich. Mr. Turner said he had to trouble the society again with rather a technical subject—viz., that of the temperature of the transit-circle room at Greenwich. He found it was a considerably complicated matter when he looked into it, depending on many minor sources of heat, such as gas-lamps and the heat from the observer's body, all of which affected the refraction of the air and the apparent places of the stars.

Mr. A. A. Common read a paper on the construction of his 5ft. reflecting telescope, which he illustrated by photographs thrown on the wall. The paper will be printed at length in the *Monthly Notices* of the society.

ROYAL METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this society was held on Wednesday evening, the 16th inst., at the Institution of Civil Engineers, Mr. Baldwin Latham, M.Inst.C.E., president, in the chair.

Mr. R. H. Hooker, B.A., Mr. A. B. MacDowall, M.A., Mr. E. G. Ravenstein, F.R.G.S., and Mr. R. Hedger-Wallace were elected Fellows of the society.

Mr. W. Marriott gave the results of the investigation undertaken by the society into the thunderstorms of 1888 and 1889, which he illustrated by a number of lantern slides. The investigation was originally confined to the south-east of England; but as this district was found to be too circumscribed, it became necessary to include the whole of England and Wales. After describing the arrangements for collecting the observations and the methods adopted for their discussion, Mr. Marriott gave statistics showing the number of days on which thunderstorms occurred at each station, the number of days of thunderstorms in each month for the whole country, the number of days on which it was reported that damage or accidents from lightning occurred, and also the number of days on which hail accompanied the thunderstorms. In 1888 there were 113 days, and in 1889 123 days on which thunderstorms occurred in some part of the country. The number of days with damage by lightning was 33 in 1888, and 38 in 1889; and there were 56 days in each year on which hail accompanied the thunderstorms. The tables of hourly frequency show that thunderstorms are most frequent between noon and 4 p.m., and least frequent between 1 a.m. and 7 a.m. Thunderstorms appear to travel at an average rate of about 18 miles per hour in ill-defined low barometric pressure systems, but at a higher rate in squally conditions. The author is of opinion that individual thunderstorms do not travel more than about 20 miles, and that they take the path of least resistance, and are consequently most frequent on flat and low ground. Detailed isobaric charts, with isobars for two hundredths of an inch, were prepared for 9 a.m. and 9 p.m. each day for the month of June, 1888. An examination of these charts showed that instead of the pressure being so very ill-defined, as appeared on the daily weather charts, there are frequently a number of small but distinct areas of low-pressure, or cyclones, with regular wind circulation, and that that these small cyclones passed over the districts from which thunderstorms were reported. Sometimes it is not possible to make out well-formed areas of low-pressure from two hundredths of an inch isobars; but there is a deflection of the wind which shows that there is some disturbing cause, and thunderstorms have usually occurred in that immediate neighbourhood. The author believes that the thunderstorm formations are small atmospheric whirls, in all respects like ordinary cyclones, and that the whirl may vary from one mile to ten miles or more in diameter. There are frequently several whirls near together, or following one another along the same track. The numerous oscillations in the barometric curve are evidently due to the passage of a succession of atmospheric whirls; and it appears that lightning strokes are most frequent when these oscillations are numerous.

Mr. F. J. Brodie read a paper "On the Prevalence of Fog in London during the Twenty Years 1871 to 1890." The popular notion that November is, *par excellence*, a month of fog, is not confirmed by the figures given by the author. The number of fogs in that month is, if anything, slightly less than in October or January, and decidedly less than in December, the last-mentioned month being certainly the worst of the whole year. The latter part of the winter is not only less foggy than the earlier part, but is clearer than the autumn months. In February the average number of days with fog is only 6·6, as against 8·9 in January, 10·2 in December, 9·2 in October, and 8·8 in November.

THE LANTERN SOCIETY.

On Dec. 14 Mr. E. M. Nelson gave a paper on "Condensers for the Optical Lantern." He said that a question often asked was, What is the focus of a condenser? It was a difficult one to answer, because there was the equivalent focus and the equivalent back focus, the actual focus and the actual back focus. It was therefore necessary, in the first place, to understand which of these four foci were meant. He then explained, by means of diagrams, how, with only simple arithmetic, the position of these four foci might be calculated with sufficient accuracy for all practical purposes. He next spoke of the importance of reducing the spherical aberration, which necessarily was very great in the bending of the marginal rays through such a large angle, to a minimum; and he explained that spherical aberration and unevenness of illumination were correlative terms. The greater the bending of the rays the greater will be the aberration, and the more lenses that this is accomplished with the less will be the aberration. A quadruple condenser has less aberration than a triple, and a triple than a double. Freedom from spherical aberration means greater concentration of light, as well as greater evenness of illumination; it is therefore desirable to obtain it on every account. He next touched upon the illuminating powers of condensers, and said that the question for lanternists was not so much the total amount of light condensed, but the amount per unit of area; and he showed that if a slight increase was made in the diameter of a condenser, it was necessary to make a large increase in the angle, so that the same amount of illumination per unit of area might be maintained. In conclusion, he pointed out that achromatism in converging lenses by distancing them was impossible. On the conclusion of the paper the following five condensers were tried practically in a lantern made specially for the purpose: A flint quadruple, two crown triples, a crown double, and the ordinary commercial double. The five condensers were held in a slide, and could be pushed alternately into position without needing any alteration of the other adjustments. The general opinion was that the flint quadruple gave the best definition, but that the crown double gave the strongest and purest illumination.

Amongst Calendars for 1892 we have one, called a "new patent," issued by T. Fletcher and Co., of Warrington and London, in the form of a block, from which each day's leaf can be removed—useful for hanging up or placing on the desk.

The substitution of camel's hair, cotton, paint, and chemicals, for leather in machinery belting, is said to be meeting with some success in this country. It was first invented in England, and it is claimed for the new material that it is stronger than other belting, more durable, more efficient, and as low prices.

SCIENTIFIC NEWS.

The position of Tempel-Swift comet for Dec. 31 at Paris midnight will be R.A. 3h. 9m. 43s., N. Dec. 27° 25′ 2″.

In the *Sidereal Messenger* for December, Mr. S. W. Burnham has a paper on "New Binary Stars β 416, Scorpii 185." The wide double H 4,935 was examined in 1876 by Mr. Burnham, who found that the principal star was also double. Scorpii 185 is B.A.C. 5825, and the estimates of magnitude cover quite a wide range. It is desirable that observers in the S. hemisphere should follow the close pair, and measure every year, if possible.

At the meeting of the Paris Academy of Sciences, on the 30th ult., M. Faye presented the "Connaissances des Temps" for 1894, the 216th consecutive publication. The first edition was superintended by Picard in 1679. The "American Ephemeris" for 1894 has also been published, the arrangement adopted in 1882 having been continued without radical change since then. M. Loewy is responsible for the French, and Prof. Newcomb for the American, *Nautical Almanac*.

Seismic and volcanic disturbances are apparently very prevalent in several parts of the world, and the Mexican Government have gone so far as to order the inhabitants of Colima and its vicinity to abandon their houses and seek refuge where they can, as the volcano in the neighbourhood is showing signs of activity, and the country for miles round is illuminated by the flames from the crater.

At a recent meeting of the Royal Society, Sir W. Thomson appointed as his vice-presidents, Dr. J. Evans, Profs. G. C. Foster, G. D. Liveing, and Sir G. G. Stokes, and read a note from Prof. Dewar in which that distinguished physicist announced that he had placed a quantity of liquid oxygen in the state of rapid ebullition in air (temperature − 181° C.) between the poles of the historic Faraday magnet, in a cup-shaped piece of rock salt (which is not moistened by liquid oxygen, and therefore keeps it in the spheroidal state), and to his surprise, saw the liquid oxygen, as soon as the magnet was excited, suddenly leap up to the poles and remain there permanently attracted until it evaporated. The experiment confirms what was known or thought of the properties of oxygen, and will be especially interesting to students of electrolysis.

The death of the Duke of Devonshire is more of political than of scientific interest; but the deceased peer had done much for science, and kept the name of Cavendish to the front in the world of learning. He was born in 1808, and, like his ancestor Sir John Cavendish, who lived in the time of Richard II., he was elected to the honour of Chancellor of the University of Cambridge. The deceased took great interest in Owens College, Manchester, and the Yorkshire College of Science, besides many minor institutions, while he also presented the Cavendish Laboratory to Cambridge University.

M. Vaussenat, a distinguished civil engineer, and the constructor of the observatory on the Pic du Midi, the funds for which he mainly collected himself by lecturing, and for his services received the gold medal of the National Agricultural Society of France, died the other day at Bagnères-de-Bigorre, a place at which he had settled in order to study the geology of the district.

The death is announced of Sir James Risdon Bennett, M.D., at the age of 82. Although not a voluminous writer, Sir Risdon Bennett was well known in medical circles, many of the more distinguished members of the profession having attended his lectures at Charing Cross Hospital, and also at St. Thomas's. He was elected a Fellow of the Royal College of Physicians in 1846, was censor in 1857 and 1871, Croonian lecturer in 1863, Lumleian lecturer in 1870, and in 1876 president, an office to which he was re-elected five years in succession.

Another physician, well known in naval and Court circles, died the other day in his 76th year. Dr. John Minter was inspector-general of hospitals and honorary physician to the Queen. He had seen much service in the navy.

The well-known geologist, Dr. J. W. Ewald, died recently at Berlin in his 82nd year. He was the travelling companion of Von Buch, and when the latter died in 1853 succeeded him at the Berlin Academy of Sciences.

Dr. Dietrich, Keeper of the Botanical Museum at Berlin, is also dead at the age of eighty-six years.

It is stated that Prince Lucien Bonaparte has bequeathed to the English nation a cabinet of elements which contains a specimen of Germanium—an element which is said to be worth quite sixty times its weight in gold. It is not stated, however, what is the weight of the specimen of Germanium.

At a meeting of the Prize Sheet Sub-committee of the Royal Commission for the Chicago Exhibition of 1893, Sir H. T. Wood, secretary of the Royal Commission, and Mr. R. M'Cormick, British Commissioner, being present, various points connected with the preliminary prize list issued by the Chicago executive were discussed, and a memorandum embodying the suggestions and inquiries of the sub-committee was ordered to be forwarded to Chicago for the consideration of the authorities.

The prospectus of the International Exhibition to be held at Kimberley in September next year has been received by Mr. Atkinson, the London manager. It states that all European exhibits will be conveyed from the coast to Kimberley and taken back to Port Elizabeth or Cape Town free of charge. Medals and certificates will be specially awarded for the most economical mining, electric lighting, and agricultural machinery. Special prominence is to be given to all classes of machinery adapted for use in the colony.

It is stated that an aërial machine has been invented by Mr. E. P. Frost, of West Wratting Hall, Cambridgeshire. The council of the Aëronautical Society, including Mr. James Glaisher, recently inspected the machine. It seems that Mr. Frost only waits for a sufficiently light engine, which will supply the necessary motive-power, and this Mr. Maxim has nearly invented. The machine is devised and constructed in imitation of the arrangement of every feather in the wing of a crow, the bird selected as its model. The dimensions are 30ft. from tip to tip of the large wings. The whole weight is about 650lb.

A well-known American mechanic, a leading man in his line, does not think it worth the while of the Americans to copy the "solidity and immense weight that some deem a merit in English machinery." No English mechanic deems it a merit to have immense weight, but any mechanic, worthy of the name, thinks it necessary to have every part of a machine as strong as it can be made within the limits of weight allowable.

Another American scientist, reading a paper before the chemical section of the Franklin Institute, said that the Americans are still slow in the development of chemical industries.

Compressed air for cleaning cars is used on the Union Pacific Railway at its Portland shops. The air, under a pressure of 50lb. per square inch, is delivered from a flexible hose with a small nozzle, and is used as water would be. *Engineering News* says the results achieved are said to be very satisfactory, especially in cleaning the plush seat cushions.

Warming Omnibuses.—The Paris Omnibus Company have vehicles fitted with what may be termed briquette foot-warmers. The arrangement is as follows: Along and upon the floor of the central passage is laid a second floor in the form of open network, slightly arched, and capable of containing four warmers longitudinally. The heating apparatus consists of a form of briquette inclosed in a double metal envelope, the one to retain the products of combustion, and the other a kind of grating, upon which passengers place their feet. This arrangement has diminished the height of the interior of the omnibus by about 3in., thus necessitating tall persons to stoop upon entering and leaving the vehicles. These warmers are renewed at the Bastille depot on the return journey. Apart from this system, the company has experimented at the principal depot with hot-water heaters similar to those used in railway carriages. The results of the tests were, however, unsatisfactory, and the above-mentioned method was tried, which is said to possess the great advantage of retaining the heat for a much longer period. During the present week other omnibuses have been fitted with this system. These vehicles serve the most busy districts, and are drawn by three horses.

LETTERS TO THE EDITOR.

[*We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.*]

All communications should be addressed to the Editor *of the* English Mechanic, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

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SECANT OF A VERY SMALL ARC—NEWSPAPER SCIENCE: THE SOLAR PARALLAX—TESTS FOR TELESCOPES: WHOLE AND CONSTRICTED APERTURES — PROJECTILES AND THE ROTATION OF THE EARTH—THE DIAL AT DELHI — MOTION FOR EQUATOREAL-ASTRONOMICAL EYEPIECES — RAIN-MAKING BY EXPLODING DYNAMITE — GLASS-GRINDING—SELENOGRAPHICAL.

[33008.]—In giving so very elementary an explanation as that which concludes the fourth paragraph of letter 32957 (on p. 349), instead of saying that "Such an arc has no measurable secant," I should probably have been a little more intelligible to "Alcyone" had I told him that the secant of such an arc is wholly undistinguishable from unity—or radius, of which the log., of course, is 0·0000000.

Apropos of the sines of small arcs, I have just come across a funny bit of trigonometry, conspicuously displayed in the columns of one of the leading daily papers. Many who will read these lines will be aware that Prof. Auwers, of Berlin, has very recently finished his reduction and discussion of no less than 754 measures, made with the heliometer, from various stations, of the distance of Venus from the sun's limb during the Transits of 1874 and 1882—a fact which is thus announced:

"The Parallax of the Sun. (From our correspondent.)—Berlin, Friday Night.—Prof. Arthur Auwers, the well-known Berlin astronomer, has now completed the calculations based on the observations in Germany of the transit of Venus in 1882. He finds that the earth is about 92,043,074 miles distant from the sun, and that the parallax of the sun is 8·800 seconds, with an error of three-hundredths of a second at most."

Now, either "Our Correspondent's" parallax, or his estimate of the earth's mean distance from the sun is wrong; and as I think that it may possibly at once interest and instruct "Alcyone" and other students like him, I will work out, first, the sun's mean distance from his parallax as given, and next, from the given distance deduce his parallax. Of course, to obtain the sun's mean distance, we say—as sin. parallax : earth's equatorial radius : : 1 : sun's mean distance. In other words, we divide the earth's equatorial radius in miles by the sin. of the solar parallax. With Clarke's spheroid of 1878 the equatorial semidiameter of the earth = 3963·296 miles, of which the log. is 3·5980565. The log. sin. of 8·800" is 5·6300576; taking the latter log. from the former, thus:

3·5980565
5·6300576

we get 7·9679989 the log. of 92,896,400, and certainly *not* of 92,043,074 miles. But in the next place, let us assume that this distance of 92,043,074 miles is correct. The log. of this is 7·9639911; so we say—

Log. of earth's equatorial radius	3·5980565
Log. of sun's mean distance	7·9639911
	5·6340654, which

is the log. sin. of 8·88159". *Utrum horum mavis accipe.*

Mr. Clapham's letter (32958) on p. 349 is well worth the attention of the student. Notably may his remarks about good and bad—or, what is nearly the same thing, dear and cheap—telescopes be laid to heart. His Chevalier hand telescope, by the way, must be a most admirable specimen of optical art to enable Cassini's division in Saturn's ring to be glimpsed with it. The point in your correspondent's communication, however, to which I would specially refer is one touched upon farther on by Mr. Herbert Sadler (in letter 32964) on p. 350. I mean the use of a portion only of a large object-glass. It is perfectly unfair to the object-glass of the finest telescope of small aperture to compare its performance with that of the middle of a large objective stopped down to the same diameter. The difference between the performance of central 3in. of my own object-glass and the entire aperture of a 3in. I possess, mounted on a pillar-and-claw stand, is very striking indeed.

There can be no doubt that the mode of rifling adopted in the modern service guns has the tendency to cause drift, to which your correspondent "J. R. C." refers in his letter (32969) on p. 351; but that the earth's rotation does, at long ranges, exercise an appreciable influence on projectiles fired north or south is admitted and commented on by General Owen himself in one of the most familiar of the Woolwich textbooks, his "Principles and Practice of Modern Artillery." Mine is the second edition, and if "J. R. C." possesses it, I would refer him to pp. 231 *et seq.* in corroboration of my assertion. At the bottom of p. 233, in a foot-note, General (he was then Lieut.-Col.) Owen says, "Lieut. W. F. Richardson, R.E., in a paper on the 'Deviation of Projectiles unconnected with Rifling' in the *Proceedings of the R.A. Institution*, p. 464, gives a table of the deviations of projectiles from the Armstrong 100-pr. L. Thomas's gun and 13in. mortar due to the rotation of the earth." It may well be that at long ranges the deviation of the shot from the earth's rotation would be masked by such disturbing causes as General Owen refers to in his "Elementary Lectures"; but that it would be destroyed by them I humbly venture to doubt. Currents of air would assuredly be as operative in diverting the drift of the ball derived from the right-hand rifling of the gun. Mackinlay's book has come out since my time. I think that this, in one sense, may serve also as a reply to "Brux" (letter 32971, p. 352). I have not General Boxer's book to refer to, so am unable to say what kind of gun he was speaking of. Of course, it may be that he merely gives the *theoretical* deflection of the shot, as he does not state that his deduction is the result of any experiment.

"C. H. T." (letter 32984, p. 353) will find an engraving and description of the so-called "Dial" at Delhi in part I. of Proctor's "Old and New Astronomy."

Should Mr. Smith (reply 75731, p. 354) have access to the back volumes of the "E. M." in any library in Saginaw, and will turn to p. 394 of your 2nd volume, he will find Mr. Hopkinson's contrivance (really invented by your old correspondent Mr. Philip Vallance) described in detail; the only difference being that while Mr. H. uses an india-rubber bag, Mr. Vallance employed a bladder.

Following a Scottish practice, I would answer one query (76062, p. 358) by asking "Kinetic" another. Is it a fact that a projectile shot up a considerable distance into the air will not return to the same spot, *owing to the rotation of the earth?* And, if so, why so? I assume that by "shot up" being projected vertically is meant.

"Astronomo" (query 76067, p. 358) will find 60 a very suitable power for observing the sun with his 3in. telescope. He may use double that amplification, 120, on the moon, and even a higher power still on a very fine night; 120, too, he will find very suitable for Jupiter. He can employ his 180 power on his star of the first magnitude. It will also do well for Saturn. I am, of course, assuming that his object-glass is a first-class one.

If "Hortus" (letter 33001, p. 375) will refer to the letter which he criticises, he will find that what I said about the atmospheric conditions in Madras and Texas was this: "Now, it is impossible to conceive that atmospheric conditions differ in America and in India to an extent which will suffice to explain this discrepancy"; assuredly not that they did not differ at all. If "Hortus's" letter means anything, it can only signify that while "moisture-laden clouds" were floating over Texas, they were absolutely absent in Madras; but if my memory is not more than usually in fault, the dynamite experiments were carried on in the former locality, as in the latter, in a cloudless sky, and after a protracted period of drought which had parched up the earth. If "Hortus's" calceolarias should suffer from want of water, I would assuredly not attempt to dissuade him from exploding dynamite over his garden.

"Zebra" (query 76130, p. 381) may consult Vol. III. of Holtzapffel's "Turning and Mechanical Manipulation," chap. 33, pp. 1257 *et seq.*; "Amateur Handicraft" (published by Kent and Co., London); Sir John Herschel on "The Telescope" (A. and C. Black); and the back volumes of the English Mechanic, *passim.*

Yet another antagonist to the selenographical hypothesis propounded by Mr. Peal has arisen, in the person of the Rev. John Bone, F.R.A.S., who has been reading a paper on Physical Selenography before the Lancashire Philosophical Society. Mr. Bone will have none of Mr. Peal's snow ramparts, believing that the features of lunar scenery are those of a globe which has cooled down from a molten condition, and that lava pools have welled up through the crust and left solidified banks round their margins. Copernicus and Tycho he looks upon as the two oldest craters in the moon, and considers that the "radiating streaks represent enormous fissures which resulted from that early volcanic, or perhaps tidal, catastrophe; and that these fissures were filled up with material from the interior in a molten condition, having, and continuing to have, a different reflective capacity from the surrounding surface."

A Fellow of the Royal Astronomical Society.

STAR-TESTS — OVERTAXED BRAIN — OBSERVING CHAIR.

[33009.]—Mr. C. H. Fridy (32963) ought to find no difficulty with either Polaris or the fourth star in the Trapezium of Orion with his 2¾ o.g.

Too much alcoholic drink will do his case no good, nor is there need to put away his instrument so long as its use is not made a toil instead of a pleasure. If he will write me, I will give him my own sad eighteen months' experience and results.

I have used two or three kinds of observing seats during the last twelve years, and now use a light step-ladder. I have a loose board about 12in. square, near the edge of which are fastened two flat strips of iron bent so as to clip on the back edge of one of the steps. This forms a comfortable seat. I have two other boards, 2in. and 1in. thick, to raise the observer as required. I get a firm comfortable seat in this way, available under any position.

Austwick, Lancaster. **T. R. Clapham.**

DEVIATION IN THE FLIGHT OF PROJECTILES, AND ROTATION OF THE EARTH.

[33010.]—"F.R.A.S." (letter 32925, p. 307, and letter 32957, p. 349) and Walter Herbert (letter 32970, p. 351) only assume the projectile to be fired north or south, and their explanation of its deviation to the right when fired in these directions seem plausible enough; but the letter by "N.S.W. Reserve Rifleman," quoted by "F.R.A.S." at p. 307, and still more the letter of "J. R. C." (letter 32969, p. 351), quite upsets this theory; for while "N.S.W. Reserve Rifleman" says nothing as to the direction of fire, "J. R. C." says the deviation or "drift" is "invariably to the right"—I suppose, whether fired north, south, east, or west. I cannot see how the rotation of the earth can have anything to do with the drift when fired east or west, though I could understand it being greater when fired north or south; but in the table of deflections given by "J. R. C." no allowance is made on that account. "J. R. C.'s" statement as to the deviation being always to the right is borne out by the fact that some tangent scales have an automatic adjustment for this lateral deviation, which, if it were only required when fired north or south, would as often be wrong as right. "J.R.C." says all modern rifled guns give the projectile a right-handed rotation, from which I infer that if the rifling gave the projectile a left-handed rotation, the drift would be to the left. He further says: "There is no drift in the flight of a round shot." If the rotation of the earth had anything to do with it, there should have been the same drift.

If, then, the cause of the deviation is not to be found in the rotation of the earth, the reason must be looked for elsewhere. I have an explanation to offer which I have not seen before, and which, if sound, may perhaps account for the right-hand drift of a projectile with a right-handed rotation, and a drift to the left of a projectile with left-hand rotation, and no drift with a shot having no rotation.

Taking the case of a projectile with a right-handed rotation: as the air in contact with the bottom, or that side of the projectile nearest the earth, is slightly more dense than at the highest part, it would seem that there would be somewhat greater friction on the bottom, so that the projectile would have tendency to roll to the right. Suppose that the projectile in its flight could skim along in contact with the surface of a smooth sheet of water, the water being much denser and less mobile and elastic than the air surrounding the upper portion of the projectile, I think the drift would be much greater. In this case the front of an elongated projectile would probably churn the water up and clear the way for the hinder part, so that the front of the projectile would have more deviation imparted to it than the hinder part; the deviation would become greater the farther it went, till, if there was "go" enough in the projectile, it would proceed in a circle or perhaps a spiral. It would probably be the same in a less degree when going through air only. This may be the explanation of the fact that, in the table given by "J. R. C.," the difference of deflection to be given increases on 6' in the 1,000 yards from 2,500 to 3,500 yards, whereas it increases 6' in the succeeding 500 yards. And if, in its flight, the projectile could slide along in contact with, say, an asphalte or macadamised surface, the drift would be enormous.

In these cases the projectile would want to roll over to the right; but if it had a left-hand rotation it would tend to roll to the left, and so give drift to the left, and in a round shot, as there is supposed to be no rotation, there would be no drift.

I am sure it must be very annoying to other readers who, like myself, have not had an education beyond the most elementary kind, to come across letters like those of "Brux," and F. Terby in last volume. Surely, if such persons understand English sufficiently well to read the correspondence in the "E.M." and answer thereto, they could do so in English; and if they could not, it would be much less trouble (in the aggregate) for them to have it translated before sending, as what one could do then may take hundreds to do after it is printed, as I presume there are a good many readers of the "E.M." who only know English.

Are we to understand, from what "Brux" says, that the Martini-Henry rifle gives the projectile a left-hand rotation?—i.e., contrary to the rule given by "J. R. C."—because, if that is so, my theory will not hold water, as the rifle used by "N.S.W. Reserve Rifleman" is given as the "Martini." Are they both the same? Whether this is so or not would make no difference in its connection with the rotation of the earth.

Dec. 15. **Samothes.**

PROJECTILES AND THE ROTATION OF THE EARTH.

[33011.]—Mr. Wake, in his letter (No. 33006), is quite wrong in supposing, as he apparently does, that I disbelieve in the earth's rotation causing a deflection of a projectile from the plane of the trajectory. No one who has studied a work on dynamics can question that it does so. In my letter (No. 32969) I merely quoted a passage from General Owen's lectures, in which the author, without denying that such deflection exists, speaks of it as being insignificant in *ordinary* ranges. As I understand it, supposing the length of range constant, the amount of deflection due to the earth's rotation is measured by the tangential velocity of the two ends of the range. In the neighbourhood of the pole it would, therefore, be much more appreciable than near the equator.

Charing. **J. R. C.**

THE PERIPHERY OF AN ELLIPSE.

[33012.]—Four gentlemen have given formulæ for ascertaining the periphery of an ellipse, and I wish to ask them to test their formulæ as follows: If we call the major axis a, and the minor axis b, then in an ellipse with least possible eccentricity the two foci will be infinitely near together, and b will be also infinitely near the same length as a—that is, it will equal a, and the ellipse is then a circle. With the greatest possible eccentricity the two foci will be infinitely near the two extremities or the major axis, and b will be infinitely small—that is, it will vanish, and the ellipse becomes two straight lines infinitely close together. The perimeter in this case is evidently twice a—that is, double the major axis. How will the given formulæ answer in this case? It is evident no formula is worth use that will not apply to every case, from a straight line to a circle.

I use an empirical rule I have never seen stated, which, although not absolutely exact, is far more so than either of the four proposed, and much simpler. It is that the perimeter $= \pi b + 2(a-b)$. Please note I do not claim accuracy for my formula, but simply that it is nearer than those proposed, and will apply to every case. Applied to a circle, it becomes πb, and to an infinitely narrow ellipse b vanishes, and perimeter is $2a$.

Edwin Holmes.

OVERTAXED BRAIN.

[33013.]—When a young racehorse is taken in from grass and put upon dry food and corn, then the amount, extent, duration, and severity of exercise, at first virtually nominal, is graduated in accord with the animal's slowly-increased gain of vigour and endurance. Now, cannot the querist take his hint from this?

Alcohol, treacherous both as a friend and as a stimulus, is, to him, in fact, *à la* the jockey's whip.

All the best authors *in re* the recuperative rationale of homœopathy's medicinal treatment in disease and in malaise, agree in regarding its correctly chosen medicines as being stimulants just sufficient for enabling the *vis medicatrix naturæ* to readjust the disturbed equilibrium. Beyond that, then, all drug action becomes a more or less perturbing force or δυναμις.

The querist (letter 32963) would probably bless the day which led to it, if he were to study in its literature and by his own personal experiment, what homœopathy can do towards the readjustment of his lost equilibrium. At least, such led to the such-like enthusiasm of the founder of the great silk house, Leaf's, 39, Old Change, London. Mr. Leaf having, somewhere about 50 years ago, maintained for some time the first (I believe) homœo[illegible] M.D. as a resident in the great Metropolis, the late Dr. Curie, then instituted the original Homœopathic Hospital in Hanover-square.

Mr. Leaf's death took place at the age of 85, in 1874. A Lyons silk manufacturer first pointed out to Mr. Leaf, then in a somewhat similar fix to G. H. Fridy, what curative benefits he might rely on from that method of therapeusis, i.e., Hahnemann's, and whose literature is now available to all. **Belladonna* 3, *Calcarea* 3, during first week; *Nux Vomica* 3, *Sulphur* 3, during second week; **Phosphorus amorphous* 10, *China* 3, during third week; **Arsenicum* 6 (after meals), *Bryonia* 3 (morning and night) for fourth week—would be a probably suitable course. But, as usual, the querist would no doubt be in too great a hurry to get strong, &c., until experience, dearly enough bought, had told him, *à la* the racehorse trainer, that time is a *sine quâ non*. Therefore a week's *non*-treatment between each consecutive week is advised. The asterisk indicates those acting chiefly on the brain. **The Lydney Dispenser.**

SURVEYING.

[33014.]—There is another little subject which I think would make the "E. M." additionally useful when you have an opportunity of introducing it, and that is *surveying with a prismatic compass*. I don't know any way of enjoying a stroll out in the country so well as taking a magnetic compass and a few sheets of foolscap, and making a map of your route out and home. It can be done on foot, on a tricycle, or on horseback, or from a carriage. I did much of it in South America on horseback. It is excellent training for judging distance. All tricycle men and volunteers ought to learn it, and those who go abroad, or *are* abroad, in parts where there are no maps of the country, would find it not only a pleasing and useful, but a *valuable* acquirement. If you are near a library which contains a copy of Col. Thompson's "History of the Paraguayan War with the Brazilians, 1864 to 1870," published by Longmans, you will find a number of very good maps at the end; all, except one, were done by prismatic compass, in which I assisted. There are also some notes explaining *how* the surveys were conducted.

The best article I have yet seen, however, is one in the *Naval and Military Magaziné*, New Series, Vol. V. Nov. 19, 1890, published by Allen, 13, Waterloo-place, S.W., p. 411 to 420 (by Capt. W. Verner). I see prismatic compasses advertised in your paper sometimes for 15s. Good ones, new, with all latest improvements for vertical angles, &c., can be bought for less than 30s., with slings, &c. **C. H. T.**

CALCULATIONS CONCERNING THE LENS—(*Continued*).

[33015.]—There are several methods for finding the magnifying power of a convex lens by experiment, but the use of a certain amount of apparatus is necessary. One method is, primarily, to focus the lens on a divided scale, and look at the image with one eye, while, with the other, looking at a similarly divided scale placed at the distance of distinct vision. A certain number of the magnified divisions chosen upon, will appear capable of containing a certain larger number of the divisions as ordinarily seen.

If a = the number of the former divisions, and b the latter, then of course magnification $= \frac{b}{a}$.

Perhaps, also, two experimental methods of finding focal lengths of lenses, which may be seen in the textbooks, are worth repeating. In the case of a convex lens, suppose the lens to be placed at a certain distance from a small bright object, and a distinct image thereof to be thrown on a screen at the opposite side of the lens; then if such lens be moved along its axis, there will be found one other position in which a second image, and of different size, will be distinctly seen on the screen.

Now, if the distance moved by the lens from its original position $= x$, and l = distance between screen and object, then focal length $= \frac{l^2 - x^2}{4l}$ approximately.

In the case of a concave lens, suppose we have the following order of things: first a source of light, then a diaphragm, in which are cut two parallel slits (one on each side of a common axis), then close to this diaphragm the lens, and lastly a screen. There will be thrown on the screen two bright patches, due to the light from the slits aforementioned, but they will now be wider apart.

If a = distance between lens and screen, b the distance between the centres of the bright patches, and c that between the slits in the diaphragm, then we can approximately find focal length from

$$\frac{f}{f+a} = \frac{c}{b}.$$

The drawback of this last method is that the patches are very indistinct. Although in ordinary cases the theoretical lens, mentioned in my last, is assumed for rays that are not very oblique, a lens is generally understood to be composed of spherical or spherical and plane surfaces.

Neglecting thickness, if radius of surface nearest object $= r$, and the other $= s$, and μ = refractive index of the material composing the lens, then for central rays

$$\frac{1}{f} = \frac{1}{d} - \frac{1}{D} = (\mu - 1)\left(\frac{1}{r} - \frac{1}{s}\right)$$

(standard equation), r and s being subject to alteration in sign, in similar manner to d and D.

$\frac{1}{f}$ is called the *power* of the lens.

Suppose in a double-convex lens made of glass $r = 10''$, $s = 12''$, $D = 23''$, and $\mu = \frac{3}{2}$, and we wanted d, then from the formula

$$\frac{1}{d} - \frac{1}{(+23)} = \left(\frac{3}{2} - 1\right)\left(-\frac{1}{10} - \frac{1}{(+12)}\right)$$

$$\frac{1}{d} - \frac{1}{23} = \frac{1}{2}\left(-\frac{1}{10} - \frac{1}{12}\right)$$

$\therefore d = -20{\cdot}75'$, and is therefore that much on opposite side of lens to the object.

Again, let $r = 8''$, $s = 12''$, $\mu = 1{\cdot}640$ for the convex lens, and we want the focal length

$$\frac{1}{f} = (1{\cdot}640 - 1)\left(-\frac{1}{8} - \frac{1}{12}\right)$$

$\therefore f = -7{\cdot}5''$.

A plane surface is supposed to be of infinite radius in the above calculations. **A. Gadd.**

(*To be continued.*)

[33016.]—Mr. Gadd's letter on this subject (32968, p. 351) will prove very interesting to the many readers of the "E. M." I hope, however, and so do others, that he is going to tell us how to get the curves for lenses for the home-made lanterns. How many readers of the "E. M." have made an optical lantern, all but the optical system? It is very degrading to me, after having made an optical instrument all but the lenses, to have to go to a manufacturer for these, which, after all, form the most important part. May I ask Mr. Gadd, on behalf of many readers, while he is on the subject, to give us a completely worked-out example of, say, an optical system for a lantern consisting of 4in. compound condensers for limelight, and 6in. focus double combination achromatic objective? Mr. Gadd is quite capable of thus helping the many who would like at least to know how to design their own lenses, and by so doing will confer a great boon on the many amateur workers and readers of the "E. M.," including— **Athanasius Kircher.**

HOW LONDON COULD BE CLEARED FROM SOME OF ITS DISCOMFORTS.

[33017.]—The fearfully polluted state of the Thames River, after over ten millions of money has been spent in trying to purify it, is still perplexing all thoughtful citizens; also London's smoky, foggy state of air, and unsatisfactory supply of water. Much has been said and written on these serious subjects, but no truly safe and unfailing way of attaining the desired state of the river, air, and water has ever been discovered.

I beg humbly to suggest the adoption of one way—indicated by our Almighty Creator's arrangement—put before us for attaining all these objects.

Inasmuch as the tide attains an average of about 38ft. in the Bristol Channel, only about 18ft. at London Bridge, by deepening the Thames to sea level, through its most eligible branch into the Avon and on to the Bristol Channel, and self-acting floodgates erected, to open by the rising tide and close when the ebb began, by this means a continuous flow of about 10ft. in depth of the Atlantic water (over high water at the Nore) would enter the German Ocean if the inflow at the receiving end and the Channel conveying it to London Bridge are greater than the outflow at the mouth of the Thames, as the water would flow continuously through at the tidal speed of about six miles per hour, all sedimental matter lighter than water would be carried on to the German Ocean within the twenty-four hours, and sand, mud, &c., carried onward, scouring out the bed of the river continuously. And the smokeless Welsh coal carried on the tide cheaply to all the towns, the present smoky atmosphere would be done away with; also all the springs down to the sea level would be laid open on each side, and conveyed by canals or pipes to supply superior blended spring water to all the inhabitants.

The continual flow down the Thames will prevent the fogs from running up the up-tide, being stayed by the more rapid running outflow of clear Atlantic water, with shoals of fish from sea to sea, with abundance of crumbs from every table to feed them.

Much of the shipping carrying goods would discharge at the wharves where the railways crossed, to be carried to their inland destination; also the beds of building materials found made available for use throughout the valley by the cheap tidal conveyance; also a fair supply of health-giving sea air throughout. **Peter Love.**

18, Ravensbourne-road, Catford, London, S.E.

HOW TO MAKE A VIOLIN.

[33018.]—I WILL now take up Mr. Pickering's accusations, &c., in order, and leave the impartial reader to judge, how far he has answered my letter, to what extent he has defended himself; and whether, in attempting to do so, he has kept himself free from error.

First, Mr. Pickering accuses me of "animus." I have no more animus towards him than Macaulay had towards James Montgomery. Mr. Pickering next assumes that I have got slightly mixed as regards the applicability of the word "contour" in reference to outline. Is he quite sure that it is not "he" who is "slightly mixed"?

I have always been under the impression that contour simply meant "circuit," "outline," "that which bounds a figure or surface." If this is not so, then it is not a question of being "slightly mixed," but absolute ignorance on my part.

Next, Mr. Pickering charges me with unfairness in referring to Fig. 16, p. 53. Now, I distinctly referred to his corrected Fig. on p. 108, when I wished to draw attention as to how miserably he had failed to convey a correct idea as to what the "general contour" of a violin should be, and I only casually alluded to Fig. 16 in agreeing with him.

Then Mr. Pickering does a little of what looks very like pandering to the readers of the "E. M." He says that it is no compliment on my part to assume that they do not know the use of templets.

Doubtless most mechanics know the use of templets, and certainly every skilled mechanic knows how to work to the templets used in his particular line, and, perhaps, some others; but surely I do not impugn the intelligence of the readers of the ENGLISH MECHANIC generally when I offer to give some instructions to amateurs how to make and how to work to templets used in violin construction. Then, again, Mr. Pickering says I must not gauge their intelligence by my own standard—another dash of what looks like pandering. I maintain that there is not a word in my letter that the least intelligent among the readers of the ENGLISH MECHANIC could construe into language calling into question or gauging their intelligence. Surely Mr. Pickering did not gauge the readers' intelligence too highly when he thought it necessary to enter into details about the shadow on the wall business. Let me point out why all this nonsense about intelligence has been indulged in.

I said in my letter of Nov. 13 that "Mr. Pickering was leading his readers along the most difficult path possible in advising them to construct a violin without a mould," and I maintain that he was as unjust and unfaithful towards the amateur fiddle-maker, as an architect would be were he to advise a builder to erect a church without the use of a plumb-bob or level.

Mr. Pickering says that it would appear "that I have read that which I have been 'criticising' in a somewhat superficial manner," and this because I did not recognise in that improvised tool, Fig. 28, a gouge. Now, notwithstanding my superficial reading, I dare assert here that Mr. Pickering has only "once" made use of the word "gouge," and then only to disapprove of its use. See page 6, top of third column. And yet, after I have said that this valuable tool is never absent from the fiddle-maker's bench, Mr. Pickering asserts that he not only tells his amateurs how to make gouges, but gives an illustration of them. I might use here "justly" strong and indignant language; but I will refrain, lest I be charged again with "animus." All I will say is this: that it would have been far wiser on his part to have passed my letter over in silence than stoop to this shuffling mode of procedure, which will neither defend him nor in the slightest degree prove that my assertions are unanswerable.

Now as to the positions of the *ff* holes. Mr. Pickering says there is no particular position in which to place them. I say that there is at least an approximate one. Let any amateur try as many makers as he can lay his hands upon in this way, viz.: Draw a line through the inner notches of the *ff* holes at right-angles to the central line or join of the belly, and then measure the distance from this line, where it crosses the join, to the top or bottom of the belly, and he will find that in the majority of cases this distance will be identical; and I maintain that Mr. Pickering, inasmuch as he deemed it necessary to instruct the amateurs how to sharpen a spokeshave, should at least have given them the above-referred-to distance as a guide where to place the sound-holes, which is of considerably more importance than spokeshaves and the method of sharpening them, both of which may with advantage be dispensed with in violin-construction.

Now as to what Mr. Pickering has been pleased to call my geometrical method, and which he has designated as being done to death, I will say little at present. Mr. Pickering says this method was first published in 1828. He is not quite correct in this, for it was first published in 1782. I wonder what he means by being done to death. Does he mean that the amateur should rather indulge in shadows on the wall than use a method which will give him a most beautiful and delicate outline—which is, by the way, so near the Stradivarius outline, that it requires an expert to tell the difference? I am surprised that Mr. Pickering does not say that the outline of the violin generally has been done to death, and add his name to the long list of those who have tried to improve upon it, and have miserably failed.

"All practical men, says 'Scio,' select the 'hardest wood possible' for soundposts." Mr. Pickering reminds us that he fortunately possesses very good eyesight. It must indeed be very remarkable if he can see the words 'hardest wood possible' in my letter. If I could stoop to retaliation, I would call this "wilful distortion"; but no—I choose rather to think that Mr. Pickering's eyes have deceived him for once. What I did say was "the straightest and closest grain, and 'so hard' as to have a tendency to ring like metal."

"Possibly 'Scio' will respond to the Editor's invitation, and send his geometrical method." Yes, I most certainly do intend (with the Editor's permission) to send not only "my geometrical method, but also a series of articles, in which I will endeavour to be as explicit and exhaustive as possible, so far as violin construction, and all connected therewith, is concerned.

I believe I have read nearly all the books known on the subject, and I venture fearlessly to assert that there is not one among the whole number of writers which I have read, that has not withheld a good deal of information which they should have given for the guidance of those whom they had intended to guide.

Mr. Pickering says that, in writing to a "valued friend," he lamented that his articles on fiddle-making had caused no discussion, and that that "valued friend" suggested that the articles were too concise and practical to admit of discussion, but that Mr. Pickering had better wait till he got into the realms of "theory and discovery."

Mr. Pickering has reached the realms of what he calls "theory and discovery," which might be more properly termed "theory and destruction." I shall have a good deal to say about this so-called "theory and discovery" at the proper time;—all I will say now is that Mr. Pickering's discovery was practised more than a hundred years ago, to the irretrievable reparation of scores of valuable violins by the best makers, and by charlatans, who got well paid for their mutilations.

Now, with regard to letter 32892, p. 353. Mr. Wenham appears ready to endorse anything which Mr. Pickering may write, especially as regards "theory and discovery,"—a circumstance which makes me believe that, possibly, he may be the valued friend referred to by Mr. Pickering himself.

I have already said that I am prepared (with the Editor's permission) to give faithful details concerning violin construction. Mr. Wenham may then have an opportunity of making up his mind whether to believe in my credentials or not. Meanwhile, he appears to be "all at sea" when writing about the the "probable nodes" of vibration, when he talks about the wood being very thin "within the rim," and then refers to intermediate wood, and to the "free tongue," which may synchronise with the rest.

To clear up this confusion in his mind, I would advise Mr. Wenham to turn his attention rather to some good elementary work on acoustics.

Glasgow. **Scio.**

["Scio" is a windbag. The above letter, out of which we have had to cut a quantity of irrelevant nonsense, is valueless. The information promised is still in the dim distance. We leave our readers to judge between Mr. Pickering and "Scio"; but when the latter tells an old and valued correspondent like Mr. Wenham "to go to some good elementary book on acoustics," he is simply ignorantly impertinent.—ED.]

[33019.]—I FIND I forgot to sign my remarks on the violin.

Our old friend "Orderic Vital's" questions regarding the effect of model and thickness show he is not a "fiddle fancier." It does indeed constitute the *whole* difference in tone-character, both in kind, quality, and quantity. Every player knows full well the marvellous improvement time and use have on an instrument. They grow and mature most perceptibly. I have often amused myself by altering violins, knowing quite well what would be the result within very narrow limits indeed. As gauging cannot be done from the outside of an instrument, I should think no workman would alter a finished one. The fact that the "royal" makers left their instruments thick in the wood, and consequently to go hard and crude in tone, is proof of their knowledge of the maturing effect of *time* and *use*. Yes; while Joseph Guarnerius was in prison, he "bought" his varnish, as he must have done his other supplies, from the common sources. **G. Calver.**

SILVERING MIRRORS.

[33020.]—I HERE copy from my catalogue, "Hints on Reflecting Telescopes," p. 24, the best process I have ever tried, and the one I am constantly using, and it is the handiest and the cheapest also. Dissolve (for, say, a 5in. or 6in. mirror) 50gr. of nitrate of silver in an ounce or two of distilled water; 50gr. of potassia pure by alcohol, same quantity of water.

Reducing Solution.—Dissolve 840gr. of *best* loaf sugar in distilled water, add ½ drachm of pure nitric acid, or, say, 25gr. by weight, add 3oz. of spirits of wine, and make up to 25oz.; ½oz. of this is to be added to the other solutions, when ready to immerse the mirror. Take the 50gr. solution of silver, add, drop by drop, liquid ammonia till it is quite clear; add the potassia solution, and treat with ammonia, as for the silver, till it is again clear; then add drops of silver till it is permanently turbid or distinctly coloured; 10oz., 20oz., more or less, of distilled water, according to your silvering dish, will make the bath complete.

To prepare for silvering, clean with nitric acid, well rinse with ordinary water; then with a small quantity of distilled water wipe edges clean and dry; suspend in the silvering vessel till the bath is ready for mixing. Use nothing but pure cotton wool for rubbing the surface. Nothing else is safe. Suspend the mirror face down in the bath—the liquid may be ¼in. up the edge—dip in so as to drive off bubbles, &c. Do not disturb until the silver is covering the top of fluid, and looks clear underneath the surface.

After one or more quarts of water has rinsed the surface, wipe edges; lay face up, and put *several thicknesses at once* of clean blotting paper on the silvered face, press down *without moving* the paper. Fan it with a sheet of paper, and it is dry in less than a minute. If the edges are dry, polish at once. Make a pad of soft, clean washleather stuffed with cotton wool. Dust in the finest *washed* rouge; then dust it all out again, using only what looks like a stained or coloured pad. This will polish without scratches. **G. Calver.**

INCUBATORS.

[33021.]—I REGRET having to write upon this subject again; but from what Mr. Hearson says in his last letter, he wants me to appear before the readers of the "E. M." as an impostor. When I wrote about the construction of incubators, I never had any idea that I was posing as the inventor. Mr. Hearson says I got my information from a description that appeared in the "E. M."; but there have been no drawings of his in the "E. M." since I have been a reader, and I (to tell you the truth) could not say where I got my ideas. Incubators are to be seen in various papers. I will admit that I am wrong so far that I ought to have made inquiry; but as I had found out the proper lines to work on, and also found the apparatus to work well, a result not usual in incubators, I thought I would let the readers of the "E. M." have my experience. If I had known Mr. H. was the inventor of such a thing, I would certainly have said nothing. If there has been offence, none was intended. Mr. Hearson, in a letter to me, says that he considers the apology I made in the "E. M." an aggravation of the offence. Now, Mr. Editor, as you know the facts of the case, you will do a working correspondent of the "E. M." a favour if you insert what you think an ample apology to Mr. Hearson, purporting, of course, that it came from me; something to dispel the idea that I wanted to appear as the inventor.

John Fraser.

[We think quite enough has been said, and that Mr. Hearson will be extremely ungracious if he is not satisfied.—ED.]

NATURAL DRINKS.

[33022.]—AT the request of "An Old Reader," I give a further account of simple beverages.

Maltine, commonly called *Sweet Wort,* is made by putting 3oz. or 4oz. of newly-crushed malt into a clean jar, immersed to the neck in a deep saucepan of boiling water; after pouring a quart of boiling soft water over the malt, put the pan on a hot hearth, or very slow fire, and keep the contents at scalding point for an hour; then remove, and strain the wort through a new hair sieve. If considered too sweet, add some hops or gentian root. I have seen children gain weight and strength on this liquor, its nutritive qualities coming next to milk. I am very partial to it.

Mint Tea.—Gather a handful of young leaves and stalks from the growing plants; put them in a quart jug with the juice of a lemon, and a shred of the peel; add a teaspoonful of white sugar; pour in boiling water till the jug is full, cover the mouth with a saucer till cold. If taken hot, this is a sudorific draught; if cold, it allays febrile thirst. I drank it for years, instead of tea, in Lower Bengal. It will not keep over a few hours.

Cliver Tea.—When I was a child herbal drinks were given in the nursery, during the spring months, to purify the blood; the favourite was this cliver, or goosegrass (a *Galium*), it is a common weed in England, trailing over the ground in hedges, its rough little seed vessels clinging to the coats of dogs; stems and leaves very sticky. A large handful of the plant is put in a jug with a piece of lemon-peel and some sugar, then boiling water was poured over it, and when cool a teacupful of the draught was given each morning; it is not unpleasant.

Eau Sucrée of the French, and the popular sherbet of India, is made of sugar dissolved in boiling water, and drunk very hot as a medicine, cold as a refreshing draught. With me, who dislike sweets, the former acts as a mild emetic.

Tamarind Sherbet.—Put an ounce of pulp in a jug, pour in a pint of boiling water; when cool strain the liquor, and add a little su ar. Very cooling in bilious disorders and fevers.

Fruit Sherbet.—Bruise blackberries, raspberries, or other fruits in a glazed pan, add boiling water, let it stand an hour; then strain, sweeten to taste, after putting into the liquor the juice of a lemon. Preserved berberries so treated, being very acid, require no lemon-juice.

Raspberry and Black Currant Vinegars.—A quart or two of either fruit, picked very sound and clean, is placed in a clean, glazed milk pan, bruised with a wooden spoon, and then enough of the best pale vinegar poured in till the fruit is covered. Protect the pan with a board for 48 hours, strain through a jelly bag, and let the liquid stand in another pan till quite clear. Sweeten to taste with white sugar, and draw off into half-pint bottles, cork and seal. Very agreeable additions to water in hot weather for tourists, as they allay thirst, and check excessive perspiration. I have used jams of both these fruits, when I could not get the fresh produce.

I must omit many fruits and berries of India and South Africa, which are not to be obtained in Europe, and require to be freshly gathered. All oleaginous nuts, when roasted, as filberts, beech mast, &c., make good substitutes for chocolate, and are, I fully believe, used in adulterations. I have tried horse-beans, Indian peas, and large-grained wheats and rice, carefully roasted—even burnt bread—as substitutes for coffee. The British officers and their wives, in the first Kabul war, were forced to use them, and, as the brave Lady Sale said to a grumbling young friend of mine, "Young man, I ate my dinners, cooked with camel's dung for fuel!" The ripe seeds of "Indian shot" (Canna Indica) of our gardens, I have often been told, when roasted and ground, constitute the most perfect imitation of coffee.

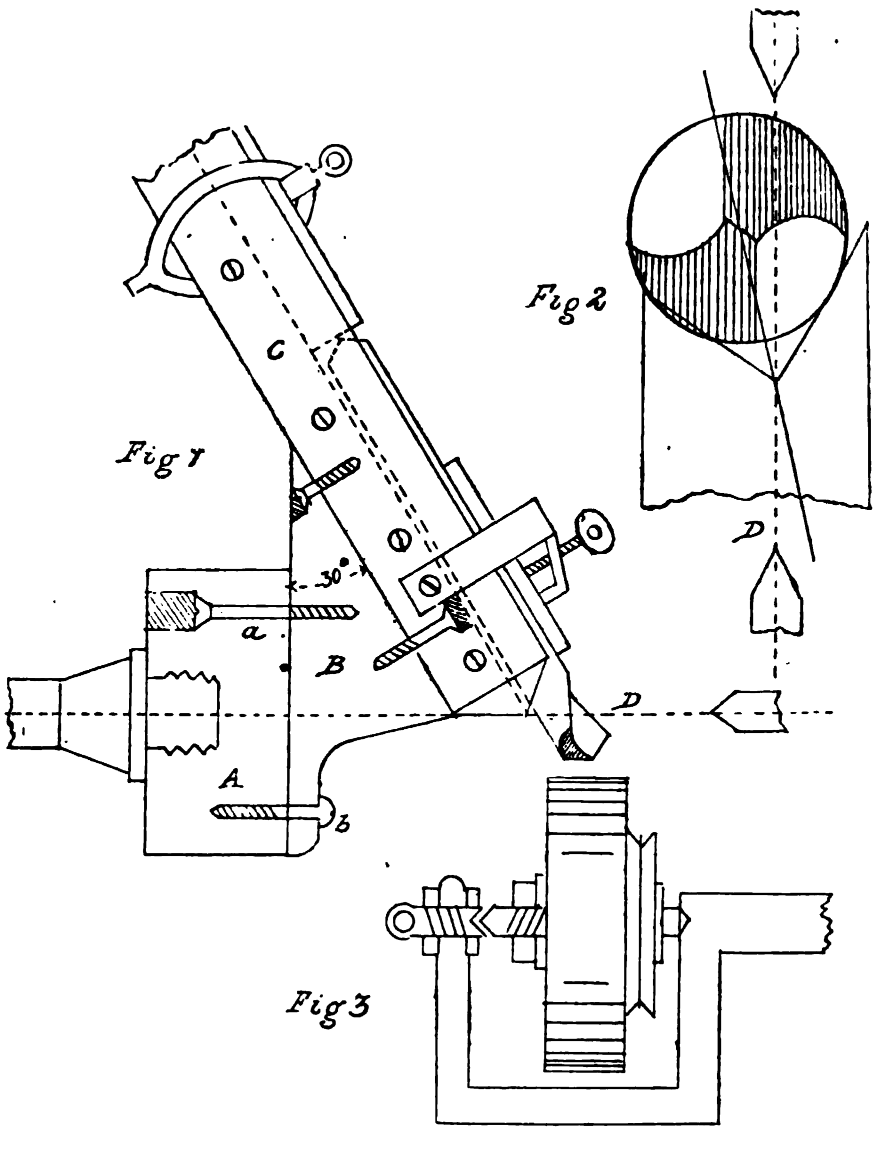
Carbonised shells of tropical nuts, ground and boiled in milk, I have seen used by Europeans and natives in obstinate diarrhœas, and even in dysentery, with benefit, when medicines were unobtainable. Burnt rice, and also cork so treated and boiled in fresh milk, were the favourites; and newly-burned wood-charcoal ground, was equally good, in my experience. "Salep misree," the dried tuber of Orchis mascula, is brought down by traders from the Upper Himalayas; it always commands a high price, as it possesses great restorative and invigorating properties, when boiled with milk, and taken on an empty stomach. It is the favourite early meal of the wealthy classes. We have a wholesome weed in India employed to thicken milk, and render it apparently rich. The vendors of "cowjuice" (as Hindoos term milk), use it largely. Eos.

LATHE MATTERS.

[33023.]—Dividing for ornamental turning can be done well enough by a ratchet, as "O. J. L." wishes, without any expensive or complicated apparatus. I described this in Vol. II. of *Amateur Mechanics* (now defunct), at page 67. The ratchet passes a given number of teeth, *but will not hold the mandrel*; the expense and complication come in just here. However, this is got over by simply screwing up the mandrel, so that, though the handle of the ratchet will move it easily enough, the drill or cutter will not do so. This makes the whole thing perfectly simple, and renders anyone who has a set of change-wheels independent of the division-plate. You make a small lever with a pawl, to fit on tail end of mandrel, then put on a large change-wheel, say the 120, and you have only to confine the movement of the lever so that it will take the proper number of cogs each time. I removed the cross-head of headstock, with its two bars, so as to get on the large wheel, and then screwed in short bars, which acted as stops for the lever. It is very simple, and you can count away in the dark if you like. Of course the plan will not do for wheel-cutting, but only for light work. F. A. M.

GRINDING TWIST-DRILLS.

[33024.]—I send a sketch of a chuck for holding twist-drills during grinding, by which any angle, sharpness of cutting-edge, or clearance may be produced.



A disc, A, of hard wood, 3in. in diam. and 1½in. thick, is screwed to the lathe-nose; to this a piece, B, ¾in. thick, having an angle of 30°, is attached by screws, so that it can rotate on the screw *a*, having a ⅜in. slot at *b*, in the upper end of which is a screw to fix it at any point. The disc A has a ¾in. circle on the face which coincides with the sides of B when placed centrally. To the top of B, a straight piece, C, ¾in. thick, having a right-angled V on the top, which terminates at line of lathe centres, is screwed. I find it easier to fit if made in two pieces ⅜in. thick, the line of junction also serving as a good guide in grinding. The drill is secured by a screw, and the back supported by a piece of hardwood. The emery-wheel, driven by overhead, is held in slide-rest, with its axle at height of lathe centres, and face parallel to line of centres. In order to use the appliance, the drill should be screwed with the cutting lip to be ground parallel to line of lathe centres, and projecting about 1¼ to 1½ times the diam. of the drill beyond the line of centres. This piece, B, is then placed eccentrically above the line of centres, about the same distance as the size and flat portion in the centre of the drill, to give lead to the cutting-edge. The greater the eccentricity, the keener the cutting-edge, and the more the drill projects, the less the clearance. If C be supposed to represent the long hand of a clock, it should be raised to about 13 minutes past the hour, and the emery wheel advanced just to grind; it is then gradually raised to about 5 or 7 minutes past the hour, and the grinding is done in this interval. When one lip is finished, the drill is turned half round, without moving the emery-wheel, and the other lip done, the back support insuring the proper length. The curve of the ground surface is not quite the same as that which we find on a new drill, but the effect is equally satisfactory.

In making another drill-holder, I should provide for the eccentricity of the drill in a different manner, so that there would be no change required for any size of drill by placing the V at an angle as shown in Fig. 3 on a larger scale; each drill will thus be perfectly placed, irrespective of size.

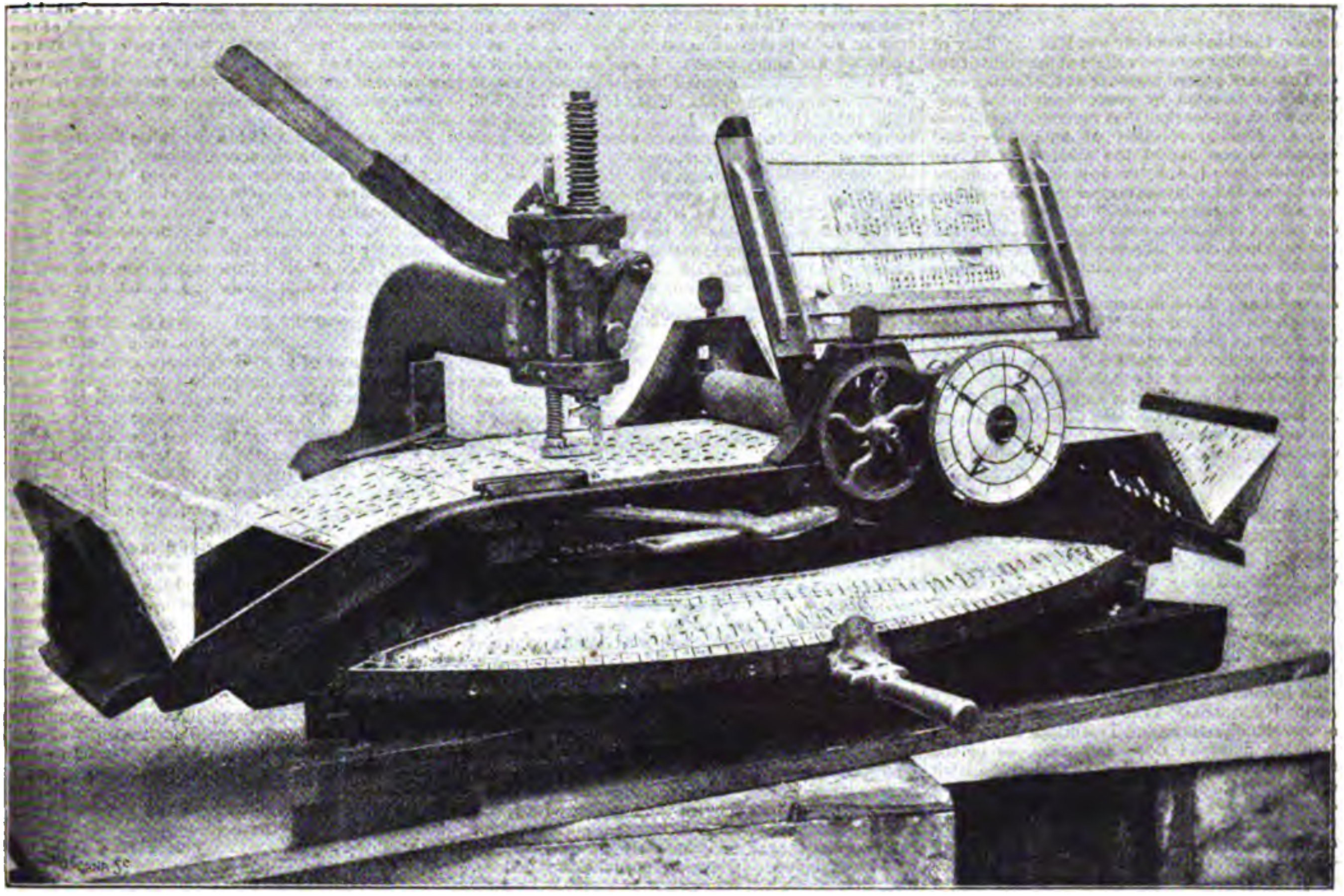
The emery-wheel may run between centres and the holder be carried on the drilling spindle.

Aiguiseur.

ORGANETTES (AND PIANISTAS)—XIII.

[33025.]—Though in a former letter of mine (Feb. 1, 1884) I described a method of marking and cutting the tune-bands by hand, the method is too slow and tedious when we have to prepare the long lengths required for performing overtures, quadrilles, and such pieces as can be played by the better class of automatic instruments. I propose, therefore, to now go more fully into the matter, and show how the bands can be punched by special apparatus with considerable speed. Mr. Wenham has already described the apparatus he employs; but, unfortunately, it is not adapted for perforations of varying length, such as are required for organettes and other wind instruments in which the notes have to be not merely struck, but held down.

Before coming to the mechanical part, however, it seems needful to refer to the musical limitations that have to be considered. Dr. Johnson remarked of the dancing-bear that the wonder was not that it danced so well, but that it danced at all; and I fear, to a certain extent, the remark is true of the automatic instruments. We can produce (roughly) a forte or piano effect, or a crescendo or the reverse; but we can't emphasise a single note only, nor produce the delicate shades of expression that a human performer can, as it were, translate from his thoughts into his music. Again, even the 54 or 60-note pianista can but utilise the 4½ or 5 octaves out of the 7 (or even 7¼) which are comprised in the compass of a modern piano. Thus the lower notes in the bass and the upper notes in the treble are not available, and we therefore lose a great deal of the richness and variety that depend on their employment in conjunction with the central octaves of the keyboard. Again, we find (as has been previously mentioned) that the smaller automatic instruments have an imperfect scale, so that the notes have to be confined to a few keys only, which greatly hampers the "setting" of the tunes. If the scale were chromatic, one might make the channel through which the tune-band passes movable laterally, and so transpose the air into a different key by bringing the perforations over different action-levers. In this case, however, the



scale of the tune-band would have to be reduced, or there must be spare levers (and notes) to allow of the lateral shifting. This seems better than Ehrlich's plan of shifting the whole reed-pan and its fittings and reeds, as claimed in his patent.

Replying here to R. Bennett's query (page 278, Vol. LIII.), I think there is (or was) a 60-note pianista, made and sold under the Ehrlich patent, as well as the 54-note one described in my last letter; but, except Mr. Wenham's, I know of no other. I am pretty sure that neither the "Dual-syreno," nor any of the organette class of instruments, exceeds 46 or 48 notes.

In the case of the larger wind instruments, more variety is possible than with the organettes just referred to, or with a pianista playing a piano, because by means of the stops we can gain variety of tone, and the octave coupler gives an extended compass; but I must own to soon getting tired of the performance of even the best of them. For dance music, where accurate time is of more importance than expression, the pianista is, however, an excellent "performer" that *never makes mistakes!*

I have already referred *passim* to the materials of tune-bands, but may devote a paragraph to the subject. Besides the perforated paper of various thicknesses up to very stout millboard, there have been patented other ways of making the bands, such as paper backed with muslin, tin-plates, embossed metal, and embossed paper (like stereotype moulds), besides the varieties of "planchettes," which latter may be taken to include those formed by long and short type-like studs set in grooves in a flat disc. For electro-magnetic instruments, I do not see why conducting dots and strokes on a non-conducting band should not serve as well as the usual perforations, provided the conducting springs were in pairs side by side, but insulated from each other till their ends simultaneously rested on one of the dots or strokes. This reference to electro-magnetic actions reminds me that I have come across an curious patent by Goundry in 1863 for playing an enharmonic organ (with any desired division of the octave) from an ordinary keyboard by a complicated arrangement of electro-magnets and cross connections. The No. is 2490 of that year.

Coming, now, to the setting out the tune preparatory to its being marked or punched, we have to consider first the actual and then the relative time. The former depends on the speed of the tune-bands, and, therefore, on that of the handle; while the latter depends on the character of the music, i.e., on the number and value of the notes in a bar. The speed of the tune-band varies in different instruments; but I take the pneumatic pianista of Thibouville-Lamy as a convenient example to illustrate the whole subject of preparing and punching the bands. In this, a convenient speed is, at most, about 70 turns per minute of the handle, and as each turn advances the tune-band 1·3in., we get 70 by 1·3, or, say, 7½ft. per minute, which is therefore the actual or absolute speed, and which is intended not to be *exceeded*. Not more than four perforations per inch can well be punched, so that the most rapid repetition of the same note would be 364 per minute, or, say, six per second. In the case of two notes, as in a shake, or in a succession of different notes, this would not apply; but the further consideration of this will be better postponed till we come to deal with the *lateral* dimensions of the perforations, and the question of their overlapping each other in some cases.

The *relative* speed depends (as mentioned) on the value of the note in relation to the length of a bar, but obviously we can assign any length we please to a bar, and therefore to a note. If we start with the smallest practicable perforation, and the smallest practicable interval between two perforations, as instanced in the four per inch, we may say the ¼in. shall represent a demisemiquaver, then ½in. becomes a semiquaver, and so on, till we find a minim requires 3in., and if the whole bar contained four minims, or their equivalents, the length of it would be 12in. Or, if we consider the ¼in. as representing a crotchet, and such bar contains four crotchets, then a bar would be only an inch long, and each turn of the handle would play about a bar and a half. It is thus evident that some thought and care are necessary to select the right-sized perforations and the proper length of a bar, in order that with the assumed speed of the handle the air may be played at a proper "tempo." As a matter of experience, it is found that for a fantasia about 6in. is suitable, and for a waltz about 1½in., a polka 2in., and a march 3in. to 4in. to a bar.

It must be remembered that the length of a note is not necessarily the length of a perforation, and for this reason. Suppose for a minim the assumed length is an inch, that there are two in a bar, and that a bar is 2in. long; then, evidently, the two perforations, if the same note were repeated, would be a single perforation 2in. long, and produce a semibreve instead of two minims. When, therefore, a note is repeated in a case like this, a space must be left to divide the two perforations, and the end of the preceding and *not* the beginning of the succeeding perforation must be reduced by this required space. Thus the *effective* length must be reckoned from the *beginning* of one perforation to the *beginning* of the next, and then the time will be correctly kept throughout. Thus we should (to carry out this plan) require two punches, a long and a short one, for each kind of note; but this would be inconvenient, so we can avoid the difficulty by making the perforation always of the length that it would be if the space had to be left. The sound is slightly curtailed of its proportionate length, but the time is exactly maintained, which latter is really the important point. Then, again, we have not merely ordinary notes, but *dotted* notes to be provided for, and this will also involve two lengths for each punch; but practically it is found better to use fewer punches, and to take a second "bite" for the longer hole. The series of punches in the machine now being dealt with consists of five, which, however, are combined in one piece, as will be presently described.

We can now proceed to examine the Fig. 34 (which is taken from a photograph), and see how these several requirements are provided for. If (as is probable) the details are not very clear, the sketches in the next letter will, I hope, remove any difficulty.

Suppose we took a sewing-machine, and replaced the needle by a punch, we should get a single line of holes. If we then shifted our tune-band laterally, we could punch a second line of holes, and so on. In this apparatus we reverse this proceeding; we keep the tune-band in the same position, but give the lateral motion to the arm itself (and therefore to the punch which it carries) by sliding it to and fro in V grooves, like those of a slide-rest in a lathe. This to-and-fro motion is given by the arm and link, of which the handle, with its index, lies just below the curved strip of paper on which the notes are seen to be marked. When the index is brought opposite any note on this paper scale, the punch is simultaneously put in the exact position to punch a hole (or a line of holes) in the tune-band corresponding to such note. As the length of traverse of the handle is about 4 to 1 of that of the arm carrying the punch, accuracy is insured in the position of the punch.

It will be seen that the punch is *stepped*, so that the length of the perforation depends on how many "steps" pass through the paper, and this is determined by a set of "stop-pins," which are contained in that part of the arm through which the punch-rod works up and down. Thus, when all the four pins are pushed out, the punch can only descend far enough to use one step; and when three pins are out, two steps come down; when two pins are out, three steps; when one is out, four steps; and when none are out, five steps, which is, of course, the longest hole that can be punched at one "bite."

But as the length of the punch varies, so must the length of the hole in the die be varied to suit. This is managed by means of a sliding piece, which can be moved back as a larger hole is to be punched, and *vice versâ*. The arm, then, that adjusts these pins, and so selects the particular "step" of the punch, has also to adjust by the same movement the sliding block of the die. This arm does not show very distinctly, but it lies a little above the arm that traverses the punch arm, already described.

To draw the tune-band forward is the duty of the two indiarubber covered rollers at the right of the figure. These are geared together at the farther end, and are also connected by gear-wheels to the disc-wheel, on which are marked (but reversed) the figures 1, 2, 3, 4. Each revolution of this disc-wheel corresponds to one bar of the music, and its face can be divided into 4, 6, 8, or any desired number of notes in the bar. Moreover, as the gear-wheels are, in fact, "change-wheels," it is easy to select them in such a relation to each other, that one turn of the disc-wheel shall advance the tune-band by any desired amount corresponding to the number of inches in a bar.

Thus we have three movements to attend to—first, the disc-wheel, for the "time"; second, the arm for "size of perforation"; third, the arm for "placing the punch in position." Then the hand lever is depressed, and the hole is punched. For ordinary dance music, 25 holes can be punched per minute, and even for a fantasia as many as 10, so that the speed is considerable.

I must leave what remains to be described for another letter. **A. S. L.**

EYEPIECES — COTTON-SEEDING MACHINERY—HURRICANES—ANTS.

[33026.]—In answer to the letter of "Arcturus" (32854, p. 220), I may say that the magnifying power of my 250 eyepiece is not of optician's recording. The eyepiece was made to order for a 3in. telescope of shorter focus than my present instrument, and as I determined its power with accuracy on the 3in., a simple sum in proportion gave the increase on the long focus. I entirely agree with "Arcturus" as to the utter unreliability of the opticians' estimates. Doubtless the public are thereby deceived now and then as to the excellence of the telescopes they buy; but the trick is quite unworthy of a respectable firm. But that the power is always *over* estimated, one might put it down to carelessness, but I fear it is only a dodge like advertising the magnifying power of a cheap field-glass or microscope in square measure.

I am quite sure that "Arcturus" could not use anything higher than 150 on Jupiter in the English climate, and with the planet's south declination. I never found that I could use 250 with advantage in Ireland, even with double stars. The air here is entirely different. On the great majority of moonless nights I can see eight stars in the Pleiades with perfect ease with the naked eye—a feat I never accomplished at home. I have never succeeded in glimpsing Jupiter's satellites; but that says nothing as to the possibility of doing so, as my eye always finds it most difficult to discern a faint *comes* to a bright star.

November has been a wet month here, much to the delight of the sugar planters; and the lunar eclipse was a failure. The first and last contacts with the shadow were visible, and no more. It is a pity, as there will be no other total eclipse during my service here.

The heavy rain has disturbed the clearness of the atmosphere of late, and I have made few observations. I hope to have some good views of Orion shortly.

A phenomenon which has much perplexed me may be seen here on most fine evenings. From the place where the sun has set, streams upward a vast fan of light, composed of alternate streaks of rose colour and blue—the blue, to all appearance, being simply the openings of blank sky, as seen through the intervals. Something like this I have seen at sunset in England occasionally, but here it is much brighter, and it is quite the exception not to see it. The curious thing is that, a few mornings ago, I was out of doors at sunrise, and observed the familiar fan, still over the sea to the westward. There was a fainter display in the east, and the ribs of the two fans could be followed across the sky in places, like a ship's timbers, brightening greatly as they neared the eastern, and still more on the western horizon. Can anyone explain this, to me, very curious effect?

I should be greatly obliged if some reader would give me a description of the machinery used in separating seeds from cotton. I have a fine silk cotton tree (Bombax Ceiba) in my premises, which bears a large, annual crop of a beautiful fleecy substance, of great value for the stuffing of cushions. No doubt it would also make a very fine fabric, if spun. Unfortunately, it is full of seeds, rather smaller than those of the cotton of commerce, and the labour necessary for picking them out by hand is almost prohibitive. I want to make a simple machine for the purpose, if it be possible to do so, and shall be much obliged for hints, as I know nothing of cotton machinery.

I have been speaking to a survivor of the hurricane at Martinique. His description was just like that of all other witnesses of these awful phenomena. "The sea and the waves roaring; men's hearts failing them for fear." It seems to me very doubtful if exact scientific observations will ever be made during a great hurricane, as the noise and the very imminent peril seem to confuse the bravest. There appears to be very little doubt that an earthquake accompanied this cyclone, as it probably has many others. I find reliable records of hurricanes, accompanied by real earthquakes, in the following years—1722, 1762, 1766, 1772, 1806, 1813, 1816, 1821, 1831. Lyell says, "Many of the storms termed hurricanes have evidently been connected with submarine earthquakes, as is shown by the atmospheric phenomena attending them, and by the sounds heard in the ground, and in the odours emitted." Evidently he is correct; but the cause of the connection seems to me very obscure. Undoubtedly the sudden lowering of the atmospheric pressure—to the extent, let us say, of some 1lb. to the square inch—may allow the subterraneous forces to come into action; but I think this is an inadequate solution of the question. The whole subject of West Indian hurricanes is eminently deserving of study, and offers a better field for practical theorising than the problematical lunar glaciers, or even the canals on Mars. For here we have a phenomenon occurring in an exceedingly narrow and well-defined tract of the ocean, and for the most part actually within the limits of a single month. The three last weeks of August are responsible for an exceedingly large portion of the damage done by cyclones in the West Indies, and the 11th, 12th, 13th, and 14th of that month will account for more hurricanes than any other four days in the year in the Windward Islands. Here are data for a theory such as we seldom have provided for us. Who will be the scientist to make his name famous by predicting a hurricane? (And having his prediction fulfilled, which is quite another thing).

Devastating as they are, these cyclones have now and then brought blessings in their train. Towards the close of the last century the Windward Islands were in a sorry plight. They were overrun by ants of the ominous name of "Formicæ omnivoræ." The species is not at all uncommon now; but then it was everywhere. They covered the whole face of the country like locusts, and devoured all that came in their way, with a marked preference for "flesh meat," as the vegetarians somewhat unfairly call animal food. Calves, pigs, chickens, babies, and invalids — all who were too weak to help themselves were attacked. It was actually debated whether Barbados should not be abandoned altogether. Martinique offered a reward of £40,000 for a remedy, Grenada £20,000. Holes were made in the ground and lighted wood put therein, upon which the ants are recorded to have rushed till their bodies were piled up in heaps, and the coals extinguished. Myriads were killed; but no effect was caused by all man's efforts. The army of destroyers was innumerable, incalculable, as when the dust of the land of Egypt became lice upon man and upon beast.

Then, in 1780, came the great hurricane, and swept the Caribbean Sea from the outlying rock of Barbados to the shores of Jamaica and Cuba. In its track it left death and destruction, so great and widespread that for awhile the wars of the rival nations of France and England ceased in sheer dismay. The forts were ruined, but the ships that might have taken advantage of their defencelessness were either at the bottom of the sea or creeping home like wounded sea-birds, with torn sails and broken masts. It was a time of calamity such as has scarcely been seen since; but it had a gleam of hope for the future. The ants were gone—drowned by the rain, or swept away by the storms. Since then they have only once appeared in numbers, namely, in 1814, but it was then found easy to get rid of them. It may well be questioned whether, without the great hurricane, there would, at this date, have been any settlement in the Windward Islands at all.

Venus and Mercury have been very beautiful in the evening sky on some evenings this month.

T. Preston Battersby,
Barbados, Nov. 29. Capt. R.A., F.R.A.S.

AMATEUR GLASS-BLOWING—VACUUM TUBES.

[33027.]—There is probably no class of work open to the amateur which will give more deeply-interesting results, or repay him for his trouble, than the construction of vacuum tubes. While these are very expensive to buy, on account of the labour and time required to produce them, their materials are comparatively inexpensive, and any-one who has succeeded in making even a very rough mercury pump, for which full instructions have already been given, will have little difficulty in making some of the simpler forms of vacuum tubes, which, for the purposes of study, are far more useful than the elaborate designs of purchased specimens.

Two blowpipes will be required—one to give a moderately small, steady, sharp-pointed flame, and the other to be as large as possible, so that a large and powerful flame may be obtained.

The platinum wire for fusion into the glass should be of moderate thickness, about No. 28 or 30 gauge being the most generally useful; but it must be perfectly clean, and should never have been used for any other purpose. To show the necessity of this precaution, I may mention that a piece of platinum wire which had been exposed to fumes of burning phosphorus cracked every tube into which it was sealed, although apparently quite bright and unaffected.

For the electrodes within the tubes the most suitable metal is aluminium—platinum, silver, brass, and nearly all metals when used as electrodes speedily cover the glass in their vicinity with a black opaque coating of metallic particles torn off by the discharge, aluminium and magnesium being apparently the only metals which do not show any traces of this effect. Thin aluminium foil may be used, as it is so light weighing that the expense is very trifling.

The nature of the glass requires special attention. It is very convenient to have a supply of English lead glass, and of good German soda glass, in small and large sizes, and the greatest care must be taken to keep each make of glass quite distinct, for in all combinations it is absolutely necessary, in order to insure a good joint, that the glass used should be of the same composition throughout, and this is best secured by always using the same make. It will be found in practice that lead glass is the least liable to crack during and after manipulation, and hence may be used with advantage wherever suitable. But it requires a very powerful flame to work large sizes, or to blow a good bulb, without blackening the glass with reduced lead, and for this reason the beginner will probably find it easier to use soda glass for his larger work. Again, soda glass must be used in tubes to show certain of Crookes's effects, as no other glass phosphoresces so brilliantly.

We will commence by making a plain tube as shown completed in Fig. 1. Take a glass tube about ⅝in. or ¾in. in diameter, and 10in. or 11in. long. Its thickness should barely exceed one millimètre, as it is a fatal mistake to use too thick glass. In small diameters the thinnest glass will stand the pressure if well made. Clean the tube well inside, and fit one end with a perforated cork and small tube for convenience in blowing. Close the other end in the large blowpipe, if necessary removing it to the smaller one in order to pick off any slight projection at the end; then heat it uniformly in the large flame, and blow it gently into regular shape. In closing a tube of this diameter, care must be taken to keep it in rapid motion when first brought over the flame, and the heat should be first applied one or two inches from the end of the tube, until that part is just softening, and then gradually brought up to the end. For if a tube be too suddenly heated at the extreme end, a crack is very liable to start longitudinally down the tube, and as the glass there is cold, nothing can be done to stop it; but if the glass be well hot at a little distance from the end, a crack can be immediately followed up with the flame and stopped without doing any injury. In order to avoid waste in closing, a bit of glass long enough to hold comfortably should be used to make a rough connection to the end of the tube, in order to form a sort of handle. This rough joint must be kept hot, as it will crack off if allowed to cool. Do not pull out the tube much, or the glass will become too thin, but allow it to fall together by its own weight, only pulling out as much as is absolutely necessary. Its appearance will now be as shown at *b*. Before

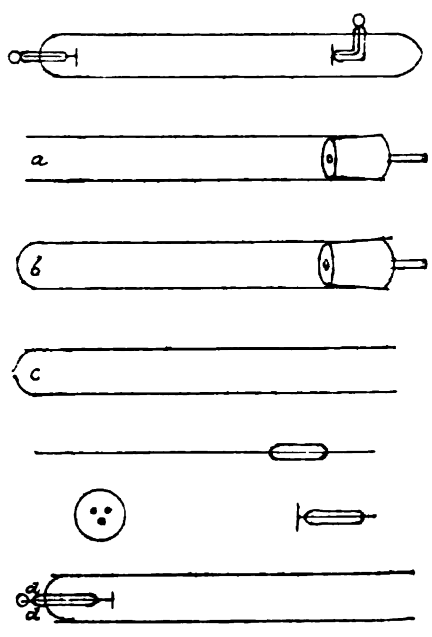


Fig. 1.

allowing it to cool, remove to small blowpipe; get the smallest and sharpest flame possible—the smaller the better—and let it soften a point at the end of the tube where terminal is to be inserted. Touch the point with a bit of platinum wire, so that the wire just passes into the glass, then remove from flame and withdraw the wire, which will bring with it a very small hollow tube. Break off this tube gently with a small pair of pliers, which will leave a ragged hole about one millimètre in diameter, and let a small flame touch it for an instant, in order to round the edges; then warm the whole end thoroughly, and allow to cool in cotton wool.

In the meantime the terminals may be prepared. Do not cut off just the length of platinum wire intended to be used, or it will be too short to hold, but take a piece of it, and leaving about ¾in. of it untouched, coat the next ⅝in. with an even, regular layer of glass about $\frac{1}{16}$in. diameter. This can be done by pulling out a thick thread of glass, and sticking it roughly on the wire in sufficient quantity, the whole being then well fused until it runs into a regular mass. A clean, sharp-pointed iron rod is here sometimes useful to equalise the distribution.

It must be mentioned that the kind of glass used to coat the wire is of the greatest importance. If the tube is of lead glass, white arsenic enamel, which may be purchased with the glass, is very convenient for this purpose; but it is not always safe to use it with soda glass. The safest and best plan is to coat the wire with a fragment of the tube itself, the portion removed when the end was closed being pulled out into a thread for the purpose. This practice will insure safety from cracking after sealing, which is almost certain to occur if the glass used differs from that of the tube itself.

Cut out a round disc of aluminium, rather smaller than the diameter of the tube, using a threepenny bit or a sixpence as a pattern; put it on a cork, and with a needle pierce three small holes, as shown in *e*, Fig. 1. One end of the wire can now be threaded through the holes, and then pinched tight with the pliers, thus giving a firm attachment, the completed terminal being shown at *f*. Of course, this plan is not so neat as soldering, but is equally effective, and avoids the possibility of melting the solder during the fusing in. Now drop the terminal into the tube, so that the wire passes through the hole, and make a neat loop by twisting wire round the end of an iron rod, putting the finger upon the edge of the hole meanwhile, in order to relieve as much as possible the strain on the thin edges of the glass. The terminal is now ready to be melted into the glass, and this operation should be immediately proceeded with, for if the tube is left in its present state for, say, all night, it is very liable to crack. Have a good piece of cotton wool in readiness, pull a thin thread of glass out of the same piece as that used on the wire (or of enamel, if that was used on the wire), and then warm the whole end of the tube gradually and carefully, using first the small blowpipe with a large flame. As the glass becomes warmer lower the flame, and when well heated throughout use a moderate-sized, fine-pointed flame, and let the point of it impinge on the terminal. Don't let it soften the glass too much just yet; but put the end of the iron rod into the loop, and pull it a very little way outwards, so as to make good contact all round. Then with the thin glass thread coat a little glass round the part marked *d*, to form a small shoulder, which will make everything tight, and secure the end of the loop. Then very thoroughly heat the terminal to as high a temperature as possible, and also do the same to the glass in its neighbourhood. The terminal inside will move downwards by its own weight, and the tube must be turned round to counteract this. Turn up the flame, and warm all the end of the tube carefully, and then immediately wrap up in cotton wool. It is most important that it should be allowed to become quite cold before being disturbed, and this will take some time. The other terminal must then be fused in.

Leicester. E. E. B.

BALANCING SWELL PEDAL.

[33028.]—"Leo" (letter 33007) cannot understand how my suggestion of weighting the shutters would answer. I think if he refers to my letter—I have not a copy at hand—he will find that I advocated "balancing," say, by screwing a strip of sheet lead on the back side of the shutter near the top edge, or otherwise, no matter by what means, so long as the shutters are "balanced." If this is done, it does away with all leverage; in fact, the simple key to the whole business is to "balance" everything, so that the shutters and mechanism will stand still at any point. And this is the reason why balanced shutters do not close *tight* like the recovering pedal, which closes the shutters tight by a weight on spring.

A balanced pedal can only be made to stand closed to the first point of contact, whilst the recovering pedal will "nip" the shutters close to, giving that delicious, far-away effect not obtainable by other means. I believe the recovering pedal is recommended by the College of Organists. I am glad to hear that "Leo" looks favourably on my idea for maintaining the recovering pedal in any position. The wording of his letter seems to throw some doubt as to the idea being my own. I can assure him that it is entirely my own invention, and that no one else had a hand in it in any shape or form.

There are a great many improvements yet to be made in organ building, and I think it will not be long before we shall hear some surprising suggestions, which, if carried out, as they undoubtedly can be, will revolutionise the art of building medium-sized organs.

Sudbury. Thos. Elliston.

REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75687.]—**Casting in Lead (U.Q.)**—To "Practical Caster."—I should have answered your query before, had I been able. (1) The kind of paper that this is printed upon makes very good tubes. The diameter depends (1) upon that of your penholder, and (2) the quantity of paper you roll round it; make them of pieces 18in. long. (2) Insert pins according to your sketch No. 2. (3) From a small iron ladle. (4) A round hole is best.

Practical Caster.

[75687.]—**Casting in Lead (U.Q.)**—"Practical Caster" appears to have missed the query, so I will try to help. (1) I have used common writing-paper to make moulds for lead caps for battery carbons without meeting with any difficulty; but cartridge-paper, rolled up with paste to two thicknesses and well dried, would be better. Diameter large enough to slip pin down, and as little larger as will admit of steady pouring down the tube. (2) Sketch 1 is right. The object is to make a small hole, through which the lead will filter into the mould when poured into the tube. The head should be cut off, and the holder with pin be used as a bradawl to bore through the whiting down to the pattern. (3) Pour out of iron ladle into the paper tube. (4) "Practical Caster" says 3in. *diameter*. This word shows that it is intended to be round. The sides of hole have to support the mass of whiting—that is their only object, so the shape is not material; but there can be no doubt as to what is meant by the very clear instructions on p. 183. The only thing that occurs to me is that no ventilation seems to be provided for. Possibly the whiting is sufficiently porous to allow the air to escape through it when the metal is poured; but if, on trial, you find the metal is not solid, try again, and prick the surface of mould (*outside* the paper tube) with, say, three pinholes reaching down to the pattern.

Glatton.

[75523.]—**Logarithms.—Decomposition of Numbers into Factors.**—The example given by me in the "E.M.," p. 334, was for the purpose of calculating the logarithm to 12 or 14 places by means of Steinhauser's Tables. It has occurred to me that possibly some readers might like a general rule for any number of places to which auxiliary tables might extend. The advantage of Gray's method of decomposition over Steinhauser's is, I think, evident on account of its greater brevity. It may, perhaps, be rendered easier to remember by a few preliminary words. Supposing we have a number, N, and we wish to break it up into factors of this description:—A, 10^7+B, $10^{11}+C$, $10^{15}+D$, and so on; A being a number of four figures, and B, C, D, &c., being each any number under 10,000. The first four figures of N are A. Divide the remaining figures of N by A, and the first four figures of quotient are B. Let the remainder at this point be R; consequently, disregarding final ciphers, $\frac{N-R_1}{A} = 10^7 + B$. R_1 is then divided by $N - R_1$, and the first four figures of quotient are C. Let the remainder then be called R_2. Consequently, $\frac{R_1 - R_2}{N-R_1}$, without its final ciphers, is C. R_2 is then divided by $N-R_2$, and the first four figures of quotient are D; and if the remainder is then R_3, it follows that $\frac{R_2 - R_3}{N - R_2}$ is D, and so on. If N consisted of an infinite number of figures, it would be evident that the differences between the number of figures in the divisors would be 7, 11, 15, 19, &c.; the divisors containing respectively 4, 11, 22, 37, 56 figures, and so on. But in practice, since we do not want more than four or five factors, the divisor is never more than 12 figures in length. Unless extreme accuracy in the final figure of the logarithm is wanted, after the divisor is made 10 figures long, the remainder of the division may be contracted, as in the following example, which illustrates the decomposition of the same number that "A. D. L." gave.

```
          1371) 2885  7423  8623  5368  7      (2104
                2742
                ----
                 143  7
                 137  1
                 -------
                   6  642
                   5  484
                   -------
1371,2884,584)     1  1583  8623  536
                   1  0970  3076  672          (8447
                   ----------------
                       613  5546  8648
                       548  5153  8336
                      -----------------
                        65  0393  0312  7
                        54  8515  3833  6
                        -------------------
                        10  1877  6479  1
                         9  5990  1920  9
                        -------------------
       1371,2885,74)        5887  4558  2      (4293
                            5485  1543  0
                            ---------------
                             402  3015  2
                             274  2577  1
                             --------------
                             128  0438  1
                             123  4159  7
                             --------------
                               4  6278  4
                               4  1138  7
                               ------------
                                  5139  7      (3748
                                  4113  9
                                  -------
                                  1025  8
                                   959  9
                                  -------
                                    65  9
                                    54  9
                                    -----
                                    11  0
                                    11  0
```

If absolute accuracy in the 20th figure of the logarithm is wanted, with a strong probability that the 21st figure is correct also, we must give 12 figures to the last divisor, making it end, *in this case*, with the figures 7,424, at the same time annexing two ciphers to the dividend. In the above instance this would extend the division one or two lines further, giving us an additional quotient. Thus—

```
11108
10970
-----
  138(101
  137
  ---
    1
```

This additional factor would cause an alteration in the 21st figure of the logarithm. T. S. Barrett.

[75725.]—**Horse-Power (U.Q.)**—I do not know of a satisfactory rule for the power absorbed by a fan. Molesworth gives a rule for H.P., and another for pressure, which may be modified thus:—

$$\text{H.P.} = 1{\cdot}56\,P^3A\,;$$

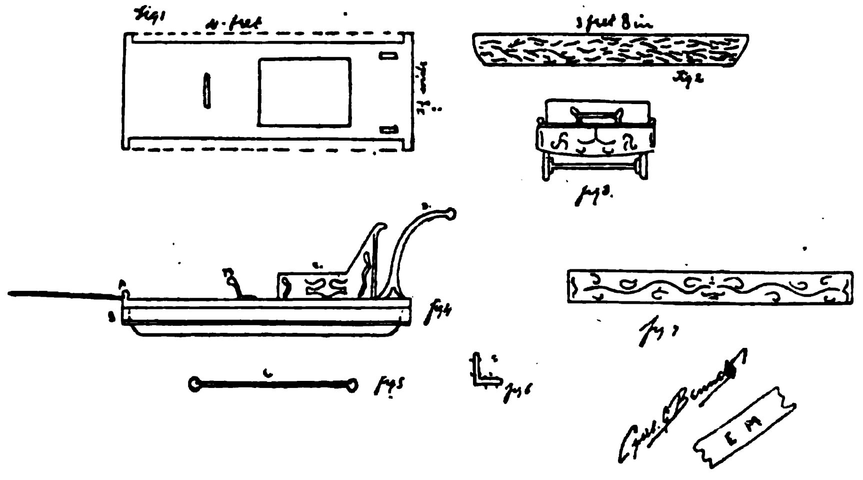
$$\text{or H.P.} = \frac{AV^4}{6{,}081{,}250{,}000}$$

where P = pressure of blast in lbs. per sq. inch.
V = speed of tips of blades in feet per second.
A = sum of areas of tuyeres in sq. inches.
H.P. = horse-power.

The value of P is given as $\frac{V^2}{97{,}300}$. I see, by the bye, that the formula in Molesworth for fans is given in Bourne's "Handbook of the Steam-Engine" as well. With regard to the shearing machine, Dr. Hartig found that a machine cutting 4,648sq.in. of cut surface per hour in plates $\frac{1}{16}$ths of an inch thick, required 5H.P. You will find a *résumé* of his results in Clark's "Rules and Tables," and also in *Engineering*, Vol. xviii. p. 338. Rankine (p. 562, "Machinery and Mill-Work) recommends that the work of one cut should be estimated as 12,500 Ct^2, where C = length of cut in inches, and t = thickness of plate in inches. This will be in *inch*-pounds. The work in *foot*-pounds per stroke will be 1,042 Ct^2 nearly. Of course, a heavy flywheel must be provided to store the work during the interval between two cuts.

Glatton.

[75633.]—**Sledges.**—If you look well at my sketches you will see how to make your sledge. Fig. 1 is a piece of deal 4ft. long and 2¼in. wide. You will see by the sketch that some wood must be cut away so as to put the runners in their proper places; this is very soon done by marking 2in. off each end, and cutting as shown. In Fig. 2 is shown the ash runner, 3ft. 8in. in length. You must have two of these, and they must fit in the places cut in the wood in Fig. 1. Fig. 3 represents the



runners fixed with a bar between them to keep them apart. There is a front board shown in this figure; this is carved with a fret saw on a piece of soft wood, and when finished is nailed on a piece of common wood, and then fastened on to the front of the sledge. Fig. 4 is the sledge made up. A is a knob made of brass to fasten the traces on to the sledge, B is a foot-rest, and C is the seat made out of deal covered with velvet or carpet, with pieces of wood nailed round; D is the pushing handle made of iron (which would have to be cast for you), fastened on the sledge with bolts; S is the side-board, which is also made of deal, and which has to have nailed on it a piece of carved wood, shown in Fig. 7. Fig. 5 represents the bar on the end of the traces made of brass. Fig. 6 shows the angle brackets, which are used to fasten the runners to the floor of the sledge. A tandem sledge would be made in the same way, only two seats instead of one. This sledge is very light to push, as all weight is at the back. This sledge is very nice when made up, and not expensive to make. Of course, the carving rests with you; if you do not like the pattern it is easy to make another. I shall be pleased to make clear through the "E.M." anything you do not understand.

C. G. M. Bennett.

[75825.] — **Tide Gauge.** — There are several arrangements for measuring the rise and fall of the "tide." The querist should look up the letters of the late Rev. J. Pearson, of Fleetwood, and if he refers to p. 253, May 23, 1884, he will find an illustration. I believe Mr. Pearson erected at Fleetwood a gauge, and if I recollect he illustrated a gauge in some number of the "E.M." which I cannot now refer to.

R. S.

[75826.]—**Choosing a Pianoforte.**—The best advice that can be given to any one who needs to ask such a question, is to seek the assistance of an expert. A "full compass" is seven octaves, and the majority of the instruments made nowadays fall little short of that; trichord is not much advantage; but the iron or steel frame is. Check action, of course, or its equivalent. See Mr. Davies's papers in the volumes published some years ago.

Forte.

[75834.]—**Electrical Water-Level Indicator.**—There are some designs for water-level indicators illustrated in back volumes. I suppose the querist means that the acting apparatus is to be at the reservoir, and the indicator at the office. The question seems to be of only individual interest; but in spite of that, much information on the subject can be found in back volumes.

T. L.

[75835.] — **Maquay Battery.**—The Maquay battery was illustrated and described in the "E. M." for July 16, 1886, and there is a note referring to it by Dr. Paget Higgs in the number for July 23, 1886. Of course the querist knows that the use of a battery for lighting work is very expensive; but no doubt the Maquay is as good as any.

L. M. P.

[75846.] — **Tamarind Wine.**—Macerate the tamarinds with hot water and sugar, and ferment in the usual way; but it is better to use them as a decoction, sweetening to taste, and mixing freshly as required.

R. S.

[75896.] —**Hysteria.**—Canceroso^{1}, third dilution, with occasional bath of Canceroso^{6}, will completely cure.

Mattzist.

[75923.]—**Problem.** — With all deference and respect to "Puzzled," and those who have replied to what he calls a problem, is no problem at all, and is nothing more than a small sum in arithmetic of the elementary rules of decimal fractions. To say that $x = \frac{2195 + \cdot182236}{\cdot006727} \times [\cdot984708 - (\cdot625 \times \cdot173648)] = 18301$, is as absurd as to say $x =$ the National Debt. If the above calculation be divested of its algebraical garb ("$x =$") the result will be just the same, and if it forms any part of a problem at all, it must be the tail end, and the head withheld, and, therefore, no one can make "top nor tail" of it as a problem. x is one of the letters which represents an unknown quantity in algebra; but, at the same time, an equative, relative, or comparative quantity. I should consider that "Puzzled" has overlooked the fact that x has an equative value, which he does not give, and that 220352·937942, as I make it from the figures he gives, would be equal to $12x$, then $x = 18366\cdot$; but the whole of the proposition should have been given, then "Puzzled" could have been assisted.

Wolverhampton. W. Witton.

[75930.]—**Gas-Engine.**—I must thank Mr. T. C. Smith for his reply, which meets my case, as I found a leak in gas-bag. Have been letting out mixed gas and air through a small cock before starting, which has made a great difference. Could you say if a tin-plate gas-bag would answer as well as the cast-iron ones which, I understand, Crossley's are now fitting to their engines, and how one knows when they are full or empty?

Shunt.

[75973.] — **Telephones.**—Wind each magnet with No. 40 double silk-covered copper wire to a resistance of 70 ohms. See also "Telephones: their Construction and Fitting," in which you will find scale drawings of both the single-pole and double-pole Bell receiver.

F. C. Allsop.

[75980.] — **Soldering.** — "Amateur" will no doubt partially succeed in tinning the cast iron by the processes given, but I fancy he will find bald places left. Now if while the iron is still hot and the solder fluid, he will apply some soldering solution, and with a file in one hand and a hot copper bit in the other, quickly file and rub the exposed places; the solder will run from the good places and cover everywhere. If it is a flat surface, use the end of the file more as a scraper. Plenty of solder must be put on in the first place, the excess being easily squeezed out when the tin-plate is put on, or it may be wiped off previously with a rag. Above all things, do not make the iron too hot, but just warm enough to keep the solder fluid while working.

F. Search.

[76024.] — **Clicking Noise in Telephone Receivers.**—This most likely arises from your having taken off the receiver while they are ringing at the other end, the "clicking" arising from the alternating current from the magneto generator passing through the receiver. Noises in the receiver also arise from too much battery on the microphone, or too loose adjustment.

F. C. Allsop.

[76025.] — **Electric Lighting.** — I see two replies, by two of our best correspondents, as to the cost of motive power, in which they say that the gas-engine costs more to drive than the steam-engine. In my humble opinion, this is hardly correct, as my experience teaches me that the gas-engine is cheapest. I had a 6H.P. steam-engine (Tangye) that cost about 25s. per week in coal. Now I drive an 8H.P. Otto gas-engine from 20s. to 22s. per week. In the case of the steam-engine, it took the best part of a man's time, having to make many journeys per day to see to his fire, and look after the water, besides the nuisance of sometimes letting steam get too low, and sometimes to find his fire nearly out when he came in the morning, and not being able to start at the proper time, thereby keeping hands idle. Now he simply lights the gas to heat ignition tube, and while that is getting hot, oils up, and then starts, and does not go to the engine till it is time to stop it. Consequently the man has much more time to work at other things. There is no coal to get in, or ashes to wheel out, thereby saving that cost. It also takes up less room. A friend of mine had a 3H.P. steam-engine which cost 10s. per week in coal, and 8s. per week for youth to attend to it. He invested in a 4H.P. gas-engine, which does the same work for 7s. 6d., including oil, one of the workmen stopping and starting it. I have several more friends whose experience is similar. It would be interesting to have the opinion of other correspondents who have had both kinds of engines. I also think that a few articles on "How to Make a Gas-Engine" would be welcomed, as where gas is obtainable, I think the small steam-engines have had their day. Trusting you will find room for this, and hoping it will lead to a little discussion, I thank you in anticipation.

B. B.

[76037.]—**Galvanometer.**—See my book "Electric Bell Construction," where you will find scale drawings of the linesman's galvanometer, with bobbins, needles, &c., in detail.

F. C. Allsop.

[76050.] — **Hook-and-Eye to Gut Band.**—Don't warm the hook. Holtzapffel says burn off the gut point after screwed in with nearly red-hot wire. Be careful not to strip thread on gut by overscrewing.

Mac.

[76069.]—**Lathe.**—Turn grooves V-shaped.

Mac.

[76078.]—**Boring Square Holes.**—There was a tool described some time back for boring square holes in wood. It consists of a square steel case, in which a twist-bit is accurately fitted, to be operated by brace, and as bit bores out round holes in wood, the chisel edges of case squares them. The bevelled edges of case are from the inside. If I remember aright, it is an article on sale, and was described in *Work* some time back. No doubt some reader could tell you number of paper; but if not, I will look it up and let you know. There is a shoulder near shank of bit which presses case forward with bit.

J. H. Nurse.

[76088.]—**Electric-Light Installation.**—Not many. Crossley's 5-man-power will just about do six 8c.p. lamps at full power. Cost of erecting engine and dynamo depends on the kind of engine and dynamo and the arrangement of the place where it is to be erected. See the articles on "Electric-Light Fitting" so far published, and carefully note the following ones on running wires and casing.

F. C. Allsop.

[76090.]—**To Mr. Allsop.**—Wind the receiver with No. 40 double silk-covered wire to about 70 ohms resistance. The uneven winding does not matter much. It is almost impossible to wind them otherwise.

F. C. Allsop.

[76096.] — **Atmolysis.** — Fowler's "Medical Vocabulary" gives meaning of the above word as follows:—[*Atmos*, vapour; and *luo*, I set free. Greek.] In Chem.: A method of analysis which admits of a partial separation of mixed gases and vapours of unequal diffusibility, by allowing the mixture to permeate through a plate of graphite or porous earthenware into a vacuum.

P. L.

[76098.]—**Rouge.**—In my electro-plating days I always made my own, in two ways: By calcining sulphate of iron in a small crucible, then crushing it to fine powder, and lastly collected by elutriation—i.e., the powder is stirred in a large glass jar of rain water, the impure and heavy particles fall to the bottom, the liquid is gently poured into another vessel, where the choice portion subsides, and is afterwards collected and dried. Or dissolve the crystals of sulphate in rain water, filter the solution through fine muslin; make a saturated solution of soda in rain water, filter it in a large glass jar; mix the two liquids; when the grey precipitate has subsided, collect and wash it repeatedly, put into a covered crucible, and raise it to a dull-red heat, pour out the oxide into a metal dish, and let it cool, when it will become a fine dark-red colour. For plated work I always made my powder of two-thirds rouge and one-third druggist's magnesia or levigated whiting, which should always be secured in a tightly-covered pot to keep out the dust.

Eos.

[76103.] — **Soldering Cast Iron.** — Sodium amalgam can be purchased from any dealer in chemicals. Metallic sodium combines instantly with mercury, a considerable amount of heat being evolved during the combination, and the result is sodium amalgam. It should not be touched with the fingers, as it dissolves the skin, and is liable to make painful sores.

Thos. Fletcher.

[76105.]—**Siphon.**—There is no limit to the possible "size" of siphons save that of convenience. The siphon partakes of a barometric action, its regulation being by atmospheric pressure. Supposing the respective limbs of a siphon to be A, A', the latter symbolising the longer limb, and H the highest part of the bend; then, as A' is, say, 12in. longer than A, the pressure at H is stronger from the direction of A by the amount of the difference in weight of the two columns of water, and so long as the suction and delivery—if I may say—vary, the former being highest, the siphon will continue to work, the pressure at the delivery varying as the length of A compared to A'. Of course, if your variation of lengths—or heights—is but small, the larger pipe will not appear to behave so well as a smaller one. Be sure that no third hole exists in larger pipe. Walter Strafford.

[76107.]—**Moles.**—Which? The subterranean or the superficial? I think with the former you may be successful; with the latter I think electrical fire may act as an escharotic, and so injure the epidermis that you will carry a scar instead of the natural mark of a delicate skin. I say, Don't.

Eos.

[76109.]—**Steam Pump.**—I have known Tuck's packing to last for a very considerable time in the presence of water at 212° Fahr. Asbestos packing is also endurable; but neither these nor any other flexible packing stand if neck-brushes and glands are slack on rods, or if rods be badly scored or bent. The querist should see to the latter.

Walter Strafford.

[76110.] — **Electric Lighting, Cost of.**—Reckoning the six rooms to require about 20c.p. each, and that the two arc lights are to be of 1,000c.p. each, using incandescent lamps of 50 volts, and arc lamps 50 volts, taking, say, 8 ampères, making with the incandescent lamps a total of, say, 22 ampères at 50 volts pressure, you would need a good compound-wound dynamo of about 1,100 watts output, taking about 2H.P. to drive, and costing from £22 to £30, according to maker. The gas-engine to run such a dynamo will cost from £103 to £120; arc lamps, £6 to £8 each; incandescent lamps, 5s. each; brackets or pendants, 5s. each; wiring and fitting, say, 4s. per lamp. I cannot price the cable exactly, as you do not say the distance you have to run; but you may average it at 9d. per yard. S. Bottone.

[76111.]—**Glass and Caoutchouc Joints.**—If the ends of the glass tube are made properly taper, and the rubber fits well, you hardly require anything to make a tight joint, for the more the exhaust the tighter the fit. Herein lies the essential difference between such a joint for pressure of air from within the tube and the pressure of air from without in the case of exhaust. Z. Y. X.

[76113.]—**Thirty-Light Dynamo.**—Wind the armature with 10lb. No. 13 d.c.c. copper wire and the field magnets with 60lb. No. 18 in series with each other, but in shunt with the brushes. This dynamo will take about 2½H.P. to drive it, and should be run at about 1,200 to 1,500 revs. per minute. S. Bottone.

[76115.]—**Riveting Felts on Piano Hammers.**—I can add very little to what I have stated. The rivets are generally copper wire, which are passed through the felt and hammer core, where the felt is thinned down close to the hammer shank. The wire is doubled before being passed through the hole, something like a hairpin, and when pushed nearly through, flattened out above and below, so as to grip the felt. Look over some good piano actions; you will surely see several done in this way. S. Bottone.

[76116.]—**Carbon (Filament).**—The average life of an incandescent lamp varies inversely as the 25th power of the E.M.F., and is usually a little below 1,000 working hours. (Captain Bax, in "Popular Electric Lighting," 1s. 6d., gives 600 hours as the mean.) The carbon filament is made of carbonised bamboo in the Edison lamp, while that of the Swan consists of a cotton thread immersed in sulphuric acid, and carbonised as before. The filaments are then "flashed" to make the resistance equal all through. If the vacuum was perfect (which is at present impossible), it is doubtful if the filament would ever be consumed. The "life" varies slightly if alternating or continuous currents be employed. A 105-volt lamp on a 100-volt circuit would last much longer than the average, but would not give its full candle-power. Candle-power varies as sixth power of current, and, therefore, as sixth power of E.M.F.

A. D. Southam.

[76117.]—**Strophanthus.**—Belonging to the immense natural order "Apocynaceæ" or Dog Banes, containing about 150 species. Very remarkable for the deadly poisons, valuable medicines, and pleasant fruits they contain. The name Strophanthus is a Greek derivative, the segments of the corolla being twisted as if done by human hand. S. dichotomus is the only one, a native of India, a very handsome twining shrub. There are three others from China, South Africa, and Sierra Leone. Its introduction into the British Materia Medica seems modern, as I never saw it used in Indian practice. Tabloids containing two minims of the tinct. strophanthus are now sold, but I am not personally acquainted with their properties. Eos.

[76118.]—**Accumulator.**—You cannot make an accumulator to give exactly 5 volts, since each cell gives but two volts. Any two cells of accumulator, which are in working order, will, if coupled in series, give four volts. The question of ampères is not so easily answered, since the ampères of current furnished depend entirely on the resistance in circuit. One square foot of positive lead surface will furnish 6 ampère hours; that means that you can draw off 6 amperes for 1 hour, or 1 ampère for 6 hours. Roughly speaking, neglecting the internal resistance of the cell itself, which in the square-foot size is low, you could get a current of 3 ampères for 2 hours from two cells, each containing a pair of plates of one square foot surface if connected in series, and coupled to an outer resistance not exceeding two-thirds of an ohm.

S. Bottone.

[76120.]—**Greenhouse Boilers.**—1. Try a coating of 1 part black-lead and 6 parts tallow, applied hot every few weeks. 2. Twelve parts salt, 2½ caustic soda, ⅛ extract of oak-bark, and ⅛ of potash. "A. G." will find other remedies on page 432 of "Molesworth." A. D. Southam.

[76120.]—**Greenhouse Boilers.**—A "simple cure" for incrustation in boilers is a desideratum undiscovered. If there be the convenience, let "A. G." heat up the boiler, then take away fire and hot water, replacing the latter with cold water—the sudden contraction will cause the scale to leave the metal, and may be withdrawn.

Walter Strafford.

[76121.]—**Anti-Freezing Liquid.**—I myself found out that solution of chloride of calcium was an anti-freezing mixture, and that it would do for hot-water apparatus. To my knowledge this is used by the hot-water engineers. A very slight quantity (I cannot give the exact proportions) is sufficient. This same material will absorb moisture. Thus, if you put some in a beaker and neglect to look at it, you will find that, instead of its having evaporated, it has filled and run over the sides of the beaker, and made the shelf permanently damp, for if you dry the shelf with great heat even it will again absorb damp. Z. Y. X.

[76124.] — **Photography.** — M. Rossignol recommends the following developer for under-exposed negatives:—Distilled water, 5oz.; sodium sulphate, ¼oz.; eikonogan, 40 grains; hydrokinone, 12 grains. For use, add 1 part potassium carbonate to 20 parts solution. This developer is very powerful, and will bring out as much of the image as is possible. A. D. Southam.

[76124.] — **Photography.** — The following is Thomas's formulæ:—A.: Hydrokinone, 160gr.; sodium sulphite, 2oz.; citric acid, 60gr.; potassium bromide, 40gr.; water to 20oz. B.: Sodium hydrate (in sticks), 160gr.; water to 20oz. For use, with normal exposure, take equal parts of A. and B. In warm weather add water. In case of over-exposure, use excess of A.; of under-exposure, excess of B. F. W. Mills.

[76125.]—**To Mr. Bottone.**—The apparatus to which you refer was shown by Coxeter, but was no more capable of feeding the ten 20-volt lamps than you are of flying. The dynamo did, and could, light one such lamp, and, in doing this, consumed about ⅛H.P., equal to a pressure of water at 40lb. to the square inch, and a head of 90ft. To light ten lamps of 20 volts, you would want, at least, ¼H.P., which, with a suitable water-motor, could be got from a head of water of 145ft., at a pressure of 60lb. to the inch. This you certainly would not get from the house-tap. S. Bottone.

[76126.]—**Clock Battery.**—To Mr. Bottone.—The best battery for this purpose is, according to my experience, a large (2-gallon) gravity Daniell. Earth battery no use. There was one of these at work at the 1871 Exhibition, and the battery broke down before four months were over.

S. Bottone.

[76128.]—**Battersea Enamel.**—I think you will find "gluten" prepared in the Indian way exactly what you require. I have a letter-box I made of camphor wood to resemble a large book. The back in ebony is inlaid with capital letters, which I coloured red by mixing vermilion with the gluten, and it has stood well for about 20 years. Take a handful of the best white wheat flour, tie it rather loosely in the corner of a pocket handkerchief, put it under a pump, and send rapid streams of water over that portion, squeezing occasionally till the water ceases to be white. Then remove the sticky mass and beat it hard on a clean bit of board till tough as putty. This is so tenacious that all the joints of fancy boxes are secured by it. It fills crevices and flaws, too, nicely; but it hardens rapidly and will not keep. Eos.

[76129.]—**Piano Tuning.**—Please refer to the exhaustive article I gave on this subject at page 255 of No. 1,364 of the English Mechanic for May 15, 1891. S. Bottone.

[76131.]—**Teeth.**—There is no universal system of fixing artificial teeth: everything depends on the peculiarities of the mouth, which vary enormously. Go to a dentist with a good reputation, and arrange to pay him when you are perfectly comfortable. Any dentist who understands his work will be satisfied with such an arrangement. 999.

[76132.]—**Plating Dynamo.**—To Mr. Bottone.—The gauge of your wire is small for a plating dynamo; it is about the size it should have been for a 30-lighter (see reply 76113). However, if you put a rather low shunt on, you will still get good work out of it. Wind the fields with 45lb. No. 16, and connect-up in shunt. S. Bottone.

[76133.]—**To Mr. Allsop, or Others.**—It makes absolutely no difference. S. Bottone.

[76134.]—**Magneto Bells.**—To Mr. Bottone, Mr. Allsop, or Others.—The defect lies in the hardness of the cores. As you do not wish to unwind and soften, try what sticking two or three thicknesses of paper over the face of the offending core end will do. S. Bottone.

[76136.]—**1in. Spark Induction Coil.**—The defects are two:—(1) The condenser is evidently not properly connected to the contact-breaker parts of coil, otherwise you would not get such heavy sparking. (2) You are using too fine a wire for the primary, which should carry a large current of comparatively low voltage. Hence two layers of No. 16 or 14 would have been better than the 18 you now have; and if you then couple your three cells in parallel, you will probably get good results. But see to the connections of condenser—something is wrong there. For such a coil, the hammer should be ⅜in. diameter, ⅜in. long; spring about 2in. long, ⅜in. wide, and about $\frac{1}{16}$in. thick, pretty stiff.

S. Bottone.

[76138.]—**Calculating H.P. of Gas-Engine.**—The "brake" test is most reliable for small engines. A dynamometer should be secured to first-motion shaft. Then the B.H.P. = ·0001904 W.L.N.; where L = lever in feet, W = weight of lever and weight applied to do, and N = revs. per min. The result is net H.P. − friction of engine.

Walter Strafford.

[76144.]—**Model Electric Motor.**—"Multipolar" will find one of these motors fully described and figured in my book (not the articles) "Electro-Motors: How Made and How Used," at p. 86, § 40, Fig. 42. The mode of winding, the style of armature required, &c., are therein carefully explained. S. Bottone.

[76145.]—**Electric Motor.**—To Mr. Bottone.—The ratio between the resistance of fields and armatures refers not to the length of the wire on the latter, but to the running resistance of the latter. For a ring or drum armature, the resistance of the wire falls to quarter of its total length, since the current divides itself between the two halves of the ring, above and below the brushes. This is not the case with shuttle armatures. Presuming yours to be a ring type armature, 120 yards No. 22 would have a total resistance of about 4·5 ohm. Taking quarter of this as the running resistance—viz., 1·125, and reckoning two-thirds as a fair balance on the fields, 1lb. No. 20 will do on the fields if they are wound in one continued length, or 4lb. if they are wound in parallel. Series winding will be best in your case. S. Bottone.

[76146.]—**Furnace Casing Mixture.**—The quality of this depends entirely on experience in mixing, moulding, and burning. The sawdust mixture with fireclay is awkward to deal with, and it will be much more satisfactory to get it made by someone with experience of the peculiarities of the material. Thos. Fletcher.

[76149.] — **Lathe Treadle.** — To "Lathe Struck."—I have had no practical experience of the driving gears named. I have had the chain gear and friction pulleys removed from my own lathe partly to shorten it to stand in a recess, and partly because the hardened centres, if well fitted, still remain the neatest, cleanest, and most satisfactory of all. Ball bearings might answer well, but I have not tried them. Chains pick up dirt terribly.

O. J. L.

[76150.]—**Tricycle**—The object of having one wheel geared to the other by one or more idle bevel pinions is to allow the tricycle to be steered whilst the motive power is applied to both wheels. The bevel pinions are attached to the plate that carries the cog-wheel for chain, and form the connecting link between the two driving-wheels, allowing them to revolve in opposite directions if required.

Dynamite.

[76151.]—**Dynamo Sizes.**—Armature 6in. dia., 6in. deep, wound with 6lb. No. 16; field-magnet cores 7in. long, 3in. dia., wound with 30lb. No. 22, connected in shunt. Do most workers prefer longer field-magnets? S. Bottone.

[76152.]—**Lantern.**—Perhaps you have omitted to place the glass plate in front of the combustion chamber of your lantern, or you have left the back door open; or, lastly, your chimney is not slid out high enough. S. Bottone.

"Spot" Masks for Lantern Slides.—The Fry Manufacturing Co., of Chandos-street, Charing Cross, have issued some useful "spot" masks for lantern slides, which should have a large sale, as they will clearly indicate at once which is the right side of the slide by the white spots on the mask.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75537. Wool Winder, p. 184.
75540. Osbo-Premier Battery, 184.
75544. Thickness of Metal Pipes and Cylinders to stand Steam Pressure, 184.
75568. Estimation of Lead as Sulphate, p. 185.
75569. Medical Coil, 185.
75575. Model Screw Propellers, 185.
75576. Camber, 185.
75589. Engine, 185.
75591. Organ Pipes, 185.
75596. Mason's Stamps, 185.
75597. Iron Chuck for Brushmaker's Lathe, 185.
75598. Fan for Forge, 185.
75601. Furness Railway Co.'s Engines, 185.

75871. Scroll Chucks, p. 272.
75821. Golf Balls, 272.
75828. Double Launch Engine, 272.
75850. Small Arc Light, 272.
75851. Midland Raiway, 272.
75853. Small Riveting Machine, 272.
75854. Hot-air Engines, 272.
75856. Fish Refuse, 273.
75858. Colouring and Stiffening Sea Weeds, 273.

QUERIES.

[76153.]—**Distilled Water for Domestic Use.**—Is it possible for a good mechanic to fit the necessary apparatus for this in his house, and what is required?—AQUA.

[76154.]—**Varnishing Violin.**—Will Mr. Pickering be good enough to give recipe for sizing violin a deep orange colour? I propose varnishing with the so-called amber varnish.—CARLO BERGONZI.

[76155.]—**Drying Hose-Pipes.**—A tower 60ft. high, and 20ft. base, is to be used for drying hose pipes, &c.; they are 100ft. long, and hung up in the middle. Will some one please state the best means of hanging them up, only one or two to be pulled up at once, but about 30 lengths are required to be hanging up at one time. All the work is to be done at the base of the tower. If single pulleys are used, which is best—wood or iron, and why? If they are hung on pegs, how are they put on, and taken off?—A. B.

[76156.—**To Mr. Bottone.**—I have made myself a model steamboat 4ft. in length, and wish to drive it by an electric motor. Could you tell me what kind I require, and what would be the cost of one, and how many cells would it take to work it? I should also be glad to know how low I can allow the specific gravity of the solution of a secondary cell to fall before recharging it?—D. H. HUTCHINSON.

[76157.)—**Barley Bread.**—Is bread made from barley flour nutritious? When made same as other bread, it seems somewhat heavy. How can this be avoided?—TENZO.

[76158.]—**Gums Receding.**—What is the best remedy for this? The person affected is about 30 years old.—TENZO.

[75159.]—**Sundials.**—The interesting articles on sundials in recent numbers require only a concise table of corrections to be applied to calculate true mean time at place; the correction for longitude E. or W. of Greenwich any one can easily remember after determining his longitude from the Ordnance maps. Does the equation of time vary much for different years, and, if so, please say, in addition to above information, what the correction should be?—MAC.

[75160.]—**Coil.**—Will Mr. Bottone or some of your electrical correspondents assist in the following? I desire to build a good useful medical coil, also to be useful for electrical experiments Are there any objections to the following dimensions? What quantity and quality of primary wire, and also secondary wire, will be required? Length of tube (paper) between discs, 8½in., brass tube (for soft iron bundle) 1in. diameter. The secondary wire to be laid in six separate and distinct sections for as many powers. Will any advantage accrue in having the first or sixth layer twice the length of the rest to be worked with from two to six Bunsen cells?—NOVICE.

[76161.]—**Wimshurst Machines.**—To MR. BOTTONE.—I intend making one of these machines. Will you please say what size sparks may be expected from that described in your book on "Electrical Instrument Making"? Also if the machine described by "J. W." in a recent issue of the "E. M." would give better results. I suppose tin sectors are to be stuck on both sides of the discs.—A. B.

[76162.]—**Phonograph.**—Will any reader kindly say how to fix glass (1-200in. thick), which I have as diaphragm, without breaking same? Apparently it must be under spectacle frame, as weight of cone breaks it. Screws also break it when tightening, though it is between rubber washers and surfaced off flat.—F.S.Sc., London.

[76163.]—**Manchester Dynamo.**—To MR. BOTTONE.—Would you kindly let me know what results I may expect from a machine of the above-named type? Dimensions are—armature (laminated), 4in. diam., 4½in. long, with 12 cogs; malleable iron field-magnets, 6in. long, 2½in. diam.; heavy cast-iron pole-pieces; nearly 3lb. No. 18 d.c.c. American wire gauge on armature, and 11lb. of the same size wire on magnets; shunt connected to brushes. What size of cable should I use from terminals, and how many 16c.p. incan. lamps should it light, and most suitable voltage of same? Would there be any danger of burning armature coils through shutting off one or two lamps while machine is working at its proper speed for full output?—EXC.

[76164.]—**Speed.**—Would "Vulcan" help me with the following? I wish to drive a dynamo (armature 4in. diam.) at about 2,500 revs. per minute from a steam-engine. On the crank-shaft there is a cogged wheel 30in. diam., geared into a pinion 10in. diam. On the shaft of this pinion I propose fixing an 18in. pulley to drive a third shaft, which will carry a pulley to drive dynamo. The engine is a short-stroke powerful one, but I cannot alter existing arrangement of cog-wheels. Particulars of diameters of pulleys, breadth of belts—the one from 18in. pulley will have to be crossed. Will that work well at the speed? Also, what is your opinion of good canvas hose as a driving band?—EXC.

[76165.]—**Metronome.**—Would some of your readers give me a full description of the above instrument, as I wish to construct one with the bell arrangement?—MACHINIST.

[76166.]—**Meteorology and High Winds.**—What is the cause of the abnormally high south-west winds we have had lately? I notice that here at Chiswick, they only blow at night.—GLATTON.

[76167.]—**L. and N.W.R. "Precedent" Class.**—Would be glad if "North-Western" would give full dimensions, together with the names and numbers of the first and last engines of this class. Also would be much obliged to him for sketch (engine only) of Mr. Webb's new compound loco. Greater Britain?—Loco. No. 2.

[76168.]—**Great Eastern Railway.**—To J. F. VICKERY.—Many thanks for your sketch and description of the S.E.R. locos. I should be obliged if you could also give me sketch and description of the six-coupled goods on the G.E.R. The class of which I require sketch are, I believe, known as "Moguls."—Loco No. 2.

[76169.]—**Bleaching.**—Could any of our chemical or technical readers oblige by giving information regarding the methods employed by bleachers to remove lampblack, blacklead (plumbago), &c., stains from linen and muslin goods?—BLEACHER.

[76170.]—**Tinning of Domestic Utensils.**—"Eos" a short time since (I have looked for the letter, but cannot find it now, so cannot give No. and page) mentioned the frequent "tinning" of copper utensils with an alloy containing a considerable amount of lead. It would be interesting to know what became of the "tinning" that it should require to be repeated so often. If any of it was dissolved in the food contained in the vessels, I think it would communicate poisonous qualities to the food. For myself I should prefer a plain iron pan to a copper one lined with such an alloy. Perhaps it may have had something to do with the considerable experience of "Eos" in connection with matters of illness and medicine.—SAMOTHES.

[76171.]—**Electro-Motor.**—I propose constructing "The Simple Electric Motor" described April 6, 1888. Is No 18 (iron) American gauge same as Birmingham? if not, what number is it in Birmingham? Is No. 16 cotton-covered wire same in America and here?—if not, what gauge?—F. J. S.

[76172.]—**Recharging Electric Lamp.**—Would Mr. Bottone kindly answer this query? I have a Pitkin eight-volt hand-lamp which appears to be run down. I wish to recharge. I have a Kapp dynamo, volts 145, ampères 125, and 100 accumulators to charge every day. Where could I place the lamp to recharge, and what strength should the acid be, and how to know when fully charged.—ELECTRIC.

[76173.]—**Dancing-Floor.**—What is the best way of working up into a really slippery condition a floor for dancing, the same having a foundation of beeswax, this not being found satisfactory?—J. ARTHUR S. HARVEY.

[76174.]—**Steam Generator.**—Can any reader give information about a new system of generating steam that is spoken of as a great and new idea, viz., by making hot compressed air and steam? Why would this plan offer any advantage over the old system of injecting sufficient water for making steam for each stroke of the piston into a heated chamber or into the cylinder itself in such a way as to generate steam instantaneously?—H. J. CLARK, 14, Lysander-grove, Upper Holloway, N.

[76175.]—**Violin.**—Has it ever been attempted to increase the number of strings on the violin? If so, with what success? Of what material, metallic or otherwise and irrespective of purity of tone, can strings be made to give on the violin the fifth above and double fifth above the open E on the first string?—NED.

[76176.]—**To "F.R.A.S."**—Thanks for reply to my query. Will you further help me please? In *Nautical Almanac*, 1892, pp. 226-269 are given the logs of true distances and radii vectores of the planets from the earth and sun respectively. How are the absolute distances found from these? With parallax 8·848", and semi-diameter of earth = 3963·296 miles, the log. of earth's distance comes out at 7·9656366. Should I compute the mean distances of the other planets by Kepler's law from this? Take, say, Jupiter on January 1st, 1892, p. 250 *N.A.* It is just these practical details, which are not to be found in any book I know of, which puzzle some of us amateurs whose mathematics are not very strong, and for which I am grateful for help.—ALCYONE.

[76177.]—**Voltmeter.**—Would Mr. Bottone kindly explain the construction of the "sucking" selenoid referred to in his instructions for making a voltmeter in "E.M." for October 10, 1890, and also how it is made? I can hardly see through sketch, as one side of selenoid is curved and one straight. Of what material is it made, and is it like an ordinary bobbin?—E. J.

[76178.]—**Galvanometer.**—Would galvanometer with coils (as described in "E.M." for December 11, 1891) be very sensitive, and would it be suitable for ordinary experimental work? Sorry to trouble Mr. Bottone with two queries in one week; but any information would oblige.—E. J.

[76179.]—**Differential Calculus.**—I am glad to see the republication of the late Mr. R. A. Proctor's lessons on this subject, though I wish that the figures were not left out, and that there were not so many typographical errors. There seems to me, however, to be an error of a different character in the working out of the last example (the racing boat) on page 368.

If
$$y = m\,x^3(1 - x)$$
$$\frac{dy}{dx} = 3\,m\,x^2\,(1 - x) - m\,x^3$$

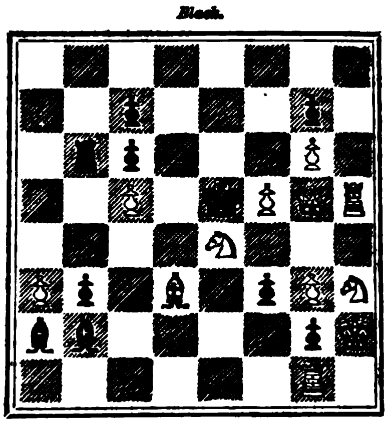
which gives $x = \frac{3}{4}$ instead of $\frac{2}{3}$, and the weight 9st. 5½lb. instead of 14st. 3⅜lb. Surely this is a more likely result!—H. G. M.

CHESS.

All communications for this column to be sent to the CHESS EDITOR, at the office, 332, Strand.

PROBLEM MCCLXXXVI.—By W. T. PIERCE.

Black.



White. [12 + 10.

White to play and mate in three moves.

SOLUTION TO 1284.

White.	*Black.*
1. R–Q 8.	1. Any.
2. Q, R, B, or Kt mates.	

NOTICES TO CORRESPONDENTS.

CORRECT solutions to 1284 by L. Pfungst, G. H. Inson, T. H. Billington (a clever and pretty little problem), J. Kistruck, R. W. Houghton, H. Fellows, A. Fellows, W. L. Smith, Alec Anderson, A. C. Hurley, Biene, W. T. Hurley, J. Nield, and F. Slade; to 1283 by F. Slade, H. Fellows, A. Fellows, G. H. Inson, Biene, A. C. Hurley, R. W. Houghton, W. L. Smith, J. Kistruck, T. H. Billington (not enough variety for force employed), L. Pfungst, and W. L. Martin; to 1282 and 1283 by A. Robson (the dual in a three-mover can only occur in a variation after Black's first move; it is not a second solution); to 1282 by A. C. Hurley (solution overlooked) and H. Fellows; to 1277 by W. F. Slipper (sorry for error).

J. NIELD, R. Inwards, W. T. Hurley, and W. T. Pierce are thanked for problems.

H. HILBRAND.—Your solution to 1283 is incorrect.

K. D. PEARSON.—Too easy; bad duals.

W. JAY.—Thanks for letter and inclosure; sorry you will not be able to compete.

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The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, JANUARY 1, 1892.

FOOT-POWER SAWS.

NOT a few of our readers have in all probability tested the power of the sinews of their legs in the endeavour to drive a circular saw by treadle action. If so, I will venture to say they duly ascertained that it was not the sort of exercise for ordinary mortals to enjoy, and should be kept for the reformation of those criminals who have conscientious objections to the treadmill. There is only one saw in the market that will rip up an inch plank by foot power, without undue exertion, and it is quite work enough to cut up a lot of ½in. stuff with the ordinary pattern of circular saw. Our old friend Bergeron, however, designed a method by which foot power may be used to greater advantage, but it was a vertical or reciprocating saw that he adapted to the purpose, so that the direct weight of the workman might drive the saw in its downward course through the wood. The saw delineated in this paper is a modification of the old French design, but is, I think, easier to construct, and also simpler in detail. I have drawn it to scale of about ¾in. to the ft., and left it for the most part in outline. The main frame is of beech or red pine 4in. by 3in. The side pieces, 6ft. high, are mortised into the cross-pieces which form the feet, and which may with advantage be of somewhat larger scantling. These are cut out below, that they may stand more firmly. The top bar is notched into the uprights, and secured with an oak pin in the usual way. B B is the table of 2in. plank, 3ft. square, cut out to admit the standards, and further supported by brackets C C (Fig. 1) and D D (Fig. 2). It should also be secured to the standards by bolts with sunk nuts, which will add materially to the stability of the structure. The plan of this table is shown in Fig. 3, and B are oblong holes through which pass the side pieces of the saw-frame. The iron bars A A, Fig. 2, upon which it slides, and which should be 1in., at least, in diameter, and cleaned up bright as far as the upright portions extend. The saw passes through a slot in the middle of the table marked C in Fig. 3. *a b* and *c d* in Fig. 3 are slots for the purpose of admitting a pair of rollers centred just underneath. They are not essential, but will facilitate the traverse of the board to be sawn. The upper edge of the rollers must only just clear the upper surface of the saw-table. I may say at once that it is not suggested to make this machine or its table of metal, or to add to its cost by any refinement of construction. It is meant to be a strong, simple tool for the amateur, and it is not meant for cutting stuff over 2in. thick; but it should do this comfortably, and at a fair rate of speed, if the saw is well sharpened and set so as to clear.

Fig 1

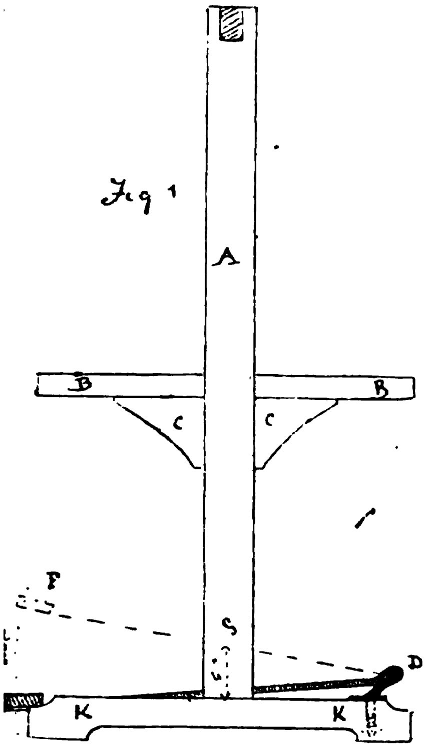


Fig 2

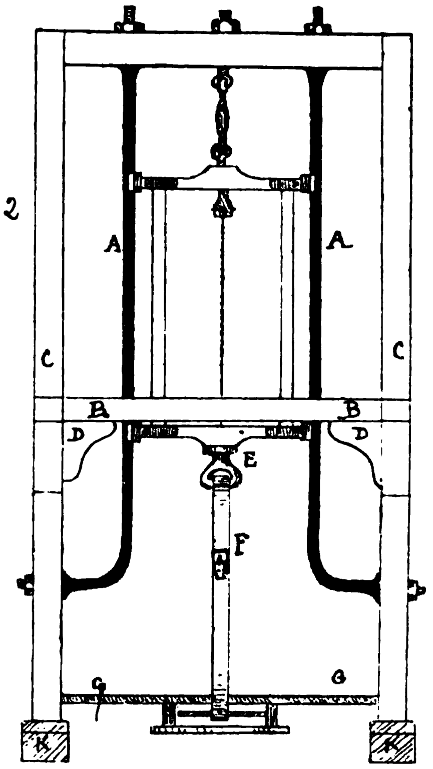


Fig 3

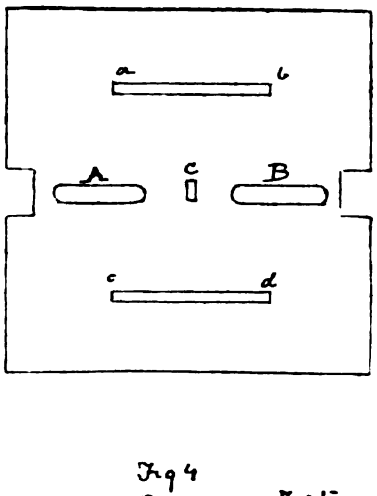


Fig 4

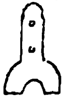


Fig 5

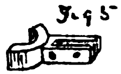


Fig 6

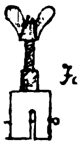
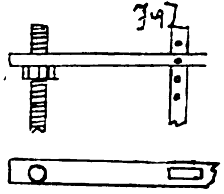


Fig 7



The saw frame, of ash or beech, is made so as to strain the saw tightly; the usual clamp is represented at Fig. 6, but may be modified to suit the method of suspension. I have shown it supported by a single india-rubber door-spring; but as this will come in the way if the saw tension is arranged in the centre, it may be better to hang the frame to two such springs, leaving the centre free. If one is used alone, the saw can be mounted on a frame in which the slides pass through mortises in the upper and lower bars, these side bars terminating in a screwed portion. Nuts inside the top and bottom bars—i.e., under the upper and above the lower, will enable the saw to be tightly strained. The screwed parts must, of course, pass freely through their respective mortises. In any case the top and bottom bars of the frame are to extend about 2in. beyond the sides, and are fitted with shoes, Figs. 4 and 5. These are to be preferably made of brass or gunmetal. They are filed out to fit over half the upright iron bars, upon which they slide. They are made in this particular way as being easier to fit together, the shape of the irons and the position of the saw preventing anything like sleeves or circular collars from being used. There is no need, moreover, for any more than half of the iron rods being in contact with these slides. To remove the saw frame it is only necessary to take out the small pins or screws which attach the shoes, and to unfix either the top or bottom bar. These saws, it may be noted, do not need a frame mortised and glued, because the tense saw itself prevents the bars from being pulled off endwise. These bars, made with a screw or a mortise and pin, Fig. 7, are quite secure, but as soon as the saw itself is unpinned, the frame can be at once taken to pieces. I have represented the treadle as linked by a strap to a ring in the bottom of the frame. It is a simple expedient, free from stiffness and silent in action, and a fairly stout strap, like a stirrup leather, will last a long time. It is necessary, however, to refer to Fig. 1, in order to get at certain constructive details of this part of the machine. Suppose the treadle arranged as there shown, and intended to have a rise of 1ft.: I have shown that at the part under the saw-frame where the strap is attached, the rise will only be 4in. Now, although this will cut a 2in. board, it would entail many more cuts than should be needed. It is, in fact, a waste of nearly the whole length of the saw. Hence, although I have purposely left the treadle in order to show this special drawback, it is evident that the nearer we get the tread directly under the saw, the greater length of the latter will come into action. If the foot rises and falls 12in., that length of saw will come into action. Now, the table is 3ft. wide, therefore there are 18in. between the body of the workman and the saw; and if any of our readers will make the experiment by standing close to any table, they will find that the foot can be easily advanced 18in. forward, as it would be if the footboard of the treadle were underneath it at that distance. The foot, however, cannot rise much over 12in., or the knee will come into contact with the table. I have left the table clear in the drawing; but in practice a guide of some sort to insure a straight cut would be required, and is easily fitted similar to that which is to be found on the tables of circular saws. It would also be better to inlay a little square bit of brass plate where the saw passes through the table with a narrow slit, in which the back of the saw may take a bearing; or a grooved pulley may be used, if it is kept below the level of the upper surface of the table. The following observations are added as specially applicable to the kind of saw. The space between the upright standards is not such as to admit of cross-cut sawing, nor is the saw itself capable of such work. It is intended specially for deal boards, which seldom exceed 11in., the inside measure of the saw frame. Any amateur desiring to adopt the pattern represented can, of course, substitute a wider saw frame; but a frame there must be to keep the saw tense and true. A wider blade might perhaps answer without such frame if properly guided; but the narrower it can be kept the less will be the friction, and friction is the element to be specially kept in sight in designing a machine of this kind. Another consideration is this, and it is inseparable from such machines; the board, especially at the commencement of the operation, projects straight out in front, having only a bearing of 18in. on the table. If the board is a long one, it needs independent support, and must rest upon a trestle with a roller pivoted to it on the top, as usual in steam sawmills, where several are fixed to lead the planks up to the saw. But this is no drawback, and is easily provided. The other matter for consideration is that because of the projection of the board the workman has to stand at the side of it; but this, again, is inseparable from all such saws as are worked by the foot of the operator, whether vertical or circular.

There is, however, nothing in this simple design that implies expense, and it is such as any amateur can construct of the quartering obtainable at a timber-yard, which need not be even planed so far as the main frame is concerned. It may also be modified so as to do away with the iron bars used as guides if the saw frame is made wider, or the main frame is made narrower and the standards grooved on the inside, so that the saw frame can take a bearing in such grooves; or, again, fillets may be attached to the sides of the saw frame to slide in these grooves. There are all kinds of devices, in fact, available; but whatever plan is used, all working parts should be strong and well fitted, so that with a 2in. board as a fair limit a breakdown may be rendered almost an impossibility. It will probably strike some of our readers that by adding a flywheel and working the saw by a crank pitman or connecting rod, we should arrive at something more like a saw-mill in miniature, and greatly add to the speed of the sawing. Such is the case; but I have simply suggested a very cheap and fairly efficient form of saw, modernised from Bergeron's design,* pleading for the principle of a vertical instead of circular motion, because the latter needs more leg power than can be willingly supplied by **O. J. L.**

ASTRONOMICAL NOTES FOR JANUARY, 1892.

As heretofore, we preface our Astronomical Notes for the first month of the New Year with such explanatory remarks as may be needed to make them useful and intelligible to the ordinary amateur observer, appending to each table which appears to require it a description of its construction and mode of use, and furnishing, moreover, wherever it is necessary, numerical examples fully worked out.

Beginning with our first table, that of the Sun, there will be found in column two, for every fifth day of the month, the instant which should be shown at Greenwich by a clock regulated to show Mean Time when the Sun is on the Meridian (or accurately south) and a sundial marks 0h. 0m. 0s. What is called in the almanacs "The Equation of Time," or the amount to be added to—or subtracted from—this instant of apparent Solar Noon, is calculated for the Meridian of Greenwich, but may, for ordinary purposes, be employed for any other station in the United Kingdom, since the most westerly point, Valentia, is only 41m. 23s. west of Greenwich (less than 0·69 hour), and the variation in the equation for one hour is but 1·19s. on Jan. 1, diminishing to 0·377s. by the 31st, a quantity absolutely inappreciable on the largest and most perfect sundial ever constructed. Columns three and four give the Right Ascension and Declination of the Sun (to the nearest second of time and arc respectively) on the days specified, when a Mean Time clock at Greenwich marks 0h. 0m. 0s. Finally, column five furnishes the Right Ascension of the Meridian, or Sidereal Time (to the nearest hundredth of a second) at the same instant.

The Sun.

Day of Month.	Souths.	At Greenwich Mean Noon.		
		Right Ascension.	Declination South.	Sidereal Time.
	h. m. s.	h. m. s.	° ′ ″	h. m. s.
1	0 3 37·91 P.M.	18 46 5	23 1 56	18 42 26·86
6	0 5 55·88 ,,	19 8 5	22 31 55	19 2 9·65
11	0 8 1·77 ,,	19 29 54	21 50 48	19 21 52·44
16	0 9 52·71 ,,	19 51 28	20 59 6	19 41 35·23
21	0 11 26·61 ,,	20 12 44	19 57 23	20 1 18·02
26	0 12 41·96 ,,	20 33 43	18 46 22	20 21 0·81
31	0 13 37·51 ,,	20 54 21	17 26 47	20 40 43·59

The quantity tabulated in the last column (Sidereal Time at Mean Noon) is one often required by the observer for the instant of Local Mean Noon at his own station; and this may be obtained by the addition of 9·8565 seconds for every hour (and proportional parts for minutes and seconds), when the place is to the west of Greenwich; and by their subtraction when it is to the east. For example, what is the Sidereal Time at Local Mean Noon at Limerick on January 6th? The longitude of Limerick is 34m. 30s. west of Greenwich; so we say 60m. : 34m. 30s. : : 9·8565s. : (what we shall find to be) 5·667487s. Turning now to our table above, we find that the Sidereal Time at Greenwich Mean Noon on the 6th is 19h. 2m. 9·65s., and adding 5·67s. to this, according to the precept (Limerick being west), we obtain 19h. 2m. 15·32s. as the Sidereal Time at Limerick Mean Noon on the day specified. Or, suppose that we require the Sidereal Time at Norwich Mean Noon on January 21st, Norwich being in longitude 5m. 12s. east. Here, as in the former case, we say 60m. : 5m. 12s. : : 9·8565s. : 0·85423s. The Sidereal Time at Greenwich Mean Noon on the 21st is 20h. 1m. 18·02s., and if from this (Norwich being east) we subtract 0·85s., we finally get 20h. 1m. 17·17s. as the Sidereal Time at Norwich Mean Noon on the required day.

At 11 p.m. on January 2nd the Sun is said to be in Perigee; in other words, the earth is then at her least distance from him. Accepting the Official Solar Parallax of 8·848″, an interval of 90,842,919 miles separates the centres of the sun and earth at the instant referred to.

Spots, faculæ, and other indications of Solar disturbance should be watched for whenever the Sun is visible.

Occultations of (and Near Approaches to) Fixed Stars by the Moon.

Day of Month.	Star's Name.	Magnitude.	Disappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.	Reappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.
			h. m.		°	°	h. m.		°	°
9	σ Arietis	6	12 42 a.m.	Dark	35	355	1 29 a.m.	Bright	286	246
10	τ Tauri	4½	†11 40 p.m.	S. by E.	168	133				
11	118 Tauri	6	†5 16 ,,	N. by W.	344	28				
13	39 Geminorum	6½	†6 55 a.m.	N. by E.	8	332				
13	40 Geminorum	6½	6 57 ,,	Dark	37	2	7 22 a.m.	Bright	337	304
16	42 Leonis	6	11 17 p.m.	Bright	163	199	12 5 ,,	Dark	243	275
17	B A C 3579	6	3 43 a.m.	Bright	105	89	4 55 ,,	Dark	318	289
17	*i* Leonis	6	†6 21 ,,	NE by N	30	352				
18	B A C 3996	6	†9 40 p.m.	S.S.W.	203	242				
19	*b* Virginis	6	5 9 a.m.	Bright	178	164	5 57 a.m.	Dark	254	232
20	γ^1 Virginis	2½	4 2 ,,	Bright	168	175	5 3 ,,	Dark	266	262
20	B A C 4277	6	5 6 ,,	Bright	121	117	6 26 ,,	Dark	312	293
23	8 Libræ	6	‡1 39 ,,	Bright	125	162	2 42 ,,	Dark	294	327
23	*a* Libræ	2½	‡1 47 ,,	Bright	129	165	2 51 ,,	Dark	291	323

† Near approaches. ‡ Moon has not risen.

The Moon

enters her First Quarter at 1h. 12·2m. in the early morning of the 7th, and is full at 3h. 26·7m. a.m. on the 14th. She will enter her Last Quarter at 3h. 42·6m. a.m. on the 22nd, and be New at 4h. 38·6m. on the evening of the 29th.

Day of Month.	Moon's Age at Noon.	Souths.
	Days.	h. m.
1	1·4	1 24·5 p.m.
6	6·4	5 46·9 ,,
11	11·4	10 9·1 ,,
16	16·4	1 49·8 a.m.
21	21·4	5 20·1 ,,
26	26·4	9 12·1 ,,
31	1·8	2 0·3 p.m.

The Moon will be in conjunction with Venus at 3 a.m. on the 2nd (Venus 3° 17′ N.); with Jupiter at 4 p.m. on the 4th (Jupiter 4° 2′ N.); with Saturn at 10h. a.m. on the 19th (Saturn 1° 57′ S.); with Mars at Noon on the 24th (Mars 1° 15′ N.); with Mercury at 9h. p.m. on the 27th (Mercury 3° 59′ N.); and finally with Venus, for the second time this month, at midnight on the 31st (Venus 3° 42′ N).

When the year opens the Moon is in Sagittarius, but passes into Capricornus about 2h. 30m. p.m. on the 1st. She is travelling through Capricornus until 8h. a.m. on the 3rd, and she then leaves it for Aquarius. Her journey across Aquarius terminates at 7h. a.m. on the 5th, at which hour she enters Pisces. In the course of her passage through Pisces, she arrives at 1h. a.m. on the 6th on the confines of an outlier of Cetus, which she then enters; to come out again in Pisces at 7 o'clock the same evening. Pursuing her course through Pisces, she at 10h. p.m. on the 7th plunges into another outlier of Cetus, from which she finally emerges at 6 o'clock the next morning in Aries. She quits Aries for Taurus at 2h. 30m. p.m. on the 9th; and Taurus in turn for Gemini at 7h. 30m. a.m. on the 12th. It is not until 6h. a.m. on the 14th that she leaves Gemini for Cancer. Here she remains until 7h. 30m. p.m. on the 15th, at which hour she enters Leo. Her passage across Leo occupies her until 6h. p.m. on the 18th, when she quits it for Virgo. She is travelling over this great constellation until 11h. 30m. a.m. on the 22nd, when she passes into Libra. Journeying over Libra, she arrives at Noon on the 24th on the Western edge of the lower part of the Northern Spike of Scorpio, which she takes exactly twelve hours to cross; and at midnight emerges in Ophiuchus, in which constellation she continues until Noon on the 26th, when she enters Sagittarius once more. She is in Sagittarius until midnight on the 28th, when she quits it for Capricornus; as she does Capricornus, in turn, for Aquarius at 4 p.m. on the 30th. She is still in Aquarius at midnight on the 31st.

The first four columns of the above table need no explanation. The fifth, headed "Moon's Limb," indicates whether the limb at which the disappearance occurs is the bright or the dark one; column nine giving the same information

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* Bergeron's saw will appear in the next paper.

Jupiter's Satellites.

Day of Month.	Satellite.	Phenomenon.	H.	M.	S.	Day of Month.	Satellite.	Phenomenon.	H.	M.	S.	Day of Month.	Satellite.	Phenomenon.	H.	M.	S.
1	I	Tr I	5	42	P.M.	10	*I*	*Tr E*	4	31	P.M.	17	I	Sh E	7	32	P.M.
1	I	Sh I	6	54	,,	10	*III*	*Sh I*	4	40	,,	17	III	Tr E	7	51	,,
1	I	Tr E	8	0	,,	10	I	Sh E	5	36	,,	17	*III*	*Sh I*	8	43	,,
1	*I*	*Sh E*	9	11	,,	10	III	Sh E	7	50	,,	18	*I*	*Ec R*	4	47	40,,
2	I	Ec R	6	29	11,,	14	II	Tr I	5	14	,,	21	*II*	*Tr I*	8	1	,,
5	II	Oc D	7	20	,,	14	II	Sh I	7	26	,,	23	IV	Oc D	6	55	,,
7	*II*	*Sh I*	4	49	,,	14	II	Tr E	8	7	,,	23	II	Ec R	7	3	53,,
7	II	Tr E	5	20	,,	15	*IV*	*Sh I*	8	54	,,	24	I	Tr I	6	14	,,
7	II	Sh E	7	37	,,	16	*II*	*Ec R*	4	25	41,,	24	I	Sh I	7	11	,,
8	I	Tr I	7	42	,,	16	I	Oc D	7	3	,,	24	*I*	*Tr E*	8	33	,,
8	*I*	*Sh I*	8	50	,,	17	*III*	*Tr I*	4	27	,,	25	I	Ec R	6	43	50,,
9	*I*	*Oc D*	5	2	,,	17	*I*	*Sh I*	5	15	,,	28	III	Ec R	5	44	5,,
9	*I*	*Ec R*	8	24	33,,	17	I	Tr E	6	31	,,	30	*II*	*Oc D*	5	12	,,
												31	*I*	*Tr I*	8	16	,,

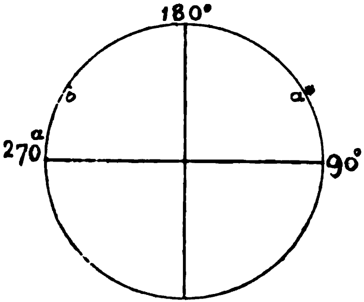
Ec, Eclipse; Oc, Occultation; Tr, Transit of Satellite; Sh, Transit of Shadow; D, Disappearance; R, Reappearance; I, Ingress; E, Egress. The printing of a phenomenon in *italics* indicates that its visibility is rendered doubtful, either by the brightness of the twilight, or by Jupiter's proximity to the horizon.

Approximate Times of the Greatest Eastern Elongations of Saturn's Five Inner Satellites, visible at Greenwich.

Day of Month.	Satellite.	H.	Day of Month.	Satellite.	H.	Day of Month.	Satellite.	H.
4	Enceladus	6·8 a.m.	11	Dione	1·0 a.m.	25	Mimas	3·4 a.m.
6	Mimas	6·8 ,,	11	Enceladus	3·3 ,,	26	Mimas	2·1 ,,
7	Enceladus	12·6 ,,	12	Tethys	11·1 p.m.	26	Tethys	4·2 ,,
7	Mimas	5·4 ,,	15	Enceladus	5·9 a.m.	26	Enceladus	4·9 ,,
8	Mimas	4·1 ,,	17	Enceladus	11·6 p.m.	27	Mimas	12·7 ,,
8	Dione	7·3 ,,	19	Dione	6·0 a.m.	27	Mimas	11·3 p.m.
9	Mimas	2·7 ,,	21	Dione	11·7 p.m.	28	Tethys	1·5 a.m.
9	Tethys	4·5 ,,	22	Enceladus	2·3 a.m.	28	Rhea	10·2 p.m.
10	Mimas	1·4 ,,	23	Mimas	6·1 ,,	28	Enceladus	10·8 ,,
10	Tethys	1·8 ,,	24	Mimas	4·8 ,,	29	Tethys	10·8 ,,
11	Mimas	12·0 ,,	24	Tethys	6·9 ,,	30	Dione	4·8 a.m.

The above table gives the approximate Greenwich Mean Times at which the Five Inner Satellites of Saturn will attain their greatest elongation East of the planet, and is intended to assist the student in their identification. Titan, Saturn's chief satellite, is so large and conspicuous an object as to be visible in the smallest telescope; shining as it does, as a star of the 8th magnitude. Its Eastern elongations on Jany. 4 and 20 will both be visible. Hyperion is only visible in the very largest telescopes, and Mimas cannot be perceived with less than 6½ inches of aperture. Iapetus may be recognised by the considerable distance from the planet to which it travels. It is at its brightest when to the West of Saturn.

with reference to the reappearances. From New Moon to Full Moon disappearances take place at the dark limb and reappearances at the bright one. From Full Moon to New Moon stars disappear at the bright limb and reappear at the dark one. In columns six and seven, by "Angle from N. Point" is meant the arc included between the star when in contact, and the point of intersection of the limb, with a circle passing through the North Pole of the heavens and the centre of the Moon's image; and by "Angle from Vertex," the arc between the star at contact and the point where a circle passing through the zenith and the Moon's centre (or a plumb-line passing through her centre) cuts her limb; in other words the top of the Moon as seen with the naked eye. A figure will illustrate this.



Here N. is the true north point of the Moon's circumference (the bottom as seen in an equatorial with a Huyghenian eyepiece), and the angles are measured right round from 0° to 360°, through East, South, and West, just as in measuring the position-angle of the components of a double star. Hence a star disappearing at *a* would be said to do so at an angle of 120°; and were it to reappear at *b* it would be said to do so at an angle of 240° from the N. Point, and so on. The "Near Approaches" are given, because at stations suitably situated they may become actual occultations. Take, for example, a star that approaches close to the S. by E. part of the Moon's limb as seen from Greenwich; then as viewed from a station far enough to the N. by W., the Moon would, from parallax, appear so depressed in the sky as to cover it.

Mercury

is a morning Star throughout January, and is very badly placed for the observer, to boot. He rises about a quarter past seven on the 1st, and rather less than half an hour sooner at the close of the month. He will attain his greatest elongation west (24° 14′) at 8 p.m. on the 19th. His angular diameter decreases from 9·6″ at the beginning of January to 5·6″ by the end of it.

Day of Month.	Right Ascension.		Declination South.		Souths.		
	h.	m.	°	′	h.	m.	
1	18	10·0	20	19·6	11	27.7	a.m.
6	17	54·2	20	16·4	10	52·3	,,
11	17	55·0	20	49·1	10	33·4	,,
16	18	8·2	21	35·2	10	26·8	,,
21	18	29·1	22	14·7	10	28·0	,,
26	18	54·7	22	35·4	10	33·9	,,
31	19	23·3	22	30·3	10	42·7	,,

The curiously looped path indicated in the above ephemeris lies wholly in Sagittarius, a portion of it being described on the confines of that constellation and Serpens.

Venus

is an evening star, and although her position when the year opens is as bad as that of Mercury, it improves as the month goes on. She is very notably gibbous, and her diameter, which subtends an angle of 11·2″ on the 1st, increases imperceptibly to 12·6″ by the 31st. She is by no means an interesting object in the telescope, though, at present.

Day of Month.	Right Ascension.		Declination South.		Souths.		
	h.	m.	°	′	h.	m.	
1	20	37·1	20	17·6	1	54·4	p.m.
6	21	2·5	18	38·6	2	0·1	,,
11	21	27·4	16	46·6	2	5·2	,,
16	21	51·7	14	43·2	2	9·7	,,
21	22	15·4	12	30·0	2	13·7	,,
26	22	38·6	10	8·8	2	17·3	,,
31	23	1·4	7	41·1	2	20·3	,,

Hence it will be seen that Venus travels over a considerable part of the constellations Capricornus and Aquarius, but through a part of the sky quite destitute of any conspicuous stars.

Jupiter

is still an Evening Star, but is now so rapidly approaching the west that he should be observed the moment that it is sufficiently dark enough for him to be visible. His angular equatorial diameter diminishes from 36·7″ on the 1st to 34·4″ by the 31st—a difference not very perceptible to the ordinary observer.

Day of Month.	Right Ascension.		Declination South.		Souths.		
	h.	m.	°	′	h.	m.	
1	23	1·3	7	32·5	4	18·2	p.m.
6	23	3·9	7	16·0	4	1·7	,,
11	23	7·9	6	49·8	3	45·4	,,
16	23	11·5	6	26·9	3	29·3	,,
21	23	15·1	6	3·1	3	13·3	,,
26	23	18·9	5	38·4	2	57·4	,,
31	23	22·9	5	12·9	2	41·7	,,

The whole of the arc thus indicated lies practically in a very barren region in Aquarius; but on the last night of the month Jupiter will be actually on the boundary separating Aquarius from Pisces.

Saturn,

in so far as his meridian passage is concerned, is a morning star; but as he rises about 11h. 5m. on the first day of the year, and some two hours sooner on the last day in January, we resume our ephemeris of him. The planet now presents a curious and beautiful spectacle in the telescope, with its rings (save in very large and powerful instruments), merely presenting the appearance of a line of light. On January 1st the angular equatorial diameter of the planet is 17·65″; the major axis of his rings measuring 40·62″, and the minor axis only 2·60″. By the 31st the angle subtended by the equatorial diameter is 18·52, and those of the major and minor axes of the rings 42·68″ and 2·54″ respectively. These dimensions will enable the student to draw outlines of the planet to scale.

Day of month.	Right Ascension.		Declination North.		Souths.		
	h.	m.	°	′	h.	m.	
1	12	3·9	2	1·3	5	22·5	a.m.
6	12	4·1	2	1·3	5	3·1	,,
11	12	4·2	2	2·4	4	43·5	,,
16	12	4·1	2	4·6	4	23·8	,,
21	12	3·8	2	7·8	4	3·8	,,
26	12	3·4	2	12·1	3	43·8	,,
31	12	2·8	2	17·2	3	23·5	,,

The pendulum-like path indicated above is described to the north-west of the 3—4th magnitude star η Virginis.

Mars

continues to be, for the purpose of the observer of his physical detail, invisible, a remark equally applicable to Uranus.

Neptune

is visible all night long, and continues in an excellent position for the observer; save, though, in very large telescopes he is not very easily distinguishable from a 7—8th magnitude star.

Day of Month.	Right Ascension.		Declination North.		Souths.	
	h.	m.	°	′	h.	m.
1	4	20·9	19	51·2	9	36·9 p.m.
6	4	20·5	19	50·3	9	16·8 ,,
11	4	20·1	19	49·6	8	56·8 ,,
16	4	19·7	19	48·9	8	36·7 ,,
21	4	19·4	19	48·5	8	16·8 ,,
26	4	19·1	19	48·1	7	56·8 ,,
31	4	18·9	19	47·9	7	36·9 ,,

This short retrograde arc is described a little to the west and north of the 4—3rd magnitude star ε Tauri, the northernmost of the Hyades.

Minima of the Variable Star Algol

will occur on the 2nd at 4h. 44m. a.m.; on the 5th at 1h. 33m. a.m.; on the 7th at 10h. 22m. p.m.; on the 10th at 7h. 11m. p.m.; on the 22nd at 6h. 26m. a.m; on the 25th at 3h. 15h. a.m.; on the 28th at 12h. 4m. a.m.; and on the 30th at 8h. 52m. p.m.; as well as on other occasions when from daylight the phenomenon will be invisible.

Shooting Stars

should be especially watched for on the night of the 2nd, when they seem to radiate from the northern part of Boötes, where that constellation is conterminous with Draco. The 5th, 9th, 17th, 22nd, and 25th are also dates on which showers may be looked for.

Greenwich Mean Time of Southing of Sixteen of the Principal Fixed Stars on the Night of January 1st, 1892.

Star.	Souths. h.	m.	s.
α Andromedæ	5	19	27·67 p.m.
α Cassiopeiæ	5	51	56·54 ,,
Polaris	6	35	35·62 ,,
α Arietis	7	17	25·82 ,,
α Ceti	8	12	50·04 ,,
α Persei	8	32	45·54 ,,
γ¹ Eridani	9	9	2·69 ,,
Aldebaran	9	45	40·54 ,,
Capella	10	24	31·69 ,,
Rigel	10	25	11·77 ,,
α Leporis	10	43	46·00 ,,
α Orionis	11	5	3·82 ,,
Sirius	11	55	59·42 ,,
Castor	*12	43	10·93 a.m.
Procyon	*12	49	6·16 ,,
Pollux	*12	54	8·98 ,,

* Early morning of the 2nd.

Were the stars rigidly and absolutely "fixed," any given one would South 3m. 55·91s. (*i.e.*, 235·91 seconds) sooner every day, as indicated by a clock regulated to show mean time. Now, this is so nearly true for a considerable proportion of them, that, for our present purpose, we may assume it to be accurately so; and to find the Greenwich mean time of transit of either of the stars in the above list for any other night in January, we have only to multiply 235·91s. by the number of days which have elapsed since the 1st—*i.e.*, by the day of the month − 1, and subtract the result from the time given in our table. For example, at what hour will α Orionis south on the night of Jan. 16, 1892? Here we say 16−1=15; and 15×235·91s.=3538·65s., or 58m. 58·65s. If, then, from the time given above, 11h. 5m. 3·82s., we subtract 58m. 58·65s., we obtain 10h. 6m. 5·17s. as the Greenwich mean time of southing of α Orionis on Jan. 16, a result less than 0·01s. in defect. With some stars the discrepancy might have been slightly greater, such discrepancy increasing as we approach the Pole; but Polaris crosses a wire so very slowly that, in practice, and for the purpose of rating an ordinary clock or watch, this may be neglected.

Let us now suppose, further, that we wish to know the Local Mean Time of southing of any of the stars in our table. This we obtain by subtracting 9·8565 seconds for every hour of longitude (and proportional parts for the minutes and seconds) when our station is west of Greenwich, and by the addition of that quantity when it is situated to the east. Thus at what hour will Capella south at Penzance on January 1st? Penzance is 22m. 10s. west of Greenwich; so, as previously explained under the heading of "The Sun," we say as 60m. : 22m. 10s. : : 9·8565 : (what we shall find to be) 3·64143s. Subtracting, then, 3·64s. from 10h. 24m. 31·69s. we obtain 10h. 24m. 28·05s. as the Penzance Mean Time of Transit of Capella on the night of the 1st of January. Had we required the Ipswich Mean Time of southing of that star on the same night (Ipswich being 4m. 40s. to the east of Greenwich) we must have added 0·77s. to our 10h. 24m. 31·69s., and hence obtained 10h. 24m. 32·46s. as the time required.

GEOLOGY FOR STUDENTS.

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Chapter XX.—Silurian System—Cambrian Formation.

NOW that the student has mastered the chief classes of the animal and vegetable kingdoms, he is in a position to begin the study of the various geological systems in which are found animal and vegetable remains.

On reference to Table VIII. on page 170 he will see that the lowest and oldest of these systems is the Silurian. This system will now be studied upon the plan laid down and explained on p. 81 (Table VI.)

A. DERIVATION.—The system is named from the old British tribe, the Silures, that held the country between the rivers Severn and Towy, in Caermarthenshire. A reference to the syllabus given in the first chapter of this work (p. 6) will show the student that by some geologists the system that I prefer to call Silurian is divided into two systems, the Cambrian and Silurian. I am following, however, the results of the most recent researches and conclusions of geological science in including the old system, Cambrian, under the larger and more modern one, Silurian. As a matter of fact, these oldest Palæozoic rocks are really in three very distinct groups; the so-called Cambrian and the lower and upper Silurian. They are sufficiently distinct to be treated of in succession, and the present chapter will be devoted solely to the Cambrian rocks. At the same time, they are not sufficiently distinct, in the opinion of many of our best geologists, to be ranked as three, or even as two, distinct systems. Following this opinion, I shall speak of these three formations as composing one system, the Silurian, although each formation will be treated separately.

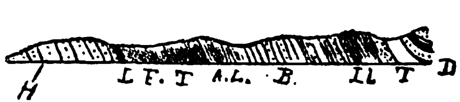


FIG. 99.

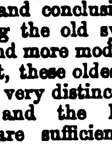


FIG. 100.

Cambrian Formation.

The Cambrian or primordial Silurian will now be considered under the usual heads.

B. WHAT. — (1) *Structure.* — These rocks, reaching in some places a thickness of 25,000ft., are as their name implies, especially developed in Cambria or Wales. They rest unconformably upon the Archæan or Pre-Cambrian rocks. They consist of conglomerates in their lowest strata, grits, slates, and very little limestone. The slates are coloured blue by iron oxide (FeO), or reddish purple by iron sesqui-oxide (Fe_2O_3).

The Cambrian rocks are marked with many sun-cracks and rain-pittings, and are singularly free from any igneous rocks. Unlike the Archæan rocks, they have undergone little or no metamorphosis, and their lines of stratification are, generally speaking, plainly marked and always more distinct than those of the Archæan rocks. In spite of all this, the Cambrian rocks have in the course of the countless ages that have elapsed since their deposition undergone much disturbance, and are often thrown on end, folded, and dislocated. Not only has a quite unimaginable time existed since they were first laid down, but the fact that they lie unconformably on the Archæan also points to the lapse probably of an immense period of time between the formation of these two systems. In Fig. 99 is shown a diagramatic section across a part of England to the west and Wales. It extends from Hirnant, in Montgomery, south-east of Bala, on the east, to Harlech, on the Merioneth coast, to the west. It includes Lower and Upper Silurian rocks as well as Cambrian. H and L F. T are Cambrian; A. L and B are Lower Silurian; Ll, T, D are Upper Silurian.

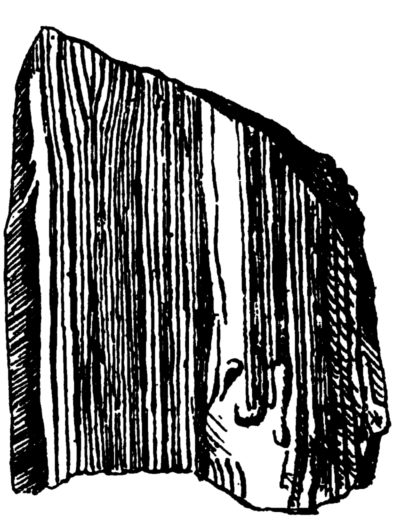


FIG. 101.

(2.) *Composition.* To understand the composition of the Cambrian formation the student should refer to Table XII.

TABLE XII.

Cambrian: Primordial Silurian.

Cambrian	Upper	Tremadoc slates. Lingula flags.
	Lower	Menevian beds. Harlech and Longmynd beds.

Here once again, and for the last time, let me insist upon the absolute necessity of the map. It is quite impossible to understand the geological systems and their divisions unless the student has before him an atlas. If possible, he should have both an ordinary geographical and also a geological map. If he can only command the former, he will experience this difficulty: that many of the names of primal importance in geology are of very secondary importance, and sometimes of no importance at all, in geography. Whoever is in the unfortunate position of not having a geological map should at least try to get access—at some reading-room or other—to such an atlas as Johnston's Royal Atlas, in which even villages and small hills are marked.

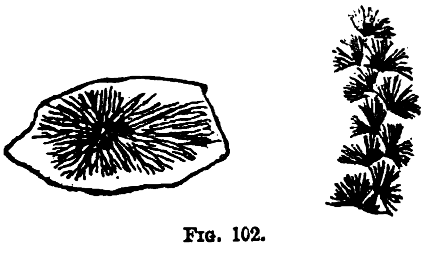


FIG. 102.

Before studying the divisions of the Cambrian formation, a word as to the names of the geological divisions. The large divisions, systems, and their first sub-divisions, formations, have already been explained. Now, just as a system is made up of formations, so is a formation made up of groups—such as the upper and lower Cambrian in the table—and the groups again are made up of beds. The lower group—e.g., of the Cambrian formation of the Silurian system—is divided into two beds, the Harlech and Longmynd, and Menevian.

Working as usual from below upwards, the lowest beds are those met with at Longmynd in England and Harlech in Wales. Longmynd is a range of hills in Shropshire, lying north of Bishop's Castle and south of Shrewsbury. They rise to a height of nearly 1,700ft. Harlech is the well-known coast town of Merioneth in Wales. These beds have a thickness in Shropshire of 25,000ft., in North Wales of 8,000ft., and in South Wales of 4,000ft.

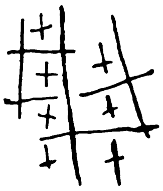


Fig. 103.

The Menevian beds are met with at St. David's in Pembrokeshire, especially. The old name of St. David's was Menevia. The thickness of the beds is about 600ft.

Passing to the Upper Cambrian group, we meet first with the Lingula flags. They take their name, not from a place, as the other beds, but from the vast number of the shells of one of the Brachiopoda that they contain. This Brachiopod shell is represented in Fig. 100. It used to be called Lingula (*lingula*, a shoetongue), but its more modern name is Lingulella (the little Lingula). The Lingula flag beds have a thickness of about 5,000ft.

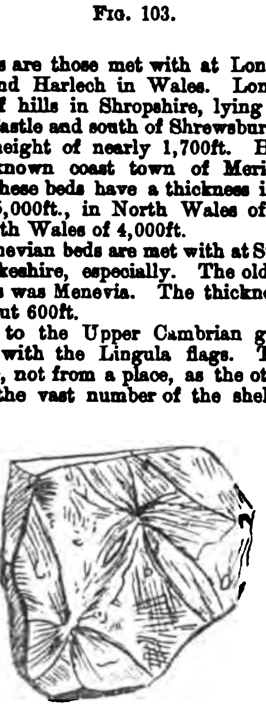


Fig. 104.

Lastly, the Tremadoc beds, about 1,000ft. in thickness, are of dark grey slates, and are met with at Port Madoc, near Tremadoc, in Caernarvonshire, and extend thence to Dolgelly.

C. Where.—1. Europe. *a.* British Isles. (i) England. Almost solely at Longmynd Hill, in Shropshire.

(ii) Wales. As we have just seen, especially at Harlech, St. David's, Tremadoc.

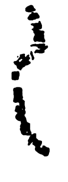


Fig. 105.

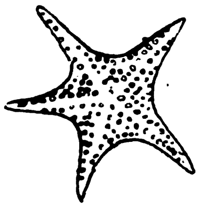


Fig. 106.

(iii.) Scotland. The Cambrian rocks of Scotland appear in the form of the red sandstones of counties Ross and Sunderland, and are especially well seen on the shores of lochs Torridon and Maree, both on the west cost of Ross.

(iv.) Ireland. In Ireland only the Lower Cambrian group appears to be represented. In Wexford and at Howth and possibly in west Galway.

b. The Continent. Always working from south to north, and from west to east, the Cambrian rocks occur in Spain, at Rivadeo in Galicia, and Vega in Asturias, both in the extreme north; in the Thüringer-Wald in Germany, and Bohemia in Austria; in Brittany, especially at Rennes, and in Normandy; in Norway, near Christiania, and in the centre and south of Sweden.

2. Asia. 3. Africa. At present there is no record of Cambrian rocks in these two continents.

4. *a.* North America. The Cambrian rock are very extensively developed in this continent. Appearing most to the east in Newfoundland they go by way of Nova Scotia and New Brunswick into Canada, where they make a large part of the valley of the St. Lawrence. More to the south they extend through the States of Vermont and New York in their northern part to the east of Massachusetts, and then diving under more recent formations they reappear in the Alleghanies, in Wisconsin, Minnesota, Missouri, Arkansas, Texas, and Georgia. Met with in many places in the Valley of the Mississippi, they, after another dive underground, reappear in the Rocky Mountains of the west.

4. *b.* At present there is no record of Cambrian rocks in South America.

D. Palæontology.—Before considering the vegetable and the animal remains met with in this formation, a word or two on its palæontology generally.

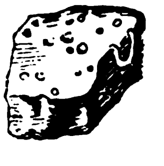


Fig. 107.

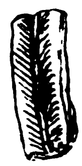


Fig. 108.

To understand that word the student should again refer, as, indeed, he should be constantly referring, to the important Table of Systems on p. 170. He will notice that amongst the Palæozoic or primary rocks, the lowest system is the Silurian, and that there are, besides, amongst these Palæozoic or primary rocks, three other systems, the Devonian, the Carboniferous, and the Permian. Now, the organic remains met with in the Silurian system are of a lower type than those met with in the other three systems. For example, there are a very few remains of backboned animals or Vertebrata in the Silurian rocks. On the other hand, the Devonian, Carboniferous, and Permian systems are very rich in Vertebrata. Hence a division has been made of the Palæozoic systems into (1) the Proterozoic and (2) the Deuterozoic. The Proterozoic are the Silurian. προτερος (proteros), first. The Deuterozoic are the Devonian, Carboniferous, and Permian. δευτερος (deuteros), second.

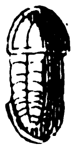


Fig. 109.

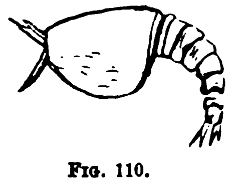


Fig. 110.

The Cambrian formation of the Silurian system is for the most part destitute of fossils. Such fossils as it has only occur generally in the topmost 600ft. of its rocks; but although they are the first appearance in the rocks from below upward of any organic remains, it is very important to notice that they are by no manner of means of a very simple order. The fossil structures met with in these strata are, in a word, much too complex to be the representatives of the first living beings evolved upon the earth's surface. It has already been pointed out that a very large proportion of the earliest forms of plant and animal life are of such delicate and even evanescent structure, that they could never have been preserved in a fossil state. A glance at the table on p. 256 will show the student how many of the classes of the animal kingdom have their names printed in italics—i.e., present no fossil remains. But this is not the only explanation of the comparatively advanced structures met with amongst the fossil remains in the Cambrian rocks. There can be no doubt that enormous numbers of individual fossils and great numbers of species have been destroyed between the Archæan and the Cambrian time. The evidence is practically overwhelming that the origin of life upon the earth was very long before the time when the Cambrian rocks were being formed.

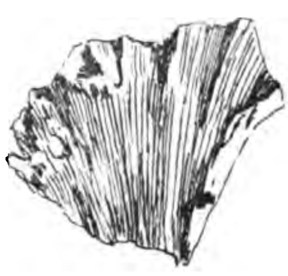


Fig. 111.

Here, then, at the very outset, the student is confronted with the imperfection of the geological record.

(1) *Palæophytology.*—The vegetable remains in the Cambrian rocks are very few. In some of the sandstones of Sweden that belong to this formation there are markings supposed to be due to some early forms of Algæ, possibly allied to the bladder sea-weed so common on our shores.

Also in Sweden has been found a fossil represented in Fig. 101, and called Eophyton. ηως (eos), the dawn; φυτον (phuton), a plant. But there is considerable doubt, almost as great as in the case of Eozoon, as to the real nature of this structure.

In the Cambrian rocks of the south-east of Ireland we meet with what is supposed to be the remains of a fossil plant in the form of Oldhamia (Fig. 102). But here also the nature of the fossil is open to question. Oldhamia is now classed amongst the Algæ. It used to be classed among the Hydrozoa.

(2) *Palæozoology.* The animal remains in the Cambrian formation are much more satisfactory and definite. First of all, there are what are believed to be the earliest traces of sponges in the form of Protospongia, Fig. 103. This organism belongs to the Porifera. It is met with in the lowest beds of the Cambrian series—that is, in the Harlech and Longmynd beds. Then there is, especially in Scandinavia, Dictyonema (Fig. 104 *a*) of the Hydrozoa. δικτυον (diktuon), a net; νημα (nema), a thread.

Of the Echinodermata there are at least three different groups represented. First, the Cistideans, in the person of Protocystites, Fig. 105. πρωτος (protos), first. This fossil is first met with in the Menevian beds. The Starfish group is represented by Palæasterina (the ancient starfish), Fig. 106. The Stone-lily group is represented by Dendrocrinus. δενδρον (dendron), a tree. This is always met with in fragments, so I do not figure it.

These two last fossils appear first in the Tremadoc slates.

Passing on to the Annulosa, two classes have left remains in these rocks. There are certain traces of holes and burrows, made probably by animals allied to our sandworms and lobworms of the sea-shore. These traces—not, let it be understood, the actual remains of the animals—are called Arenicolites. The termination "ites" is frequently used in geology for fossils that are not the actual bodies or skeletons or shells of animals or actual remains of plants, but have been due to these animals or plants in some indirect way. *Arena*, sand; *colo*, I inhabit. In Fig. 107 some arenicolite markings from the Harlech and Longmynd beds are shown, and in Fig. 108 is shown another fossil that is probably due to the action of worms, though it used to be thought to be a vegetable, and was called Cruziana.

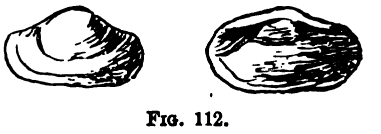


Fig. 112.

The class Crustacea is represented by the first forms of an immensely important group especially developed in the higher Silurian rocks. That is the group of Trilobites, so called because the shield covering their backs is often divided into three lobes. When we are studying the Silurian formation, where these Trilobites are immensely developed, a full account of them will be given. Here it is only necessary to figure one of them, Fig. 109, Microdiscus. *μικρος* (mikros), small; *δισκος* (diskos), a disc. Along with these Trilobites, which appear in the Harlech beds first, there is another Crustacean, somewhat allied to the shrimp of the present day, except that the front part of its body is covered with a kind of membrane, shown in Fig. 110. This fossil is called Hymenocaris. *ʻυμην* (humen), a membrane; *καρις* (karis), a shrimp. Hymenocaris appears first in the Lingula flags.

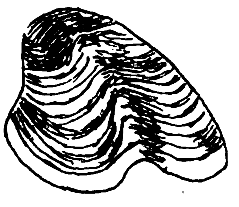


FIG. 113.

Passing to the last sub-kingdoms represented in the Cambrian rocks, we have first Fenestella, one of the Polyzoa, Fig. 111. *Fenestella*, a little window. This appears also first in the Lingula flags.

Next, there is the Lingullela, already figured and mentioned. This Brachiopod, whilst it makes its first appearance in the Harlech beds, is, as we have seen, especially in evidence in the beds that are named after it.

Of the oyster class (Lamellibranchiata), we have the first appearance in the Tremadoc slates in the person of Ctenodonta, Fig. 112. *κτεις* (kteis), a comb; *οδους* (odous), a tooth.

The Gastropoda are represented in the Lingula flags for the first time by Bellerophon, Fig. 113. Bellerophon, son of Glaucus, King of Corinth, was the slayer of the Chimæra.

Finally, the highest invertebrate class—the Cephalopoda—is represented for the first time in the Tremadoc slates by Orthoceras, Fig. 114. Orthoceras is a shell of many chambers, like that of the Nautilus, only instead of being coiled upon itself, like the Nautilus, it is straight. *ορθος* (orthos), straight; *κερας* (keras), a horn.

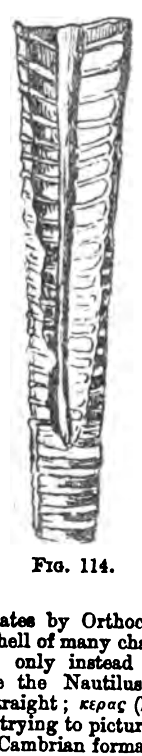


FIG. 114.

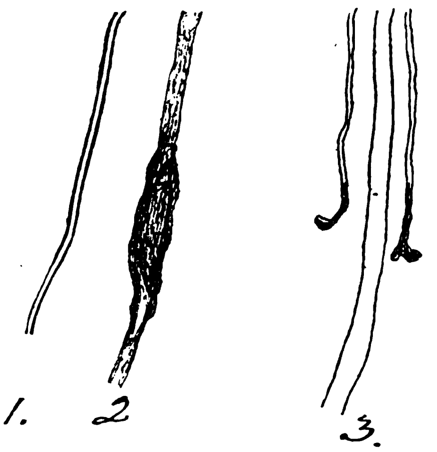
E. HOW.—In trying to picture the conditions under which the Cambrian formation was formed, let us first remember that there was probably an immense period of time between the deposition of these rocks and the deposition of their forerunners—the Archæan rocks. During the earlier part of this time the Archæan rocks underwent vast changes. To begin with, they were lifted out of the water in which they had been formed and became dry land. Then they underwent an enormous amount of wearing down by wind and rain and weather. The water-worn pebbles in the conglomerate at the base of the Cambrian rock tell of beaches of Archæan rocks and waves and tides working upon them. The land, always Archæan, upon which these seas struck was probably north of the sea and in the northern part of the northern hemisphere. The climate, we may take it, was at first very cold, then became milder, and then even moderate in temperature. The seas were shallow, and probably their bed steadily and slowly sank. As the bed sank, it received, age after age, layer upon layer of sediment from the wearing down of the Archæan rocks. Probably the rate of subsidence of the sea-bed and the rate of the sedimentary deposit kept, roughly speaking, equal. Thus were laid down in succession the Harlech, the Menevian, the Lingula, the Tremadoc beds. Only now and again this process of deposit and sinking was broken in upon, and at certain times the rocks already formed at the bottom of the sea were lifted into the air again, were dried and cracked by the sun, and pitted by the falling rain.

F. Economically considered, the chief value of the Cambrian rocks is in the slates that are met with in the Tremadoc beds.

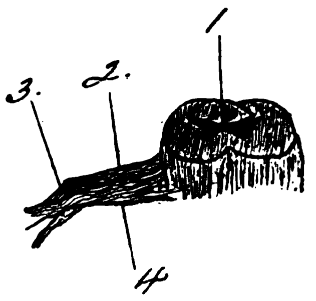
PRACTICAL MICROSCOPY FOR STUDENTS.—XIII.

By FREDERICK DAVIS, B.Sc.

NERVE tissue and the governing power in connection therewith is undoubtedly one of the most complicated of all studies. It is not our province, however, to treat fully of its physiology, but rather of its structure. Nervous tissue is divided into two kinds—nerve fibres and ganglionic corpuscles. Nerve fibres after death rapidly change in appearance, and present two essential parts—the central portion, called the axis cylinder, and an external portion, termed the sheath. This sheath is very delicate and membranous. The axis cylinder is composed of filaments termed primitive fibres. Before these changes occur—that is, if nervous tissue be examined *immediately* after death—the nerve fibres are perfectly transparent, cylindrical, and have an oily appearance. The oily character is assumed to be produced by a fluid existing between the filaments and the sheath; this is called the medulla. After death this oily substance undergoes a kind of coagulation, and deposits solid matter, which causes the fibre to separate from the sheath. It would therefore appear to resemble, to an extent, the coagulation of the myosin in muscle. Many of the large fibres are held together by a kind of connective tissue, known as neurilemma. The variety mentioned is termed "medullated nerve fibre"; but there is another variety, known as non-medullated nerve fibre. This kind may be studied by examining a portion of the olfactory nerves, sympathetic system, or some of the cerebro-spinal system. The student should obtain one of the larger nerves of a frog, and after carefully teasing out in salt solution, examine with, in the first place, the 1in., and afterwards the ¼in. objectives; these nerve fibres vary from 1-2,000th to 1-12,000th of an inch in diameter. Ganglionic corpuscles are, for the most part, stellate or spheroidal bodies, and consist essentially of granular semi-opaque matter; sometimes, however, this matter is perfectly translucent. In the centre we find the nucleus, and in the centre of this nucleus a little dark spot called the nucleolus. Each corpuscle gives off a process generally connected with a nerve fibre, or in communication with other processes given off from surrounding ganglia.



1, Nerve fibre in natural state; 2, Fibre showing the axis cylinder and constricted sheath; 3, The same treated with dilute acid.

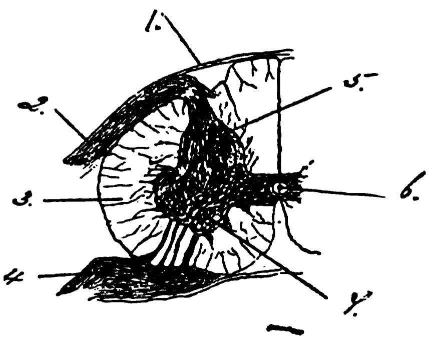


Portion of Spinal Cord showing Origin of Roots of Spinal Nerves.

1, Posterior medulla fissure; 2, Posterior root; 3, Anterior median fissure; 4, Anterior root.

Ganglionic corpuscles are found in all the great nerve-centres, such as the brain, the spinal cord, the sympathetic system, and most of the sensory organs. The student may examine a portion of this tissue by operating upon the ganglia obtained from the spinal cord of the frog. The posterior root of the nerve is the better part to be examined, and the frog should be recently killed. After teasing out in the ordinary manner in salt solution, the 1in. and ¼in. objectives should be employed for its examination. When the student has well marked its characters, and sketched its salient features, let him stain the same with magenta or Beale's solution and carefully examine again. By this means the parts will be better defined, and by mounting in Canada balsam the section may be preserved as a permanent object. It will be observed that bloodvessels and fat-cells are frequently found intermingled with the nerve fibres. It is, therefore necessary to be careful in distinguishing all parts, and not be satisfied until the desired end has been accomplished.

The mention of the posterior root of a spinal nerve to the student of physiology will be met by a knowledge of its position; but to the microscopical student an explanation may be necessary. I will, therefore, briefly describe what is intended. The nerves are divided into two great groups, namely, the "sensory" and the "motor."

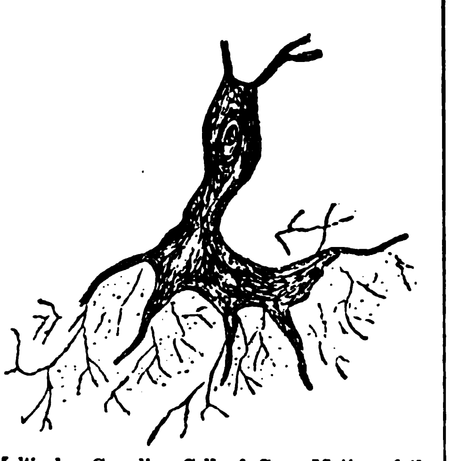


Section of Spinal Cord.

1, Dura mater; 2, Posterior root; 3, Lateral column of white matter; 4, Anterior root; 5, Posterior horn of grey matter; 6, Central canal; 7, Anterior horn of grey matter.

If we take a section of the spinal cord, we shall see it is composed of substances differing in colour; in fact, one portion is white, whilst the other is grey. The grey matter passes into the white substance, and having connection with the nerve fibres, divides this white substance into six columns. Each half of the section will therefore be divided into *three* columns, and these are called respectively the

Ganglionic Corpuscle, showing Nucleus and Nucleolus from Grey Matter of Spinal Cord.



Multipolar Ganglion Cell of Grey Matter of the Spinal Cord.

Transverse Section of the White Matter of the Spinal Cord.

anterior, posterior, and lateral columns. Generally speaking, the posterior root of a nerve is sensory, and consequently afferent, and the anterior root is motor or efferent. Let it be distinctly understood, however, that afferent nerves are *not* always sensory, neither are motor nerves always efferent. The sensory, afferent, or posterior root conveys *to* the brain. As an example, if I cut my finger, the sensory nerve would convey the sensation of pain produced to the brain, and the brain in the form of common-sense would direct that the source of pain should be removed—that is, that the cutting should desist. Such an order would be conveyed *from* the brain by the anterior, efferent, or motor nerve. The brain is the only part which is actually capable of perceiving pain, the sensory and motor nerves acting, as it were, as a kind of telegraphic communication between the various parts of the body to and from the brain by way of the spinal column. It has been definitely proven upon the living subject that if the posterior root of the spinal nerve be severed, the muscle or part served by that nerve becomes insensible to pain—that is, a pin might be thrust into the part without producing the slightest pain; but if, on the other hand, the motor or anterior root be severed, and the posterior root remain intact, the sensibility will be retained, but its power of motion or contractility will be destroyed. The spinal cord is possessed of a certain power of its own, irrespective of the brain. To a degree it is an independent nervous centre. We can prove this from the fact that the grey matter of the spinal cord possesses the power, under certain circumstances, of converting afferent into efferent impulses. In such cases the phenomenon is known as "reflex action." We will revert to reflex action later on. For examining the spinal cord, cut a thin transverse section, after having hardened the tissue by soaking for ten days or longer in a solution of bichromate of potash, prepared in the following manner: Take of chromic acid 1 part, bichromate of potash 2 parts, water 500 parts. At the time of cutting, the substance should have the consistency of cheese, imbed in wax, and cut with a sharp razor kept moist with spirit. The section may then be removed from the razor by floating in a vessel of water, and removing from the vessel by means of a camel-hair brush, and placed in a watch-glass; drain the water from the watch-glass, and pour upon the section sufficient Beale's solution to well cover; permit to remain in this position until the section has absorbed sufficient colouring matter, then remove and wash well with spirit and water—this will remove a portion of the colour, which, if too intense in the first instance, is an advantage; then cover the section with spirits of wine, and, having covered the whole with a second watch-glass, allow it to remain for some hours. Remove the section from the spirits, place upon an ordinary slip, drain away the spirits, and then drop carefully upon it a few drops of absolute alcohol; this will absorb any water from the tissues. Drain away the remaining alcohol and permit to fall by the side of the section two or three drops of spirit of turpentine: this will gradually remove the remaining alcohol and render the object transparent. Hold the slip with the section upon it above the flame of a spirit-lamp for a few seconds—not too near the flame—and then mount in Canada balsam, as previously described. This section is most lovely, and affords a fount of information with great beauty for the microscopist. If examined with the ¼in. objective, the white and grey matter is apparent with the anterior and posterior fissures, the nerve fibres, ganglionic corpuscles, and nuclei.

If the student is not engaged in the post-mortem chamber of any of our hospitals, a portion of the spinal cord of the cat or dog will answer every purpose. Reflex action occurs in the spinal cord only—that is to say, the spinal cord is its centre. To exemplify this, if we take a frog of fair size, and rapidly decapitate it with a razor, cutting from the back of the neck, we shall have separated the brain from the body. The animal will at first appear to be quite dead; but in a few minutes we shall observe its legs will be drawn up close to the body, and the heart still continues to beat. If we now hang the animal up by the remaining portion of its neck, its legs will probably hang down in a flaccid condition; but if we irritate by tickling, or placing a drop of dilute acetic acid upon one of its thighs, the other leg will raise itself, and endeavour to rub away the cause of irritation. This may be repeated several times, and always with the same result; but if we "pith" the frog—that is, insert into the neural canal a wire or small skewer, this reflex action will be destroyed, the heart cease, and the frog become permanently dead. The student must understand I do *not* recommend him to perform this experiment, as although some authorities consider no pain is inflicted, yet I think such experiments are most revolting, and in every case where necessary for purposes of study it becomes incumbent to kill any animal, let it be done in the most merciful manner possible, and with as little pain as can be, remembering we have no right to take life unnecessarily, as we cannot reinstate it, and if for no other reason, a man's character is frequently told by the way he treats the so-called inferior animals. In cases like the foregoing it is sufficient for the student to know the experiments have been performed, and there let him rest contented.

FITTING.—XII.

WITH the miscellaneous examples given in the accompanying figures I shall conclude all I intend to say on the subject of lining-out.

Levers and rods of various types form a large section of lined-out work. There is scarcely a mechanism of any kind without its numerous levers and rods. They are seldom mere flat rods, but are usually bossed up with bosses of various diameters and thicknesses. Such levers are generally lined-out on one face only—that is, directly on one of the boss faces A in Fig. 66. Whether they are lined-out also upon the sides B usually depends on what arrangements exist for machining.

Taking first a lever like Fig. 66, the methods of lining-out will differ according to whether the lever has to be shaped by hand with chisel and file chiefly, or whether it has to be shaped in lathe and shaping machine. In the first case it will have to be lined-out on all four faces; in the latter it need, as a rule, be lined-out only on one. In the first case, chisel and file being used, lines for their guidance must be marked upon each edge, for if marked upon one edge only, constant testing with the square from the surface of the lining-off table, or surface-plate, or lathe-bed would be necessary to insure that the faces shall be at right angles with each other and the thicknesses parallel. But if machined, it is sufficient to line-out on one face only, the automatic shaping machine insuring parallelism of parts.

Suppose I illustrate the maximum amount of lining-out that would be done on the supposition that all shaping has to be done without the aid of a machine, using as an illustration the lever in Fig. 66.

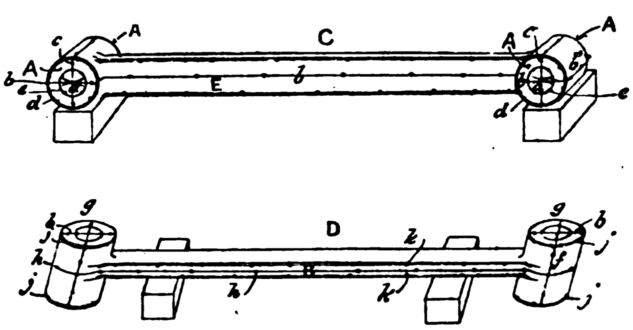


FIG. 66.

The first thing to be done is to block it up upon its side, as in Fig. 66, C. Check the opposite flat faces A A with a square from the table's face, in order to average such deviation from parallelism as may exist on those faces. Roughly indicate the centres of the bosses by means of dividers set just within the edges, thence striking short radii at *a*, the bisection of which will be very approximately the centres of the bosses, through which the horizontal line *b* will be scribed on both faces: either end of the rough forging of the lever being packed up if necessary to bring the centres parallel with the face of the table.

The longitudinal centres *c c* will be next trammelled off directly, and squared up from the table, if the bosses are in the same plane. But when the face of one boss stands out beyond the face of the other, the dimension will be set out upon the table beneath the bosses—starting from one of the lines on the table's face, and squared up from those set-out lines. The boss circles *d*, and the circles *e*, for the drilled holes will then be struck. If, as we suppose, allowance for machining has been left upon the webbed portion

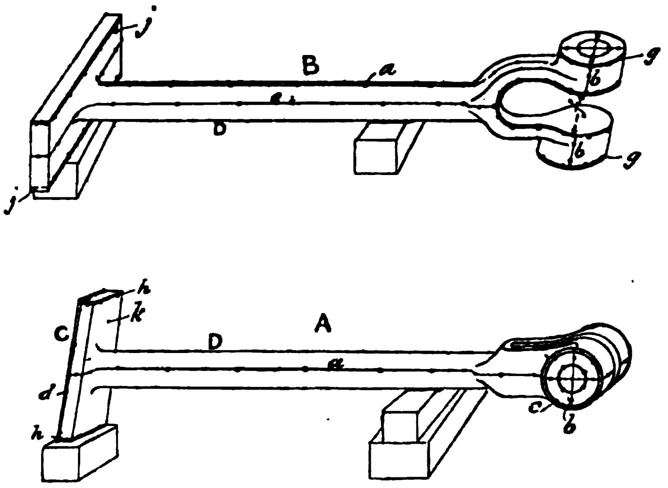


FIG. 67.

E of the lever, then lines will be scribed along that, as shown, equidistant from the centre line b already marked.

We can mark out the opposite face of the forging without removing it from its present position, or we can mark it by giving it a quarter-turn, so bringing it into right angles with the position shown in Fig. 66, C. If we let it remain in its present position, then the centres on the farther face will be marked by carrying lines corresponding with them across the table immediately underneath, and squaring up from them upon the farther face. Without actually marking lines on the table, a square might be carried across, in a position parallel with the centre lines of each boss, provided, of course, that the lever stands parallel with the edge of the table, against which the stock of the square is laid. From the edge of the square so set, measurement will be taken to another square, and a line, c, carried up from that second square over the boss faces. The boss centres will be scribed from the intersection of this line with b.

But if the lever is to be turned quarter-round, which would be advantageous in the case of levers with several bosses, having faces standing at different heights, then the centre line b must be carried round the ends, b^1, and when the lever is turned round, as in Fig. 66, D, it will be reset by means of these end lines b^1 brought into a vertical direction, and tested with a square from the face of the table. It will be set not only thus, but also adjusted for height, until a centre line carried along horizontally with the scribing block, will allow sufficient metal on all faces for finishing to dimensions. Then the vertical lines f, carried up the boss sides, will be the centres of the bosses, at exact right angles with the line b, and these will be united by lines g, drawn across the boss faces. The intersections of these, with the horizontal line b, previously scribed, will give the centres whence the boss circles will be struck.

Of course, the shaping of the bosses and web will obliterate the centre line f last marked, which is only obtained in order to get the square lines for the boss. When the bosses and web are finished, then the lever will be again set, as in Fig. 66, D, the centre line h put on, and the positions of the boss faces j obtained and scribed round, and also the lines k corresponding with the faces of the web. Fig. 66, D shows the lever thus marked out.

In workshops provided with shaping machines the lever would be marked out only upon the face A, and not squared over to the opposite face at all. The bosses would be formed upon a shaping machine by means of the circular-shaping attachment, and the web, if machined at all, would be shaped by a succession of short cuts taken transversely on a shaper. Only, however, in the case of exceptional classes of work is it the practice to shape these webs on a machine. Generally they are simply ground on emery wheels, and polished afterwards on buffs.

The best method of finishing bosses of this kind is by turning them in a special gap lathe, as far as the faces of the web, and then shaping the narrow width corresponding with the thickness of the web in a shaping machine. Or they can be turned in an ordinary lathe by making the cutting-tool revolve and feeding the boss forward on the slide-rest. Or they may be shaped right across through half their circumference, and the rest be done with the file. Or they may be wholly shaped with chisel and file.

After the bosses have been shaped they are bolted with one side against an angle-plate, upon which the bosses are faced, with or without lining-out for the purpose. It is only necessary to have their exact distances from the centre of the web; the angle-plate and the machine insure their standing at right angles with the sides. But if bossed up in the lathe they will be also faced at the same time.

I have described this job at rather more length than its simplicity might seem to merit; but I have taken it as a typical case, equally adapted to work shaped entirely by hand or by machine. But in work of this kind done in a shop well equipped with machines, there is relatively little lining-out done. Levers are commonly marked out only upon the bosses, leaving the webs unlined, these being forged or stamped so accurately that they only need to be ground a little, and merged neatly into the radii dying down from the bosses. Quite commonly, also, they are not blocked up on the lining-off table, but laid down anywhere and marked. The centre line b is scribed through the bosses, and the transverse centres c c marked with compasses or trammels. If the bosses stand at different heights, compasses or trammels having one leg adjustable for height are used.

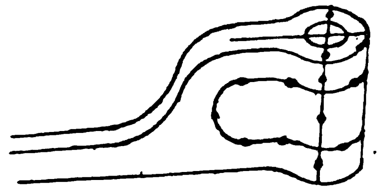


FIG. 68.

The connecting-rod in Fig. 67 cannot be lined out without two settings at right angles with each other. It will first be lined in the position A to get the centre line a, the centre b, and the circle c of the boss and its holes. At the same setting the length over the flat end C will be determined, and the line d marked up from the table. The opposite or farther face of the lever may be similarly marked by means of lines squared across and up from the table, or by turning the rod a quarter round, and setting the horizontal centres in Fig. 67, A, vertical as in Fig. 67, B, according to the method described in connection with Fig. 66. The boss curves c will now be machined, and the end C and edges h may be faced. The rod will then be returned to the table, the centre lines b carried across the shaped ends, and set vertically with the square in the position in Fig. 67 B. The other longitudinal centre line e will then be obtained and carried round, the width of the gap f marked, and also the lines g showing the width over the bosses, and the lines j and j on the flat end c, to which lines those parts will be subsequently machined.

The intersections of the centre lines a and e upon the ends will be the chucking centres for turning the body of the rod. Frequently, however, this portion is turned before any shaping is done, care being taken, by a rough preliminary test, to average the centres of the body or shank with the two ends, so that these will afterwards hold up to size. At the same time that the rod is turned, the end C is also usually faced in the lathe, and the edges h are usually turned to a radii equal to their own distance from the centre. The inner face k is also commonly turned at the same time. This is better than planing the faces d and edges h, as previously mentioned. The chucking centres remaining upon the ends when the work is done in this fashion, are guides to the marker-off for obtaining vertical and horizontal centres on the table.

If the gap is roughly cut out in the forging, the chucking can be done at that end by fitting a shouldered bridge piece across, or by holding that end in a dog-chuck, or on an angle-plate.

If the gap is narrow, the forging is frequently left solid, and slotted out, as is the case in Fig. 68, which shows the forked end of an eccentric rod marked for slotting.

There is a large class of levers, the bosses of which stand out from their webs to such a considerable distance, that they are therefore almost necessarily turned or "bossed up" in the lathe. In cases of this kind, it is customary only to line them out on one face, Fig. 69. Each boss, if there are two or more on a lever, is turned in succession. When any single boss has been turned, it is also faced and bored at the same chucking. The face and the hole are therefore bound to be at right angles with each other. Afterwards each boss is chucked, either by its outside edge, or by its hole, and the face and outside edge on the opposite side of the web are turned. These are, therefore, bound to be parallel, and concentric, respectively, with the portion of the boss upon the opposite side of the web. These portions of the bosses that cannot be turned, namely the portion a, equal to the thickness of the web, are shaped in a shaping-machine.

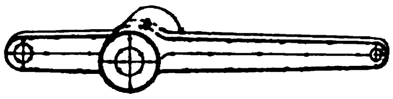


FIG. 69.

In these cases, again, it is not common to mark the webs out They are shaped or ground from boss to boss on flat faces and narrow edges, after the bosses have been finished to size.

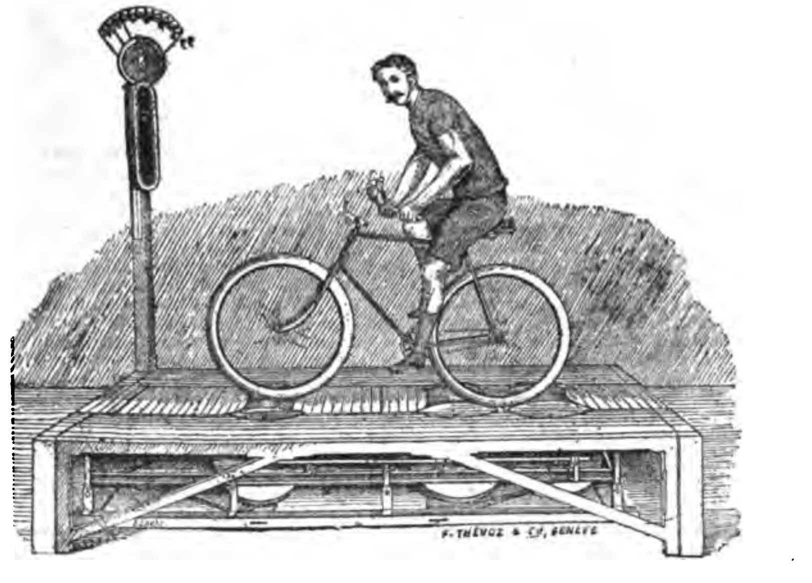
I should like to have selected a much larger number of examples of lined-out work. The subject is interesting and instructive, and the methods that may be adopted very varied. But I think I have said enough to illustrate the main principles by which the marker-out is guided, and with these, where so many other matters have to be considered, my readers and myself must be content.

I say very little about the methods of fixing and machining these examples of lined-out work, because that, of course, has nothing to do with the fitter, being done by quite a distinct class of men. Only in some cases, as in outdoor repair jobs, in very small shops unprovided with suitable machines, and by some amateurs, are faces chipped and filed, and portions shaped by hand-work. Only so far, therefore, as may seem desirable from the standpoint of the amateur and workman, unprovided with mechanism, shall I regard the hand processes involved in the shaping of outlines. Machine work, therefore, will not be noticed in this series, though it may probably form the subject-matter of future articles.

J. H.

GUIGNARD'S "TRAINER" CYCLE.

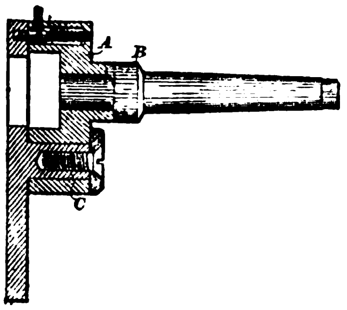
ONE of the novelties at the recent Stanley Show of Cycles at the Crystal Palace was the "Cyclone" Home, or, rather, Club Trainer, devised by M. Guignard, of Lausanne, Switzerland, and patented in many countries by his agent, Mr. Mewburn, of Chancery-lane. The "Cyclone," which is illustrated in the annexed engraving, is described as the "realistic" trainer, and is specially useful to those learning to ride without venturing on the public roads. It will be seen that the driving-wheel (if a "safety") rests on a couple of rollers, while the front runs on one, the apparatus being made telescopic to suit different-sized machines, while

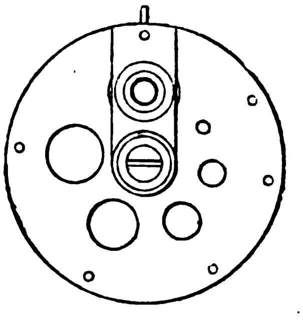


the rollers can, it is said, be so adjusted as to represent loose or muddy roads or hills. The dimensions are about 2ft. 6in. by 7ft. 6in.; there is a distance recorder, and a tachometer indicates variations of speed and registers the maximum.

A USEFUL DRILL PAD.*

NEARLY every machinist has, at times, occasion to execute work in his lathe that ought to be done on a drill press, and if the hole he is drilling goes all the way through, he wants an unoccupied space for his drill to enter after it has gone through the work. If the drill pad, or drill plate, as it is sometimes called, has a hole in it, it is generally of the wrong size—either so small the drill will not enter, or so large that, in drilling near the edge of a small piece, the latter will tip up and cause the hole to be out of square. At least this has been my experience on numerous occasions; and after resorting to various expedients, such as holding a ring between the drill pad and work, or a parallel with a hole in it, or the still more difficult feat of trying to hold up two equal parallels in such a position that the drill would pass between them, I determined to have a drill pad that would cover all ordinary requirements as to size of hole, so I made one like the sketch herewith, modelled after the little diaphragm sometimes seen under microscope stages; that is, a revolving plate with several different sized holes in it, any one of which may be brought in line with the lathe-spindle, according to the requirements of the job in hand. As shown by the sectional view, there is a casting, A, which has a steel stem, B, driven tight in one hole, the other hole receiving the stem C of the revolving plate. Stem C is slightly longer than the hole in which it revolves, so when the washer is screwed up tight against the end of stem, the latter can turn with a slight frictional resistance. I have used a countersunk screw to fasten on this washer, which looks quite as well in this instance, and has not so many internal corners to collect dirt, nor so many external corners to bark knuckles, as the hexagon-headed screw that Mr. Booth would seem to prefer. The index pin with spiral spring around it engages with the small holes drilled in back of plate, to hold any of the assorted sized holes in line with the lathe-spindle. If the hole in plate we are using is larger than the drill, and we are drilling very close to the edge of the work, the plate-hole may be left off centre enough so the drill will just clear the side of it, in which case the index-pin will stand between two of its holes, and will not enter; but the washer has friction enough to hold the plate steady.





Of course it is not necessary that there should be exactly the same amount of stock between the holes in order that this rig should be a success as a drill pad; yet any one who is fond of mathematics will find it a nice little problem to so lay out the holes that the same thickness of material is left between them. The holes in my plate are ⅛in., ¼in., ⅜in., ½in., ⅝in., and ¾in., the centre of each being ¾in. from centre of revolving-plate.

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[*] By Mr. Walter Gribben, in *American Machinist*.

THE SWELL IN THE ORGAN.—IV.*

(Concluded from p. 347.)

SO far as the application of the swell-box is concerned, it is hardly necessary for me to pass any special remarks on the department known as the Swell Organ: but whatever its tonal constitution may be, it is, of course, essential that its swell-box should be quite separate and independent of all the other swell-boxes, and controlled by a special balanced lever.

On the suggestion I have made public elsewhere as to the advisability of dividing the tonal forces of this most important department into two sections or groups, and enclosing each in a separate swell-box, I need say nothing on the present occasion. Such an arrangement would only be possible, or, at least, desirable in a Concert-room organ of the first magnitude. Even in his magnificent Sydney organ scheme, Mr. Roosevelt did not contemplate so radical a departure from ordinary usage: nor indeed, did he contemplate another departure which I shall advocate very shortly.

I now come to the Solo Organ: and here we are confronted with another important department about which difference of opinion obtains in matters of flexibility or control and expression. And when we glance at the largest and finest organs in this country—built by our greatest builder—and find their Solo departments fixed and unexpressive, we may well halt in our opinion that such departments call aloud for powers of control and expression. "Great men have great failings," and I venture to think that the neglect of the Solo Organ, in this important matter of control and expression, is a very great failing, in an artistic sense, in the builder of these large Organs; and one which, to my mind, is as inexcusable as it is extraordinary.

The very name given to the department in question is surely enough to indicate that it should, even above and before all the other departments of the organ, be furnished with the highest possible flexibility and powers of expression.

Imagine, ye Musicians, a *solo* of any description without light and shade, innocent of a *crescendo* or *diminuendo*, full of unyielding *forte* and guiltless of a single *piano*. Can you reconcile such a thing to your musical sense? The organist, satisfied with matters as they are, and with ears vitiated by the crudities of modern English organ-building, may say: "I do not expect the refinements of an orchestral solo from the Solo Organ. What I want is plenty of free sound. Just imagine, he adds, my beautiful Tubas endowed with light and shade — heaven forbid that they should have their glorious stentorian voices afflicted with powers of expression. Powers of expression, forsooth! I want them to enter into *my* music like bellowing bulls and as roaring lions; not like the approach of distant thunder or the swelling of mighty Boreas; and I want them to roar at *all times* and in *all kinds of music* at their *full blast*." On the other hand, the organ-builder may say: "Enclose my Tubas, which I have voiced on twenty-inch wind, so as almost to split your ears, in a swell-box? Never! Expressive powers? Bosh! If you cannot play the Organ as I choose to build it, without such powers of expression to help you, you had better give it up and go into the vocal or orchestral line, where you can revel in expression to your heart's content."

Well, I shall willingly leave both this organist and this organ builder to nurse their own opinions, and take my stand as an advocate for the highest possible powers of expressions in the Solo Organ.

It is usual, and we may say correct, to place in the Solo department stops imitative of the more assertive orchestral instruments, and those powerful mouth and reed stops whose voices pierce through the entire volume of the organ: but is it scientific or even logical to leave such assertive and dominating voices absolutely without any means of control and incapable of expression? Surely not. Cannot we learn the true lesson from the orchestra here, if our own musical and common sense is insufficient to guide us?

It has been stated to me that to enclose such stops as the Tubas would be to destroy all their attack and grandeur. I reply that their entry or attack wants a good deal of destroying; whilst anything that can tone down their so-called "grandeur"—blatant blast would be a better and more expressive term—will be a blessing. But the truth is enclosure in a swell-box only very partially meets these desirable ends. When the box is closed, of course the tone of the Tubas is softened to an extent which renders it agreeable; but when it is fully opened practically the full power is heard; all that the box is capable of doing is to slightly tone down the roughness of the vibrating tongues which is not of great travelling power.

As you are perfectly aware, the Tubas, as inserted in modern organs, can only be very sparingly used, and, in playing, have to be led up to. Now, admitting the value of such imposing voices, I consider this an objectionable narrowing of their value. Were the stops now placed, exposed, in the Solo departments of our large organs, enclosed in properly constructed swell-boxes, their general utility would be immensely increased, and the effect of their entry, by means of a *crescendo*, would be impressive in the extreme, without being irritatingly startling, as it almost invariably is to a musical ear under the existing crude system.

When any of the Solo Organ stops are used in solo passages, the necessity for powers of expression becomes unquestionable. Amongst the stops which, in my opinion, should find a place in the Solo department of a Concert-room organ are the following:—Concert Violin, Concert Violoncello, Concert Flute, Orchestral Trumpet, Cornopean, Orchestral Clarionet, Trombone, Ophicleide, Bass Tuba, Tuba Mirabilis, Harmonic Tromba, and Harmonic Clarion. Can any musician, with a spark of refinement in his soul, offer a single reason why these should be left in the organ in a state beyond all control and entirely unexpressive? If he can, just as a matter of curiosity, I should like to hear it.

Time is flying, and I must hasten to the last department I have to speak of on this occasion—namely, the Pedal Organ.

To those who agree with me that all the manual departments of the organ should be wholly or partly expressive, the proposition that the Pedal Organ should be also partly expressive will not only seem reasonable but truly logical. On the other hand, those of you who are satisfied with the old-fashioned style of organ-building may say that the idea of having an expressive Pedal Organ is simply absurd, and you will fail in seeing that it is at all logical. Of course, your opinions will depend very much on how you look upon the Pedal Organ. Look upon it in the same light as the majority of English organ builders, and as, apparently, the majority of English organists do, and I admit the idea of imparting flexibility and powers of expression to it does border upon a joke. Little, indeed, can be done when the resources of the Pedal department are bounded by a single booming Open Diapason, or a Bourdon and Octave Coupler; but the little that the system I advocate can do will be a substantial gain in every musical sense. No Pedal Organ may be said to so much require help of some sort to rescue it from absolute inefficiency as the fashionable one or two-stop-department—if department it deserves to be called.

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[*] Paper read before the College of Organists by GEORGE ASHDOWN AUDSLEY, F.R.I.B.A.

As regards the logical bearing of the question, just let us do a little thinking and looking around us. I shall take it for granted that you are willing to admit that it is desirable to have full powers of flexibility and expression in the manual departments of the organ; and that you agree with Dr. Turpin's view, that the Organ shines with light borrowed from the Orchestra.

Now, let us glance at the orchestra to see what it can teach us in this Pedal matter. Firstly, let us take a few instruments of the string family—say a string quartet, which, as you know, consists of first violin, second violin, viola, and violoncello or bass—and see if we can learn anything to guide our halting steps. You will all admit that during the performance of a quartet, the parts for the two violins and the viola must be rendered with all the flexibility and expression the music demands; but, of course, you will say that the composer never intended the bass part to have any expression. Taking the organ as our source of inspiration, it is only necessary before starting a quartet by Beethoven or any other composer, to give strict injunctions to the violoncellist to play his part all through at the full strength of his bow, and without the slightest *diminuendo* or expression of any sort. Tell him he must look to the Pedal Organ for a model, and go on in the even tenor of his way regardless of all musical propriety.

Now, take the full orchestra—the sun of the musical system—and see what can be done with it.

The Conductor, before commencing a Symphony, will, of course, address his forces thus:—"All the first and second Violins, Violas, Flutes, Oboes, Clarinets, and all the treble and tenor instruments generally, are to render their respective parts with the greatest refinement, delicacy and expression, paying strict attention to all the *piano* and *pianissimo* passages. But, on the other hand, all the Violoncelloes, Double Basses, Bassoons, Bass Trombone, Tuba, and all the bass instruments generally, are to render their parts uniformly, throughout the Symphony, at the full powers of the instruments, and without the ghost of a *diminuendo* even when all the rest of the instruments are playing *pianissimo*."

Gentlemen and musicians, what would your opinion be of a Beethoven quartet or symphony performed under the conditions I have mentioned, and of the leader and conductor who advocated such a state of affairs? Let me assure you that your opinions in these matters would be precisely what mine *are* respecting the music performed on an organ in which all the powers of flexibility and expression are confined to the manual departments; and respecting the organ builder and the organist who maintain that there is neither use nor necessity for flexibility and powers of expression in the true bass department of the organ.

We have in England some of the finest and most highly cultivated organ players in the world; and we have what may be considered the most advanced school of organ playing extant—a school which embodies all that is good in every other school, and much that is purely its own. Yet, with all this, I unhesitatingly say that our organists have a very faint conception of what the possibilities of the Organ are, and that simply because they are forced to adapt their playing to, and to form their conception from, the imperfect and unscientific instruments our organ-builders furnish.

If Dr. Hans Von Bülow felt tempted, for a moment, to jeopardise his "pianistical career" and to "study the Organ," on hearing Mr. Best's performance on the Glasgow Organ, with its very limited powers of expression; and that mainly on account of its "flexibility and expression," its "most delicate and exquisite *nuances*," and its "*diminuendi* and *crescendi*," what would he have felt and said had he heard the same performer on an Organ, such as I advocate, endowed with powers of flexibility and expression throughout its entire tonal structure and in every department? Such an Organ would indeed be an instrument for the *Virtuoso*—on which he could interpret his deepest and most refined musical thoughts; and on which he could produce the fullest effects of light and shade, vivid contrasts, and all those delicate *nuances* which are now possible in the Orchestra only. But to make the Organ an instrument for the *Virtuoso* and true musician, I am free to admit that more must be done than merely giving it complete flexibility and full powers of expression by means of *swells*. Its entire tonal resources must be classified and re-arranged upon a far more scientific and reasonable plan than that which at present obtains. But on this very important matter, as I have already said, I cannot touch to-night. It would require a paper quite as long as this to do it even scant justice.

I fear I have wearied you with my very lengthy dissertation, but I have only a few more remarks to make.

You must all be aware that the bass sounds of the organ have much the most effect on the ear; and that they are heard distinctly at a much greater distance than either the treble or tenor sounds. These facts alone should be sufficient to convince every logical mind that flexibility and expression are absolutely essential in the bass department of the organ. To my mind they are as essential in the Pedal as they are in the manual departments.

At this point it is right that I should briefly state what has been already done in this direction.

The earliest example, known to me, in which powers of expression are given to any portion of the Pedal, is the organ in the Music Hall, at Boston, U.S.A., built by Walcker and Co., of Ludwigsburg, in 1862. Here one finds six of the Pedal stops enclosed in the Swell Organ box. These stops are the Bourdon, 16ft., Bassoon, 16ft., Flute, 8ft., Viola, 8ft., Flute, 4ft., and Waldflöte, 2ft. Again, in the same builders' organ, erected in 1883, in the Cathedral of Riga, one finds eight Pedal stops enclosed in a swell-box, along with the stops of the Fourth Manual. The Pedal stops are the Violon, 16ft., Bourdon, 16ft., Violon, 8ft., Dolceflöte, 8ft., Viola, 4ft., Flautino, 2ft., Serpent, 16ft., and Bassethorn, 8ft.

Seeing that the Swell was neither first invented in Germany nor for a long period adopted in that country, it is somewhat remarkable that the first important step towards making the Pedal Organ expressive should have been taken by the leading German organ builder.

Coming to England, the earliest example of an expressive Pedal department is met with in the organ in the Carmelite Church, Kensington, in which we find all the Pedal stops enclosed in the swell-chamber, which contains all the Great Organ stops. This interesting organ has also an independent Swell Organ. Again the credit is due to a Continental builder. The instrument was constructed about twenty-five years ago by M. Cavaillé-Coll, of Paris. From that time until 1862 nothing was done in the direction now under consideration. In this year my friend, Mr. Thomas Casson, inserted three Pedal stops in the swell-box of the organ he had constructed for the Church of St. Mary, at Denbigh. These are the Bourdon, Quint, and Trombone. I heard Mr. Best open this organ, and can vouch for the admirable use he made of the expressive stops. The organ now in course of construction by the Casson Patent Organ Co., for J. Martin White, Esq., of Dundee, will show the most decided progress yet made in this country towards placing the Pedal Organ on its proper footing as an expressive department. The entire Pedal resources embrace six stops, of which two are unexpressive, and four expressive and enclosed in the two swell-boxes. The Violone, 16ft., is in the Swell Organ box, and the Bourdon, 16ft., Violoncello, 8ft., and the Trombone, 16ft., are in the Great Organ swell-box.

In conclusion, I may say that I advocate a much more decided treatment than any furnished by the executed examples just given. In my opinion, either the whole or a considerable portion of the Pedal Organ should be enclosed in an independent swell-chamber, and so made independently flexible and expressive. For the convenience of the performer, a mechanical arrangement should be provided, by means of which he may, at will, connect the pedal swell shutters to any one of the balanced expression levers belonging to the manual departments. With an expressive Pedal Organ, the performer can, for the first time, furnish a suitable bass for his expressive manual organs; and perform melodic passages in a truly musicianly manner. Further, his perfect control over the strength of tone of the Pedal forces, allows him to graduate his bass at all times to suit his manual tones. Can any musician question the advantages I have enumerated? If he can bring one unprejudiced and logical argument against what I have advanced, I shall give it my earnest and unbiassed consideration.

A NATURAL HARD RUBBER.

A GREAT deal has been said about various deposits of elaterite, commonly called mineral hard rubber, that are found both in this country and in Europe. It is, perhaps, not generally known that the best substitute for hard rubber in many cases is not a mineral imitation, but an animal substitute, which is every day growing scarcer, while the price is appreciating so constantly that before long vegetable hard rubber will supersede it. This animal substance is known as baleen, or more commonly whalebone, and is taken from the right whale, which lives in the Arctic Ocean. The bone of commerce comes from a sieve-like arrangement which this animal has for helping to gather its food. It is hung suspended from the upper jaw, and the pieces of bone are in length from 6in. to 10ft. and 12ft., and from 3in. to 15in. in width. As it grows down from the upper jaw it is exceedingly flexible, and can be moved in almost any direction at will. The food of the right whale is an oily substance of dark red hue, which often covers square miles of the ocean. This the creature absorbs in vast quantities, and while holding hundreds of barrels in its mouth expels the water through the whalebone sieve, retaining the oil and swallowing it. After the whalebone has been secured, which is not always an easy matter, it is cut into strips, steamed, straightened, squared, and tapered, particular care being taken if for use in whips. The bone when finished is worth about 10dol. per barrel, and one large whale will contain about 30,000dol. worth of bone. Owing to the increasing scarcity of this bone, manufacturers have been looking for a substitute for it for years, the nearest approach to it being semi-hard rubber. Another substitute that is spoken very favourably of is solid rawhide; but it has faults that have prevented its general introduction. Goodyear spent a deal of time on the production of what he called artificial whalebone, and achieved good results. While the genuine whalebone is to be had, however, it will probably be considered superior to any imitation, however good.—*Indiarubber World.*

PAQUELIN'S BENZINE BLOWPIPE.

TO the Paris Academy of Sciences Dr. Paquelin has recently presented two communications on the subject of some new apparatus. Let us begin with the new mineral oil blowpipe, Fig. 1. This apparatus consists of two rubber bulbs forming a double bellows operated either by the foot or hand, of a metallic receptacle forming a carburetter, and of a blowpipe properly so-called. The air expelled from the bellows traverses the carburetter and becomes charged therein, in passing through a plunge tube, with benzoline, the fuel of the Mille lamp. This product weighs from 700 to 710 grammes per litre. M. Paquelin employs also as a saturator an atomiser of the Giffard system, by means of which the air expelled by the bulbs, after atomising the liquid combustible, becomes impregnated with its vapours. The carburetter is characterised by its measuring and mixing cock, the plug and shell of which present a special structure. In fact, the plug, whose travel is a half-circumference, is provided on the surface with a channel inclined upon its axis. The seat is so channelled that a portion of the air from the bellows goes directly to the carburetter and another part directly to the blowpipe, becoming mixed in so doing with the hydrocarbureted air that issues from the carburetter. This point is indicated by the aspect of the flame of the blowpipe. This flame, in the first place either strongly tinged with white and fuliginous or else insufficiently supplied with hydrocarburet vapour, becomes purified to a greater and greater degree, until it assumes a very pure violet blue colour of extreme clearness. It is then at its maximum of calorific intensity, and its colour has the brilliancy and softness of a water body-colour painting. The combustible is thus utilised with its maximum of effect.

The blowpipe is formed of a single tube, like the jeweller's blowpipe. Its originality resides in the arrangement of its burner, which emits two kinds of flame—a central flame with a very finely tapering point, and two small lateral flames in the form of petals or crown, according to the direction of their channels, these latter serving to light the first and keep up its activity.

The melting of platinum may be begun with the flame obtained. Upon placing a cock of ordinary structure between the bellows and the measuring cock, the height of the blowpipe flame may be graduated at will. We can also graduate the diametrical dimensions of it. To this effect, it suffices to modify the ratios between the section of the orifices of the burner and that of the lateral orifices. We thus obtain a series of flames which measure from one millimètre at the base to three or four millimètres or more.

This blowpipe will find an application in workshops and laboratories. Pyrogravure artists also will be able to make use of it for stumping their wood. Fig. 2 represents a new model of M. Paquelin's well-known thermo-cauter. The carburetter is of metal, as in the preceding model, but of octagonal section, and may be adapted, through a large hook, to a girdle between the girdle and clothing. Owing to this it is possible to transmit to the combustive liquid a constant temperature. The rings of the hook serve as pincers for dividing the cauter in case of griping. Here there is no plunge tube. The mineral oil is contained in sponges, and there is thus no upsetting of the liquid. The charge of the carburetter suffices to supply the cauter for ten hours at the least. The products of combustion are expelled beyond the hand of the operator.

In the use of the large cauters one of these products—steam—which is formed at a temperature of about 1,800°, is used for refrigerating the starting point and the channels that form a continuation of it. The handle is swept internally from one end to

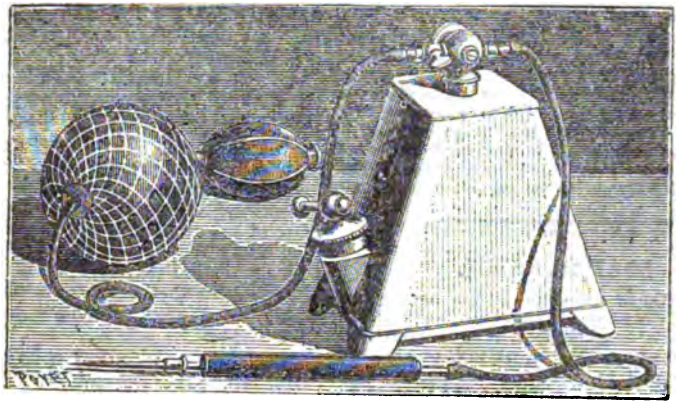

FIG. 1.—Paquelin's Benzine Blowpipe.

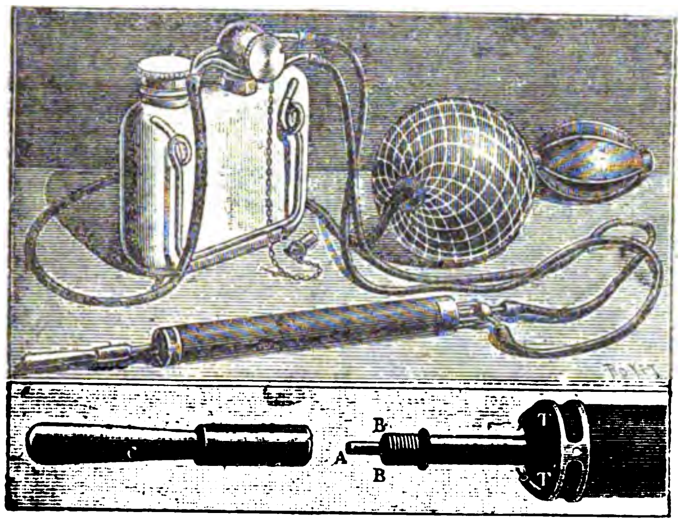

FIG. 2.—New Model of the Paquelin Thermo-cauter.

C, Details of the point of the thermo-cauter; A, tube to carry carburetted air; B B, tube for the return of products of combustion; T T, condensation canals.

the other by a jet of air coming directly from the bellows, and which is divided at the lower part so as to form around the cauter holder three zones of isolating air.

These different conditions permit of reducing the handle of the instrument to such dimensions that it may be used as a crayon, and that the hand may be in close proximity to the operating field. It measures but 12 millimètres in diameter. The older cauters widened out from the point to the base, but M. Paquelin has reversed that arrangement, for the new cauters widen out from the base to the point, the penetrating part only preserving its former dimensions. The instrument thus, with a great saving in platinum, possesses all its old advantages, and by this fact becomes a sort of *passe-partout* cauter.

The large cauters differ from the others in dimensions only in the diameter of the part formed of platinum. Both the large and small cauters are mounted upon a piece which is less than six millimètres in diameter, and all screwed to the same handle. The manufacturer has reduced the variety of the forms of the cauter to two main types, the handle and the point, and, taking into account the thermo-cauter of 1876, has arranged his new carburetter in such a way that the old cauters may be utilised. The alcohol lamp of the first thermo-cauter is done away with. Use is made of but one kind of combustible—mineral oil. The cauter is lighted by any flame whatever, or by means of the blowpipe described above, which serves also to clean it in case of need.

The applications of the Paquelin thermo-cauter are various, by reason of the forms and dimensions of the cauter. It answers the requirements of all kinds of surgery.—*La Nature.*

LESSONS IN THE DIFFERENTIAL CALCULUS.—V.

By RICHARD A. PROCTOR, B.A., F.R.A.S,

Author of "Other Worlds than Ours," "Sunviews of the Earth," &c., &c.

OBSERVE, again, that we can vary our method of attacking these problems by varying the relation whose change is to give our maximum. For instance, suppose we attacked the above problem in this wise:—

Let the angle L B A, Fig. 2, be called x. Then we know that $BL = BA \sec. x$. And the illumination at B may be represented by

$$\frac{m}{BA^2 \sec.^2 x} \cdot \sin. x$$

Putting this equal to y, we have,

$$y = m \cos.^2 x \sin. x.$$

Hence,

$$\frac{dy}{dx} = m\left[-2 \cos. x \sin.^2 x + \cos.^2 x \cos. x\right].$$

[I leave the reader to see how this is obtained by applying the rules given in a preceding paper, noting that a very moderate degree of practice will enable him to write down such a result at once.]

Equating this expression to zero, we have

$$\cos.^2 x \cos. x = 2 \cos. x \sin.^2 x.$$

Hence, $$\frac{\sin.^2 x}{\cos.^2 x} = \frac{1}{2}$$

or, $$\tan. x = \frac{1}{\sqrt{2}}$$

i.e., $$\frac{AL}{BA} = \frac{1}{\sqrt{2}}$$

Hence, $$AL = \frac{BA}{\sqrt{2}} = \frac{1}{\sqrt{2}} \text{ as before.}$$

Neither method has the advantage in this instance, but often a good deal depends on a proper choice of the method to be followed. For example, suppose B is a point on a desk (Fig. 3) sloped at an angle a to the horizon, and that we require the height A L, which will give the maximum illumination in this case. Then the first method would be very inconvenient; but on applying the second, the value of y is little altered. We only have to put, instead of the factor $\sin. x$, (i.e., sin. L B A) the value $\sin. (x - a)$ [i.e., sin. L B M], giving,

$$y = m \cos.^2 x \sin. (x - a).$$

And this is differentiated quite as easily as the other expression, giving,

$$\frac{1}{m} \cdot \frac{dy}{dx} = -2 \cos. x \sin. x \sin. (x - a) + \cos.^2 x \cos. (x - a).$$

Equating this to zero, we have,

$$2 \cos. x \sin. x \sin. (x - a) = \cos.^2 x \cos. (x - a)$$

or,

$$2 \sin. x \sin. (x - a) = \cos. x \cos. (x - a) \quad \text{(iii.)}$$

Here we want only a moderate familiarity with trigonometrical processes to get out our result, for equation (iii.) is the same as

$$2 \cos. a - 2 \cos. (2x - a) = \cos. a + \cos. (2x - a),$$

that is, $$3 \cos. (2x + a) = \cos. a,$$

or, $$\cos. (2x + a) = \frac{\cos. a}{3}$$

This is sufficient for finding x, because a is supposed to be known. Suppose, for example, a is equal to eight degrees, *the slope of my desk*, for I have taken the notion of *working out this particular problem with the practical design of determining how high I should set the moderator which illuminates the paper I am writing upon;* we have then,

$$\begin{aligned} \cos. (2x + 8^\circ &= \tfrac{1}{3} \cos. 8^\circ \\ &= \tfrac{1}{3}(\cdot 99027) \left\{ \begin{array}{l} \text{from a table of} \\ \text{natural cosines} \end{array} \right. \\ &= \cdot 33009 \\ &= \cos. (70^\circ\, 43') \text{ nearly enough} \end{aligned}$$

$$\begin{aligned} \therefore 2x + 8^\circ &= 70^\circ\, 44' \\ 2x &= 78^\circ\, 44' \\ x &= 39^\circ\, 22'. \end{aligned}$$

And A L, Fig. 3, is equal to $BA \tan. x$. Now, in the case of my desk and moderator, B A is equal to 18in., and B, the part of the desk where I actually write (shifting the paper to this point as I write on line by line) is about 4in. above the level of table, so that the height of the light should be

$$(4 + 18 \tan. 39^\circ\, 22')\text{in.}$$

I take out the log. tan. of 39° 22′, which is $\bar{1}\cdot 91404$, and add to it the logarithm of 18, which is 1·25527, getting 1·16931, which is the logarithm of 14·768. Adding 4 to this, I find that the best height for the light of the moderator (above surface of table) is as nearly as possible 18¾in.[*]

The reader has seen enough of the application of the differential calculus to problems of maxima and minima to feel satisfied of the value of the method. It remains that I should consider one other class of problems to which the calculus may be conveniently applied.

A differential coefficient is in reality a fraction of the form $\frac{0}{0}$, or what is termed a vanishing fraction, and, like many other vanishing fractions, it has a real value. Now it is often necessary to find the value of vanishing fractions, and though ordinary algebra may often be successfully applied for this purpose, it is not always possible, and often, though possible, it is exceedingly difficult to evaluate a vanishing fraction in this way. The differential calculus enables us to treat such fractions very simply.

Let us take such a vanishing fraction, and consider what is really required for its evaluation.

Take the fraction $\frac{(x^2 - a^2)}{x^3 - a^3}$ the numerator and denominator of which both vanish when x is equal to a. Now we can at once find the value of this fraction by striking out the common factor $x - a$, and so changing it into the form

$$\frac{(x + a)}{x^2 + ax + a^2}.$$

the value of which is $\frac{2}{3a}$ when $x = a$. Even to this simple application of algebra there is an objection; since striking out a factor equal to 0 is a questionable process. The result, however, is correct enough.

But the only legitimate way of treating such a fraction would be to inquire what its value is when x is taken very nearly equal to a, as $a + h$, and so trying to find out what value the fraction approaches to when x is exactly equal to a. Let us do this. Our fraction becomes

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[*] The reader well up in his "Gulliver" may be reminded here of the tailors of Laputa, who applied mathematical methods in taking their customer's measure, and were led sometimes by errors in calculation to make ill-fitting garments. An error in the working of the above problem might easily (for instance) have given 1·87in., or 187in., instead of 18¾in.; and the care necessary to secure a true result might well seem greater than the problem, practically viewed, is worth. I have, indeed, merely taken the problem as a convenient illustration of the fact that the differential calculus may often be applied conveniently to practical matters, without desiring to insist on the special value of the result obtained in this particular instance; though, be it noted, that as the light of my lamp stood but 16½in. high, I have set the lamp 2¼in. higher since I worked out the above result.

$$\frac{(a+h)^2 - a^2}{(a+h)^3 - a^3}$$

$$= \frac{2ah + h^2}{3a^2h + 3ah^2 + h^3} = \frac{2a + h}{3a^2 + 3ah + h^2}$$

Here we can see at once that by making h small enough we can get our fraction as near as we please to $\frac{2a}{3a^2}$ $\left(\text{i.e., to } \frac{2}{3a}\right)$ in value; and we therefore conclude that $\frac{2}{3a}$ is the value when h is 0, or x equal to a. But a little consideration will show the reader that the process corresponds exactly to that for obtaining the differential coefficient both of the numerator and denominator. Hence he will be prepared to find that when we have a fraction of the form $\frac{u}{y}$, where both the expressions u and y involve x, and both vanish for a certain value of x, the fraction may be evaluated by simply writing for u its differential coefficient $\frac{du}{dx}$, and for y its differential cofficient $\frac{dy}{dx}$.

Take, for instance, the expression

$$\frac{x - 1}{x^6 - 1}$$

which assumes the form $\frac{0}{0}$ when x equal 1. Following the rule, we we write for a new numerator the differential coefficient of $x - 1$, i.e. 1, and for a new denominator the differential coefficient of $x^6 - 1$, i.e. $6x^5$. Our fraction thus becomes

$$\frac{1}{6x^5}$$

which has the value $\frac{1}{6}$ when $x = 1$.

But it may happen that the new fraction thus formed is itself a vanishing fraction. In this case we must repeat the process until we obtain a fraction which is not indeterminate in form. Thus, suppose we have the fraction

$$\frac{(x-1)^3}{x^6 - x^3}$$

which is of the form $\frac{0}{0}$ when $x = 1$. We apply the rule, getting

$$\frac{3(x-1)^2}{6x^5 - 3x^2}$$

which is still of the form $\frac{0}{0}$. Again, applying the rule, we get

$$\frac{3.2.(x-1)}{6.5.x^4 - 3.2.x}$$

which is still of the form $\frac{0}{0}$. Lastly, applying the rule yet once more, we get

$$\frac{3.2.1}{6.5.4x^3 - 3.2.1}$$

And when $x = 1$, this fraction has the value

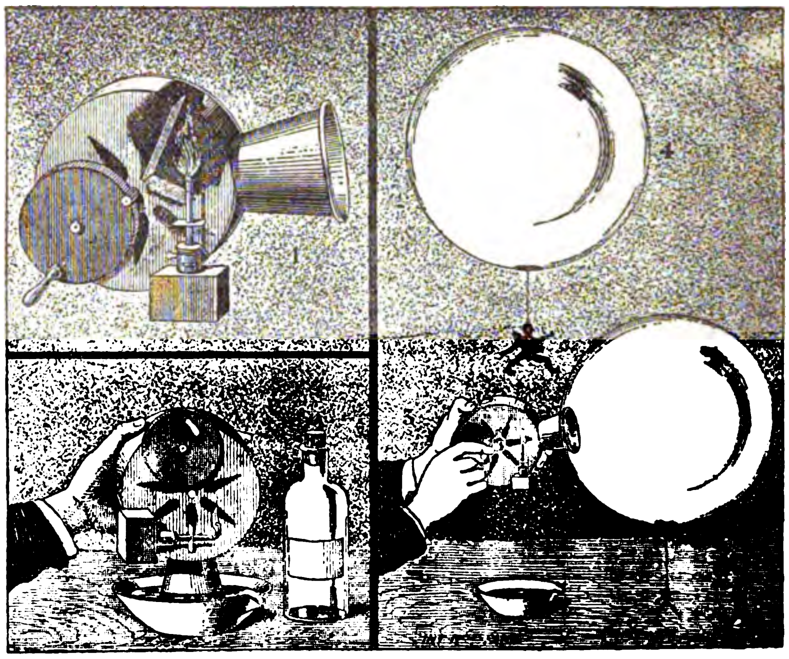
$$\frac{6}{120 - 6} = \frac{1}{19}.$$

Other vanishing fractions may be similarly treated; and this application of the differential calculus thus becomes of great utility.

Before concluding, let me point out that my object will have been misunderstood if the reader supposes that I have intended to give a complete account of even the elementary parts of the differential calculus. On the contrary, I have desired to invite the reader to the study of the calculus by taking him along a shorter road than usual to its useful application. It has been my hope that many may thus be led to a closer examination of the subject. But I would point out that without any further study of the calculus the matter contained in these lessons will enable those who had not before touched the subject to deal with a large class of problems which had been wholly inaccessible to them. They can now differentiate any expression they please, and so can obtain equations for solving a large number of problems of maxima and minima—many of these problens being of great practical utility. The power of evaluating vanishing fractions is also of great importance. But I wish the reader to regard these results as first-fruits, showing something of the power of the calculus, but in truth merely introducing the student to a subject whose real range is far wider. I cannot hope, let me add in conclusion, that these lessons have been such as actual beginners in mathematics can master. It would be vain for those who have not yet learned how to apply algebra in a practical way to expect to see the value and significance of a more advanced method. Nor is it to be expected that every reader of a journal which has so enormous a circulation as the ENGLISH MECHANIC should find every article in its pages within his reach. Precisely as the more advanced must be content to see in each weekly issue many articles which are altogether useless to them, because dealing with the elements of subjects they have long since mastered, so the less advanced reader should not be unwilling to see a moderate proportion of our space occupied by articles he is unable as yet to master. Such articles he may at some future time re-examine, to find, perhaps, that they no longer present any difficulty to him.

SOAP-BUBBLES.

THE blowing of soap-bubbles has always been one of the favourite amusements of children, and so a host of combinations have been devised to permit of obtaining double, oblong, or concentric bubbles, as well as bubbles containing a bird, a statuette, &c. Up to the present, the blowing has always been done by the mouth, thus causing a certain fatigue, especially when it is desired to obtain bubbles of a large diameter. The small apparatus illustrated herewith does away with this inconvenience, and permits of blowing bubbles 12in. or 15in. in diameter without the least effort. It consists of a small nickel-plated zinc blower set in motion by the action upon each other of two discs, the larger one of which is actuated by a winch. In one side of the apparatus there are apertures, through which the air enters the blower after having first been heated by an alcohol lamp. The hot air makes its exit through a conical mouthpiece that has been dipped into suds. On turning the winch with a continuous and not too rapid motion, there is seen to form at the extremity of the mouth-piece a bubble, whose diameter rapidly increases, and with which it is possible to obtain the most charming effects.



At first, as the bubble is filled with hot air, it will, contrary to what usually happens with soap-bubbles, have a tendency to ascend, like a true hot-air balloon. If it is desired to form bubbles heavier than the air, it will suffice to remove the lamp.

The ascensional force of this hot-air balloon is sufficient, when the bubble is somewhat strong, to lift a small figure attached by a thread to a rubber disc. It suffices to first wet the latter with the soapwater, and place it upon a support of the form shown in the engraving to the right. After the bubble is formed it is brought into contact with the disc, which attaches itself to it. Upon then inclining the apparatus so as to detach the bubble, the latter will rise and carry its burden to the ceiling, against which it will burst. In the open air, the weight of the figure will not allow the bubble to rise to a height of more than 15ft. or 20ft., but the bubble itself is capable of rising easily to a height of 90ft.

With this apparatus it is also possible easily to obtain double bubbles. For this, it suffices to fix a wire across the mouthpiece according to the vertical diameter. After blowing, as we have said, the apparatus is given a slight motion sideways, and the two bubbles, one superposed on the other, will be detached.—*Les Inventions Nouvelles.*

SCIENTIFIC NEWS.

THE position of Wolf's comet on Jan. 10, Berlin midnight, will be R.A. 4h. 16m. 22s., S. Dec. 13° 9·8′, the brightness being less than 3 as compared with unity at time of rediscovery.

"Faces in the Sky," by A. C. Ranyard, and "The Great Nebulous Areas of the Sky," by E. E. Barnard, are two articles in this month's *Knowledge* which will interest observers. The face of a man seen in the Sagittarius region of the Milky Way is curious. We learn from the same periodical that Dr. Max Wolf has succeeded in taking another most successful photograph of the Milky Way, this time in the region about Zeta Cephei.

The death is announced of Mr. T. H. Weist-Hill, principal of the Guildhall School of Music, a post he had held since 1880.

"The Ginger-beer Plant and the Organisms Composing it: a Contribution to the Study of Fermentation-yeasts and Bacteria" is the title of an important paper by Dr. H. Marshall Ward, F.R.S., recently read before the Royal Society. He finds the so-called ginger-beer plant to consist essentially of a symbiotic association of a specific Saccharomycete and a Schizomycete; but as met with in the ordinary way it invariably has other species of yeasts, bacteria, and mould-fungi associated with them. The papers should be of practical interest to brewers, vinegar-makers, and all connected with arts into which fermentation enters.

It appears that the properties popularly attributed to lettuce (its soporific effects were known to the Greeks) are due to hyoscyamine. Mr. T. S. Dymond, in a paper read before the Chemical Society, explained that the mydriatic (dilatation of the pupil of the eye) action of an extract of lettuce was suspected of being due to an alkaloid, and after treating in the usual way with chloroform, he obtained crystals in the form of silky needles, having the same melting-point and other properties as hyoscyamine, the mydriatic alkaloid known to exist in belladonna, henbane, and other plants belonging to the Solanaceæ. The lettuce (Lactuca), however, belongs to the Compositæ, and probably Mr. Dymond is the first to discover hyoscyamine or any other alkaloid of the mydriatic group in a plant not belonging to the Solanaceæ.

The use of mineral naphtha to render the low-priced alcohols undrinkable is creating some "feeling" in many quarters, and the *Chemical News* evidently thinks that photographers are much interested. Our contemporary says that the hope that alcohol dosed with mineral naphtha will not be drunk is fallacious. Mr. Crookes has known of hands at chemical works—seasoned topers—who would even toss off a "tot" or *petit* were of the coal naphtha itself. If the heads of the Revenue really wished to make the spirit undrinkable, they should have prescribed the addition of Dippel's animal oil. A mere trace of this liquid, without interfering with the legitimate uses of the spirit, renders it so loathsome to smell and taste that no one would dream of drinking it. It is no untried experiment—it is one of the legalised additions used in Germany for "denaturising" alcohol. Dippet's animal oil is a bone oil; but it is not impossible that some topers would get accustomed to that, judging by what they consume now.

Dr. Cunningham, of Dublin, publishes in the Memoirs of the Royal Irish Academy a paper in which he concludes that nearly all the giants of whom any records have been kept came into the category of "megalacriacs." This stature is the result of a morbid growth, which may affect only the hands and feet and under jaw, and may include the entire body, soft parts as well as bones. Magrath, the Irish giant, was a victim of this hypertrophy, though Dr. Cunningham declares that instead of his being 8ft. 4in. in height, a study of his skeleton in Trinity College shows that he was in all likelihood not more than 7ft. 2½in. or 3in. high, though there are records of people who have shot up to 8ft. 4½in.

The Alvarenga prize of the Paris Academy of Medicine was awarded to Dr. Batemen, of Norwich, for his rather elaborate work on Aphasia, and to Dr. Leguen, of Paris, for his treatise on Renal Calculi. The award carries the title of Laureate of the Academy.

The *Athenæum* says that one of the greatest improvements ever made in the Science Department of the South Kensington Museum is that lately introduced—the use of air, compressed by help of a small gas-engine in a shed adjoining the gallery formerly occupied by the national portraits, to drive a number of the models, some of them of great beauty and value, which illustrate the development of the steam-engine and the application of power to various manufactures. Some of these models are wonders in their way, and they are all instructive.

It is stated that the electric current derived primarily from the water-power at Niagara will probably be available in Buffalo and Rochester, New York State, in 1892. It is well known that the "energy" running to waste at the Falls is immense; but the difficulty has been to "chain" it, so to speak, and utilise it.

An international competition for a prize of £80 is announced by the Milan *L'Elettricita* for a practical, simple, and commercial battery, the decision to rest with a jury of "competent and estimable" men, who will presumably not necessarily be all electricians. The competition is to remain open from to-day (Jan. 1, 1892) until the end of next August, and it certainly ought to arouse some little excitement, though it is not easy to see whence any radical improvement in batteries is to come. The editor of *L'Ellettricita*, 2, Via Meravighli, Milan, will supply all particulars.

At a recent meeting of the Physical Society a discussion arose as to the use of the term "impedance," which the British Association Committee had defined as the ratio effective voltage / effective current. Prof. S. P. Thompson said the definition was only applicable to periodic currents, not to intermittent or transient currents. The word is certainly used ambiguously. It was also pointed out that the term "inductance," which was introduced by Mr. Oliver Heaviside, F.R.S., was used sometimes for L and at others for L *p*. Prof. Perry, Dr. Sumpner, and others took part in the discussion, and probably if the members of the Physical Society agreed upon terms and formulæ, electricians would soon fall into the habit of using them. A "horse-power" is not exactly a scientific term to use in connection with a steam-engine, but it is well understood, and serves all practical purposes.

In a paper read before the Paris Academy of Sciences M. Lefébvre gave the following determinations of dielectric constants:—Sulphur in flowers and roll, 2·6, but cast in rolls some time previously to the test, 3·9; ice, different specimens, 2·4 and 3·45; ebonite, 2·3; paraffin, 2; petroleum, 1·9; bisulphide of carbon, 1·7; and rectified turpentine (spirits), 1·5.

It is stated that M. Serullaz, who was sent out by the French Minister of Posts and Telegraphs in search of the Isonandra tree in Malaysia, has returned with several specimens which are to be planted in Algeria, while the cultivation of these guttapercha trees will also be attempted in French Guiana. M. Serullaz has discovered considerable forests of the Isonandra gutta, and has also devised a method of "milking" the trees without destroying them, as the crude operations of the natives invariably do.

A large space has been allotted in the new Imperial Secretariat Buildings in Government-place, Calcutta, for the formation of a Patent Museum, which will be an adjunct of the Patent Office. Besides specifications of inventions, the museum will contain models and drawings, of which there are already a good stock to form a nucleus.

M. Blondlot, in a paper to the Paris Academy of Sciences, gives the results of his researches on the velocity of propagation of electrical waves. The result is practically about the same as the velocity of light.

Two travellers who have just returned to San Francisco from the Niga Islands, Alaska, report that valuable coal mines are already being worked on one of the Shumagin group, 900 miles west of Sitka, and that the product will be placed on the San Francisco market next year. From four to six workable veins, each 5ft. or 6ft. thick, lie one above the other about 30ft. apart. These veins, it is said, can be traced for two miles, and the supply is virtually inexhaustible. It is asserted that cargoes can be delivered in San Francisco at 4dol. per ton. An analysis, it is reported, shows the coal to be somewhat superior to the Seattle product; but, like all Pacific-coast coals, it is of lignitic formation, and carries a large percentage of moisture.

The arrangement for science lectures at the Royal Victoria Hall during January are as follows:—January 12, Sir Herbert C. Perrot (Chief Secretary of the St. John's Ambulance Association), "First Aid to the Injured: its Object, Origin, and Development" (this lecture will be followed by an ambulance class in the Morley Memorial College); 19, Mr. Locke Worthington, "Egypt 3,000 years ago." On the 26th Prof. Reinold will deliver a lecture.

The council of the Royal Geographical Society has done good service by the issue of its circular letter containing rules for the spelling of the names of foreign places, especially on maps, according to some system.

No bird is more fecund than the sparrow. It has been calculated that as a single pair will, in, say, the latitude of London, rear twenty or thirty young in the course of a single year (and in New York this is not uncommon), if all lived, their offspring in the course of ten years would amount to 275,716,983,098 birds. The actual increase is, however, but a small fraction of this total, for millions die in the nest, in the course of nature, of hunger, or of cold during severe weather, or serve as food for carnivorous birds or other wild animals. But, assuming the annual young per pair at only twelve (and in the warmer parts of the United States, where the English sparrow is a serious plague, they are much more numerous), half males and half females, and that all live to five years, the total increase of one pair in that time would be 33,614 birds. That is the estimate made by the officials attached to the American Department of Agriculture, who, two years ago, published an exhaustive report on the sparrow in the New World.

One of the most remarkable instances of discoloration of sea-water is reported from Port Jackson, the harbour of Sydney, N.S.W. Suddenly the water presented in places the colour of blood. This was found to be due to the invasion or rapid development of a microscopic *Glenodium*, which in the course of a few days destroyed half of the shore animals. Nearly all the bivalves in the place which it affected died, the oyster-beds being seriously injured, mainly, it is believed, owing to the mollusca having swallowed it in that uncritical fashion in which a gaping shell-fish takes in what is good, bad, and indifferent, though the sea fortunately seldom contains anything noxious to the life it nourishes. This observation may explain the sudden disappearance of oysters from localities where they formerly abounded.

The City of St. Brieuc, France, is now lighted by electricity. The force is produced by a waterfall situated about nine miles away from the town. The current is generated by two Thomson-Houston alternating machines at a pressure of 2,000 volts. It is transmitted to St. Brieuc by means of a cable of pure copper supported on insulating posts. At its arrival in town, the current is transformed so that its pressure is only 100 volts. It is used for the production of incandescent light. The light is offered cheaper than gas.

LETTERS TO THE EDITOR.

◆

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor *of the* English Mechanic, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

◆

THE PROPER MOTIONS OF THE FIXED STARS.

[33029.]—On examining a list of the proper motions of some of the fixed stars recently, I noticed certain peculiarities which may interest some of your readers, and may perhaps elicit some explanation of the phenomena.

The list which I used was that of 1,167 stars, from which Mr. Dunkin deduced the motion of the sun in space in the year 1863. My object was, if possible, to obtain an elementary proof of this motion without questionable assumptions on the one hand, or elaborate computations on the other. The general principle that the sun's motion makes all the stars apparently recede from the apex and approach the ant-apex is well known; and, of course, if we select a point near the apex, or near the ant-apex, we may expect a preponderance of receding or approaching notion accordingly. Taking the North Pole as the starting point, my expectations in this respect were more than realised. The stars receding from it were more than twice as numerous as those approaching it. That the apex lies in the Northern hemisphere thus seemed certain, and the sun's motion appeared to have a much greater influence on the motions of the fixed stars than I expected.

The next step was to find the R.A. of the apex. Of course, amid the general increase of North Polar distance there would be a diminution in the case of stars lying between the North Pole and the apex. Taking the circum-Polar stars down to decl. 40° N., there was no difficulty in finding the region where the majority of the stars were approaching the Pole. Between 17h. and 19h. R.A., the approaching stars were between twice and three times as numerous as the receding.

A third step was necessary to complete the process. On reaching the apex, the approaching motion should be converted into a receding motion. At what degree of declination did this change take place? Here arose the first peculiarity to which I desire to call attention. The results already given showed that the apex lay in the Northern hemisphere, and had probably a considerable N. declination; but I found that between R.A. 17h. and 19h. the approaching stars continued to exceed the receding ones the whole way down to the Equator. Evidently there is either a general northerly drift of the stars in this region, or else the North Pole is not really a fixed point, but is drifting towards these stars. I may add that the preponderance of receding stars between R.A. 5h. and 7h. seems too great to arise from the sun's motion. It is fully eight to one.

Another peculiarity emerged on comparing the proper motions in R.A. If a be the R.A. of the apex stars whose R.A. lies between a and $a - 180°$ will have their R.A. diminished by the sun's motion, while those lying between a and $a + 180°$ will have it increased. I found, however, that a great majority of the recorded proper motions gave diminishing Right Ascensions, and that in no region of the sky did those with increasing Right Ascensions rise much above equality. The hours 17h. to 19h. were, indeed, again pointed to by a relative excess of diminishing Right Ascensions before them and a relative excess of increasing Right Ascensions after them; but the question remains, How is the great preponderance of diminishing Right Ascensions to be accounted for? From

7h. to 9h. it reaches the high proportion of seven or eight to one—a result which we could hardly ascribe to the Sun's motion in space even if the apex was on the Equator. A revolution of the Galactic Ring will not explain the facts, because such a revolution in the case of the Galactic stars near R.A. 19h. would increase the R.A. if it diminished the N.P.D., and *vice versâ*. Possibly something might be done by assuming that the apex of the sun's way is not a fixed point, but is changing at a rate comparable with the proper motions of the stars. **W. H. S. Monck.**

P.S.—Since writing the foregoing letter I have examined Mr. Stone's catalogue of the proper motions of 406 southern stars with results of a similar kind. The stars with diminishing R.A. are more than twice as numerous as those with increasing R.A. Can it be that we have slightly over-estimated the length of the sidereal year? **W. H. S. M.**

SUNDIAL—EPSILON LYRÆ.

[33030.]—AFTER reading letter 32934, on p. 309, by Mr. Walter M. Hardie, the following method of constructing a sundial occurred to me, and as I am not aware of its having appeared in print before, I send it for the criticism of those interested in such matters.

The ellipse formed by the intersection of the horizontal plane with a semi-cylindrical sundial for any latitude can be easily determined. M is such that—

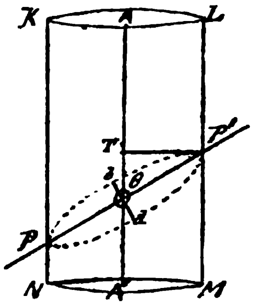


FIG. 1.

$$\text{Major axis} = \frac{\text{Minor axis}}{\text{sin. latitude}},$$

as may be seen. Let K L M N, Fig. 1, be a cylinder; A A' is axis; P P' a plane cutting it and making with the axis any angle θ. (In the case of a cylindrical dial, θ would be equal to the latitude.) From P' draw P'T perpendicular to A A'. Then—

$$\text{P T} = \text{rad. of cylinder}$$
$$\text{Major axis} = \text{P P'} = 2\,\text{O P}$$
$$\text{Minor axis} = b\,d = \text{diam. of cylinder} = 2\,\text{P'T}$$
$$\text{and} \quad \frac{\text{P'T}}{\text{O P}} = \sin.\theta \quad \therefore\ \text{O P} = \frac{\text{P'T}}{\sin.\theta}$$
$$\text{and} \quad 2\,\text{O P} = \frac{2\,\text{P'T}}{\sin.\theta}$$
$$\text{or Major axis} = \frac{\text{Minor axis}}{\text{sin. latitude}}.$$

Suppose, then, we wish to construct a dial for latitude 50°, and it is to be 12in. in diameter. The major axis of ellipse will equal $\frac{12}{\sin.50^\circ}$. Let D A D' be this ellipse. On D D' describe a semicircle divide it into 12 equal parts; through the division points draw perpendiculars to D D', and produce them to meet the ellipse in the points 1, 2, 3, &c. Now these points would also have been the terminals of the hour-lines had D A D' been an actual cylindrical dial; therefore, if we draw lines from them to the centre C of the ellipse, we have the hour-angles for latitude 50°.

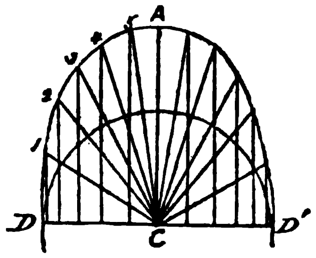


FIG. 2.

The weather where I am has been exceedingly bad for weeks, but I got two good opportunities for star work. I tried ε^1 and ε^2 Lyræ with a power of 60, but could only elongate them. With a power of 80—84, and very patient and steady looking, I could perhaps a *little more than glimpse* them double; but that is the most I feel warranted in saying. I may be allowed to add that I find much more pleasure and profit in turning my glass upon what it will show me distinctly than in spending night after night in searching for the *mirabile visibile*, of which we hear from time to time. **J. A. Campbell.**

THE TRAVELLER'S SUNDIAL.

[33031.]—No drawing of my instrument is necessary. Your Fig. 1 in "E. M." of Aug. 7 is an exact representation of its general appearance. The flat central bar, carrying in a slot the sliding piece, is marked on one side with declinations and Signs of the Zodiac; on the other side with names of the months. The use of this is clearly described in the article of Aug. 7th, and the various divisions of mine are merely different ways of getting at the same thing.

The hour-circle is divided into hours, &c., both on the upper flat surface and on the inner rim. The under surface and outer rim are plain.

The meridian circle differs from the one figured in not having the latitudes of towns, &c. In place of this it is divided on one side into 360°, from 0° to 90° four times over, as on the brass circle of a terrestrial globe. On the other side there is a division into degrees from 0° to 90°. The centre of this graduation is not the centre of the ring, but a point on the opposite side, marked by a small hole. This hole is doubtless intended for use with a plumb-line.

The suspending ring can be moved round the meridian circle to any point, and fixed by a screw.

The use of the instrument as a sundial is not made clear by the article of Aug. 7th. The writer says, "If then, the apparatus be so suspended that the circle M be in the meridian." How is this to be done? In our own experiments with the instrument the impossibility of doing this led us to reject the idea that the thing was a sundial at all. **William H. Patterson.**

GRATIFYING.

[33032.]—MAY I be permitted to express to Mr. Frederick Davis, through the medium of your most valuable columns, my thanks for his articles upon Microscopical Botany. I lately presented myself for an examination in which botany was included, and I feel confident had it not been for these articles I should *not* have met with success. I write because Mr. Davis, with such a task before him, will no doubt appreciate the knowledge that the articles have been of great service to one who had almost despaired of a success in so extensive a subject.

East Barkwith, Rugby. **R. Duckering.**

CALCULATIONS CONCERNING THE LENS.

[33033.]—THE use of a single simple lens of high power is objectionable, because of the distorted and indistinct image it produces, and also because of the dispersion of the coloured rays, which takes place during refraction. Lenses may be so combined as to remove these difficulties to a large extent.

In the case of dispersion, two lenses, when cemented together, can be made achromatic for the principal bright colours of parallel rays, or practically for those from an object a great way off, as in the case of the object-glass of a refractor telescope.

The calculations relating to achromatism are too complicated to be briefly dealt with in an article like this.

When two lenses (focal lengths $= f$ and f_1) are in contact, the power of the combination—

$$\frac{1}{F} = \frac{1}{f} + \frac{1}{f_1} \text{ (neglecting thickness).}$$

Therefore, the focal length F of an equivalent lens—

$$= \frac{f f_1}{f + f_1}$$

If the lenses be separated by a distance a, then it can be demonstrated that—

$$F = \frac{f f_1}{f + f_1 - a}$$

if the two lenses are convex, and f = focal length of lens nearest object.

Now, in the Huyghens, or negative eyepiece, which was originally made with a view to overcoming distortion to a large extent, $3f_1$ for the eye-lens $= f$ for the field-lens, and $a = f - f_1$. Therefore, substituting in the last equation—

$$F = \frac{3f_1 \times f_1}{3f_1 + f_1 - (3f_1 - f_1)} = \frac{3\,(f_1)^2}{4f_1 - 2f_1} = \tfrac{3}{2}\,f_1 \ \therefore\ = \tfrac{1}{2}\,f.$$

It just happens that, by a remarkable coincidence, this combination is achromatic when the lenses are composed of the same material. The form of these convex lenses is sometimes convexo-concave for the field-lens, and convexo-plane for the eye-lens.

So as to remove the objectionable qualities of a lens, one authority gives, for the above eyepiece attached to a refractor telescope, the following forms:—Field lens = convex lens, known by the name of *meniscus*, having radii of surfaces in ratio of 11 to 4; and eye lens = crossed lens (so called), having radii in ratio of 1 to 6, the most convex side in each case being turned towards the object-glass.

In the Ramsden or positive eyepiece, which is not achromatic—

$$f = f_1, \text{ and } a = \tfrac{2}{3} f = \tfrac{2}{3} f_1.$$

Therefore, by substitution F =

$$\frac{f_1 \times f_1}{f_1 + f_1 - \tfrac{2}{3} f_1} = \frac{(f_1)^2}{2f_1 - \tfrac{2}{3} f_1} = \tfrac{3}{4} f_1. \ \therefore = \tfrac{3}{4} f.$$

The lenses are generally convexo-plane, the convex surfaces being turned towards each other.

It is clear that, for purposes of measuring in telescopes, the Huyghens e.p. cannot be used, because if cross-wires or spider lines were placed at the principal focus of the eye-lens, they would be distorted by the eye-lens alone; but the image seen would be distorted by the field-lens and eye-lens, and therefore in a different degree from the wires, because it must not be forgotten that in compound lenses contrary distortions take place to make the image appear straight.

In the Ramsden e.p. the wires, being placed at the image of the object-glass in front of the field-lens, are similarly distorted to the image, and therefore this e.p. may be used for measurements. **A. Gadd.**

(*To be continued.*)

LONDON'S ATMOSPHERE, &c.

[33034.]—I CAN but believe that the faculty of imagination overpowered Mr. Peter Love when he publicly identified himself with the ideas in letter 33017—ideas which I scarcely think he is prepared to sensibly defend. Really, I thought any man who read the "E. M." would discover that people's credulity is not the best thing to rely upon for the support of any new, and especially gigantic, physical idea or argument, particularly any involving vast expenditure and public good as primary factors. Mr. Love puts forth no scientific or any other argument to support him, and to read his letter one can but perceive its Utopian character; for he would convey the idea that it is but necessary to perform one certain thing, and everything else will harmoniously conduct itself in consequence.

It is proposed to connect the Thames with the Bristol Channel, *viâ* the Avon, by a cutting of *sufficient dimensions* as to cause a six-knot current to set towards the mouth of the Thames; by reason of a 10ft. difference of level, which it is claimed may be gained, the advantage being at the Bristol end, the Thames valley is to be scoured out, water cleansed, fog eliminated, and many extraordinary and hitherto undreamed things accomplished (?). Also, it is but necessary to start a barge of coal away upon this convenient current and its safety and destination are assured, providing the "shoals of fish" are not too dense in this "pure Atlantic water." Where the fish are coming from I cannot tell, as they are none too plentiful either in the vicinity of London or Bristol; but I daresay they will swarm when everyone shakes their tablecloths into the river.

Now, to create an appreciable outflow towards the Nore would require a cutting at Bristol capable of conveying a volume of water very much greater than the capacity of the Thames; and then it is but a conjecture whether the tidal phenomena which exist at Bristol would occur at London. I think a few moments' thought will dissipate such a wild conception. The Manchester Canal is a big thing—but not compared to this idea. Next, "pure Atlantic water" has about $\frac{1}{32}$ saltness, and that fluid is certainly not the muddy compound seen in the upper reaches of the Bristol Channel. Then as to the fog, I am of opinion that it would be just as likely to come along with the new current, as Mr. Love asserts it does with the old. Fogs are often met with in mid-ocean, where there are no smoky chimneys, and the air is supposedly pure. As regards "sea air" in London, the very mention but adds to the ludicrousness of the whole thing, which scarce admits of serious discussion. Altogether this "truly safe and unfailing" plan is but a remedy for a defect to thrive upon, as it leaves the evils unattacked, and may bring larger discomforts than those which it is desired to dispel.

To improve the air, stop the smoke. This can but be done by improving stoking appliances in factories, fireplaces in houses, or using a different fuel, or by the complete substitution of gas. To improve the river, stop the pollution. Let the sewage be precipitated, deodorised, and returned to the land. The value and efficacy of the latter process can be practically demonstrated by anyone, or seen at the many sewage farms. Also, let the street pavings be improved. Macadamising is too ancient a process. It may suit for country roads, but for busy town thoroughfares it is a filthy system; by it all descriptions of impurities are retained, impure exhalations given off, and great discomforts occasioned, and the wet area exposed to the air can scarcely be against the fog. I believe that if we gave complete attention to these three subjects there would be no need of a No. 2 Thames. One thing, wind soon dissipates a fog. Cannot Mr. Love devise some idea for the "raising of wind"! The "making of rain" is already authenticated.

Walter Strafford.

100, Balaam-street, Plaistow, E.

WHAT WE CONSUME.

[33035.]—THE following extract from a German paper may not be without interest to many of "ours." It is based upon the average of several years, and represents the food consumption of the entire family and household, including workpeople, of a landed proprietor in Silesia, Germany, reduced to the unit of one person and per year. Home-made confectionery, 27⅓lb.; wheat, 73¾lb.; rye, 275⅓lb.; barley, 6⅔lb.; oats, 4⅓lb.; buckwheat, 17⅔lb.—all exclusive of husks; peas, including husks, 7⅔lb.; potatoes, peeled, 754lb.; butcher's meat, exclusive of bone, 115¾lb.; butter, 55lb.; milk, 661⅓lb., or 64 gallons; eggs, 13½lb.; fruit and fresh vegetables, 402⅓lb.; dried vegetables, 6⅔lb.; coffee, 11lb.; sugar, 21lb.; salt, 11lb.

It would appear from this that a human being consumes on the average no less than 2,465lb. of food stuffs per annum, or 6¾lb. per day, or, in other words, about 16 times his own weight per annum, assuming an average body weight of 150lb.

If it be allowed that the daily diet of a working man should not be less than 6oz. of proteids to 14oz. of carbo-hydrates, it would be interesting to calculate from the foregoing if such is provided or in excess. According to the list there is a daily consumption of cereals, 18oz.; peas, 0·34oz.; potatoes, 33oz.; butcher's meat, 5oz.; butter, $2\frac{4}{10}$oz.; milk, 29oz.; eggs, $\frac{8}{10}$oz.; fresh fruit and vegetables, $17\frac{6}{10}$oz.; dried vegetables, $\frac{3}{10}$oz.; and sugar, $\frac{9}{10}$oz.; leaving out coffee and salt. Deducting water contained in this food, the weight of dry, solid food will be about 44oz. per day.

	Of Proteids.	Of Carbo-hydrates.
The Cereals will contain	1·80oz.	10·00oz.
" Peas	0·07 "	0·18 "
" Potatoes	0·66 "	7·00 "
" Butchers' Meat	1·00 "	—
" Butter	0·90 "	—
" Milk	1·16 "	1·39 "
" Eggs	0·08 "	—
" Vegetables and Fruit	0·44 "	1·00 "
Ditto (dried)	0·06 "	0·18 "
" Sugar	—	0·86 "
Total	6·17oz.	20·51oz.

From which it would seem the diet is excessive in carbo-hydrates, which might be assumed from the large proportion of rye and potatoes included in the diet; but perhaps this large proportion of heat-giving food is found advantageous in the cold climate of Silesia and best adapted for all the year round.

The consumption certainly seems enormous, and yet is, I presume, considerably under the amount of food stuffs consumed in London per head per annum, especially as regards butcher's meat, and such other food as may be classed under that heading.

Having regard to the very small proportion which the butcher's meat occupies in the 44oz. of solid, dry food (about $\frac{1}{36}$), one is inclined to think that it could be eliminated altogether, and advantageously substituted by beans, lentils, &c., with a corresponding reduction in potatoes.

I should be glad to learn the opinion of readers of our journal upon this interesting subject.

I estimate the total cost of the year's food to the proprietor at £14 per head, and taking the meat at 7d. per lb., it alone represents one-fourth of the whole.

M.

VIOLIN-MAKING.

[33036.]—I HAVE read with much interest the papers of Mr. Pickering on violin construction and the subsequent correspondence. As an amateur mechanic, student of the violin, and a collector of instruments, I take a general interest in the subject, and, in my opinion, Mr. Pickering is entitled to the warmest thanks of all amateur makers. I strongly recommend him to reprint his papers in the shape of a cheap "handy book." It would be purchased by many amateurs. The larger and more expensive works of Davidson and Heron-Allen, admirable though they be, are largely supplemented with historical notes, and other matter, and there is at present no cheap and practical "handy book" on the subject, and I speak with some confidence, as several amateur makers near me are about to make instruments on the lines suggested by Mr. Pickering, and are purchasing the numbers, and express their regrets that they cannot obtain them in book form.

Notwithstanding some adverse criticism (the tone of which is to be regretted, for heat does not temper judgment), I, and all who have spoken to me on the matter, give Mr. Pickering due credit for his theory, and he certainly deserves warm thanks for publishing it.

I don't think the old makers adopted such a test; but that does not affect the value of it in any way, and in my opinion it may assist many an amateur in improving the tone of his violin. Mr. Pickering's method is not to be confounded with the ruinous universal scraping deplored by many experts. It is, if rightly understood, a delicate and finishing operation to parts which are well known to require limited thicknesses in order to promote effectual and free vibration. Otto expresses his regret that "all makers are not likewise good players, and able properly to try their instruments." He also says: "Whoever thinks I shall give an exact scale calculated in hundredth parts of an inch is mistaken." Now, he could not have done so with any positive result, because, as he knew, there would be no two instruments of identical density, even if any two were made from the same trees. Now, it is reasonable to imagine, and actually believe, that Mr. Pickering's test would be just the very plan to adjust the plates, as it is not at all likely any absolute scale would be perfect in working.

Mr. Pickering, to my mind, stated his belief with due modesty. He probably, as an amateur maker, mainly addressed his papers to his fellow amateurs; and many, I doubt not, will profit by his simple and practical instructions.

As to tools and methods, I do not think the amateur world will quarrel with him for the simplicity of some of his tools, and usually a workman prefers a simple tool to all others. I am prepared to let a man prefer his spokeshave to a drawknife or gouge, without any desire to make any comments, "unsparing" or otherwise.

As to moulds, they doubtless have many advantages; but I have seen many amateurs squarely and truly build up violins without using such an aid, and these men have cut and bent their own violin-ribs.

For soundpost I agree with Mr. Pickering that soft wood is generally the best; but I think no rule holds good as to this, and that the instrument requires to be suited with a hard or soft post according to its peculiarities. If the bridge can be changed to advantage, why not also the soundpost?

Mr. Pickering's observation about a man "getting his eye in" was considerably ridiculed. Now I ask all my friends to candidly tell me how long it took them to get "their eyes in" to the outlines, model, &c., of the various well-known makers, to say nothing of the nicer and subtle points of difference which only become noticeable after many years' study. Many have admitted the slowness with which they noticed things, which, in the long run, became very palpable. It is a common matter to hear one's friends say all the pictures in Hart's book appear alike. If I produce the photos of Fleming and Dissmore, and even the beautiful coloured pictures of Shirley Slocombe, most men (and many who play the instrument) are quite unable to see the great difference in the various pictures. It takes many years' experience and loving study of violins to get one's eye in sufficiently to rapidly take in the points of a violin. In the place of ridiculing this comment several friends have forcibly admitted to me how very true it is. No doubt, Mr. Pickering meant his method of shadowing outline to be the guide of a tiro. Most amateurs can readily get outlines by copy, and also sound-holes. I get both by simply rubbing thin white paper with heel-ball (used by shoemakers), in same way as rubbings are taken from book-covers and church brasses. I possess quite a collection of rubbings of outlines and sound-holes, taken from instruments which I have seen during the past 30 years.

I don't suppose that anybody took Mr. Pickering's illustrations for anything more than rough signposts. His purfling tool, too, which roused some ire in one quarter, may beyond doubt do work truly and well, for in it will be found all that an inexpensive tool will give. Amateurs won't quarrel with Mr. Pickering for cheapening their tool outlay.

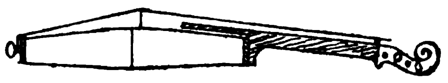
I have not seen Mr. Pickering or his work, but nevertheless I am quite willing to believe he can turn out good work. As to his experience and ability to instruct others in violin subjects, I have much confidence in him. As a man deeply interested in all matters affecting violins, I know perfectly well that Mr. Pickering is a well-known collector and expert. Amateurs will find a reference to him in Davidson's book, and Mr. Heron-Allen acknowledges him as an expert in an article in *The Strad* of 1890. These points, and others known to most collectors, satisfy me that Mr. Pickering, as a writer on violin subjects, is entitled to great respect, and I feel quite sure he could give much information and interesting details upon fiddles, old and new, which would be highly interesting to many violinists, and particularly those who are also interested as amateur makers. The latter are an increasing body, and are likely to be, and to such I feel quite sure a reprint of Mr. Pickering's papers (with additions) would be a welcome book.

It was hardly a crime to suggest that professional makers "might not deem the matter unworthy of attention," as Mr. P. did. Amateurs will thank all who instruct them or give them useful hints, and I trust this hint will not be thrown away upon writers who can do better by publishing instruction than by discounting another man's productions.

Gauging does not guarantee satisfaction. It may bring us within reasonable distance of perfection. It seems impossible to find or fix a standard, owing to many natural difficulties. Why not reduce thicknesses after stringing and before varnishing? Tonal test is, then, far better than gauging. Why a workman should never alter a finished violin, if it could be improved, I leave Mr. Calver to explain. If workmen never did, it does not follow that they could not very profitably do so if they could play as well as make.

Coventry, December 25, 1891. **Vio.**

[33037.]—IN letter 32996, Mr. J. K. Monk asks "why were many of those grand old instruments (violins) built with the ribs narrower in the upper bouts than in the lower?" This is a question to which I have devoted sufficient thought to come to an opinion, and this opinion I have verified by practical experiment, which anyone sufficiently interested may try for himself. Two strips of wood 1in. wide, ¼in. thick, glued on two blocks, as in the sketch, with string, bridge, soundpost, and a piece of wood for the neck are easily procured. It will be seen in the sketch that the breast is the fulcrum for the neck, on which it may be said to balance. From the string to the fulcrum is a short lever, and from the fulcrum to the back is a longer lever. Now, supposing we have shaped the breast and back, and cannot take a shaving more off, but find that the back is too rigid, and will not straighten a bit when the string is deflected. If we then take a carboard thickness off from the longer lever, we obtain more power, perhaps sufficient to gain what we require. This will, as a matter of course, make the upper bouts narrower than the lower ones. In the sketch it will also be seen that when we deflect the string, the extra tension will straighten the back somewhat, by that means forcing the breast, by means of the soundpost, upwards, the bridge at the same time forcing the breast downwards. Between the two a wave is formed, provided the soundpost is just as far away from under the foot of the bridge, as the breast is thick, say ⅛in. I do not think any further explanation is necessary, the sketch being almost sufficient. However, anyone can easily try it for himself, and see how it works.



J. H. Schucht.

[33038.]—BEYOND the correspondence that has appeared in this journal, I have met with no published information relating to the construction of violins and their qualities of tone, and am not aware whether the ideas that I have propounded on the subject have ever before been suggested. I believe something yet remains to be done in the matter.

Anyone constructing a tuning-fork knows that to sound well both prongs must be filed or ground alike, so as to vibrate simultaneously. Probably the two boards of a violin are somewhat analogous to the prongs of a tuning-fork, considered as synchronous vibrating bodies, and that the good quality of a violin very much depends upon the correct tuning of these pieces of wood.

There is some fanciful idea about regulating the tone by allowing more or less air space between the boards; but without running into considerable alternations from uniformity to deformity, I cannot suppose that the scarcely appreciable weight of air arising from the usual small differences of capacity can affect the result. Let some of our readers pour a wineglassful of canary seed into their violins, and try the differences with and without it, allowing the seed to collect at either end or in the middle during the trial.

It is a well-known fact in acoustics, that if two bodies vibrate in dissonance, the sound of one will, in a great degree, be killed by the other, so to speak. In constructing a violin, the question is: How is this toning of the boards to be accomplished? I should completely finish the outsides first, but leave the back with a full thickness. It is not requisite that this should be glued on for each trial, as this would be a very tedious and messy way of working. I recollect a case where a fine-toned and expensive violin belonging to my father had been left in a damp place. The glued joint round the back separated from the tail to the waist. Before being repaired, it was tried in this state, and it was remarked that no depreciation in tone could be detected. Therefore, in the course of construction, after each removal of wood for trial, the back may be held up by means of a few light clips made of veneer, notched out to grasp the thickness of the sides; or the two boards may be tested without any sides by being held together by a few distance-pieces.

As to cutting away the wood in the hollow of the back, a gouge is best fitted for roughing out and taking heavy cuts, only it is an uncertain and dangerous tool to use for light shaving thin wood, besides requiring to be pushed over the work—it obscures the result. A curved rasp, or riffler, is a safe tool to use, but gives a lot of trouble from the necessity of repeatedly smoothing the roughed surface of the wood. The best tool is the draw-shave of the wood-carvers. This is shaped like a spoon, with a long handle. The curved blade at the bowl end, if kept sharp, rapidly takes off thin shavings without any chatters, and it is easy to humour the grain of the wood.

The quality of a soundboard of any musical instrument is much deteriorated if it should get cracked or if there are holes in it. Much has been said about the *f* holes on each side of the bridge of a violin. I do not consider these as ornamental, nor do I think them necessary. The apertures for the emission of sound may be cut round as a series of spiracles through the thin wood of the sides, or like open fretwork. If there are too many openings, or they are too large, the tone may be harsh and loud, requiring the apertures to be lessened or muffled. The *f* holes, if found necessary, can be cut out by means of a small, hook-bladed knife after the violin is entirely finished. As regards the wood, if this has not been laid by long enough for seasoning, it would be advisable nearly to finish the back and belly, and keep them for some weeks in a thoroughly dry place before taking the final finishing cuts. In fresh-cut wood in thin pieces there is a strain amongst the particles which time will bring into equilibrium, and the strain from the spring of the sides will be lessened. I once saw the wreck of a fiddle that had been under a rainfall, and got partly filled with water, affording, as it lay, a strange dissection; all the sides had flown out, nearly straight, and to repair it again without the use of an outside moulding frame (which should be separable) would be a very difficult task.

The late Mr. Goding was a collector of rare old violins, many of them of fantastic forms, as tortoise, crocodile, and cucumber shaped. These were suspended by their necks from a rail by thin pieces of twine. When a violin was played in the room, one or more of these would in turn jerk or twist to different notes, affording a curious demonstration of sympathetic vibration; but I did not learn whether the liveliest dancers were considered the best-sounding fiddles. It may be asked why I myself have not put my crotchets to the test of experiment in the entire construction of a violin? For two reasons: 1st, that after a lapse of many years, during which the subject has not been thought of, my attention has only just been recalled to it by the articles of Mr. Pickering; and, 2nd, that I have not yet come across any pieces of wood that I consider good enough to use. To do this work at all, it is worth while to do it well, and not spend eight or ten days' time on inferior materials, and I know so little of the trade that I am not aware of any special dealer in this line.

F. H. Wenham.

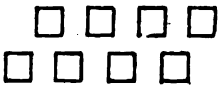
P.S.—Since the above was written, another unsavoury missile from the self-asserting "omniscient" "Scio" has crossed the path. He alludes to me as "possibly the valued friend" that Mr. Pickering refers to. This gentleman is an entire stranger to me. I do not even know his address, therefore I am as much his friend as anyone else who has read, with interest, his articles on violin construction. Let me remind "Scio" that it is generally considered mean and contemptible to skulk behind the shelter of a false name to make covert attacks on those who venture out in their real ones. I do not care for myself in this case, and it may save a criticism to say that I am unfamiliar with the subject of the violin, and do not know all about it. Just so. This I desire to know, as all may do, since ladies in our households have adopted this charming instrument as part of a musical education. If "Scio" is able to provide some useful information, instead of the personal trash that he has been at the pains of writing, we may accept it as some atonement for his past shortcomings. **F. H. W.**

HOW TO MAKE A VIOLIN.

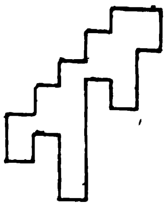
[33039.]—Along with, no doubt, many constant readers of the "E. M." I have followed the articles by Mr. Pickering with very great pleasure, and while merely a player, I have, through those papers, become more interested in the intrinsic qualities of the instrument. Shortly since, I became possessed of a violin which has, to my ear, a very pleasing tone, but which does not seem to satisfy some of my musical friends. It is slightly under full-size—what is called ⅞, I think—with a whole back of maple. The tone is mellow all through, but by no means loud—rather to the muffled side, I should say; but, to the best of my judgment, there is not a bad note in the fiddle. It is labelled inside, "Mathias Griesser, Lauden und Geigenmacher in Insbrugg, ann. 1730," and looks quite its asserted age. Will Mr. Pickering, or any violin fancier of "Ours," oblige by saying whether the maker was of repute, and if the violin is likely to be genuine? Also if the tone I speak of is a quality and not an imperfection? I should like also to ask if it would be safe to reduce the neck of this violin, say ⅛in. in thickness, as I prefer a thin neck?

Assoc.M.Inst.C.E.

35A



35B



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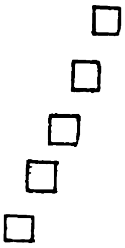

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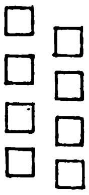

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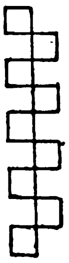
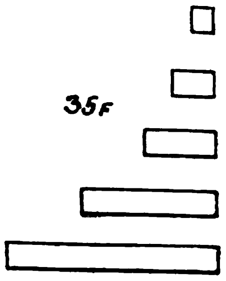


35F



ORGANETTES (AND PIANISTAS)—XIV.

[33040.]—Referring still to Fig. 34 of my last letter, the strip of paper on which the divisions are marked that determine the position of the punch is not a permanent fixture. It is thus easy, by shifting it to one side or the other, to make different notes correspond to the same position of the punch, and thereby alter the key in which the music will be played. Similarly, by substituting a suitably-marked strip, the tune-band can be punched to suit organettes that have only an imperfect scale. In cases where a part or the whole of an air has to be repeated, time and trouble may often be saved by laying a thin strip of paper over the tune-band and punching through the two, then using the thin paper as a pattern, or template, to guide the punchings when the repetition occurs.

Similarly, a tune-band may be copied photographically by the "blue-paper" process, and then punched. I am informed that lengths of upwards of a yard can thus be copied at once by the use of a long printing frame, and the correspondent to whose courtesy I am indebted in connection with the account of the punching-machine has also sent me specimens of such blue printed bands.

Suppose a tune-band when punched is, after all, found to produce the air too slowly or else too rapidly, it can be repunched from the original band so as to vary the "time" to any desired extent. This is done by using a supplementary pair of feed rollers, so that the faulty tune-band, though used as a template, shall travel at a *different speed* from the band that is intended to be punched, either slower or faster as may be required. The relative (longitudinal) position of the perforations is thus altered without altering the perforations themselves.

I believe that for trade purposes the tune is punched out in zinc templates. These are passed through rollers in conjunction with the paper tune-band, and Prussian blue is thereby forced through the template to mark the damped paper. This marked paper is then laid over several blank papers, and the whole lot punched through by ordinary hand labour.

A self-acting machine for copying a tune-band has also been made by my correspondent, but at present I am unable to give any further particulars.

We may now go into some of the details of punching-machines generally, commencing with the one that has been partially described in connection with Fig. 34. The lateral spacing or distance apart of the air-holes or levers, as the case may be, varies considerably in different instruments, and this, to some extent, affects the design of the punching apparatus. The organette in Fig. 10 has holes ⅛in. wide, separated by ⅛in. spaces, making the gauge or centre-to-centre measurement ¼in. The large instrument, Fig. 14, has $\frac{1}{10}$in. holes and $\frac{1}{10}$in. spaces, giving ⅕in. gauge. The Thibouville-Lamy pianista has its levers only $\frac{13}{100}$in., or say ⅛in. apart, *c* to *c*; but the holes in the tune-bands are about $\frac{16}{100}$in. square, and the consequence of this is that the holes for adjacent levers overlap, as in Fig. 35 A, and cut into one another, as in Fig. 35 B. If we have a run we may get 35 C; if a tone shake, 35 D; if a semitone shake 35 E, and so on. It is thus evident that it would not be possible to have a *set of punches side by side in the same line*, as each would encroach on its neighbours; whereas, for the tune-bands of Figs. 10 and 14, such an arrangement would be quite feasible.

In order to increase the rapidity of the shake, a method of cross-lacing a double perforation with fine wire is sometimes used, so as to substitute the mere thickness of the wire for the ordinary bit of the tune-band separating successive perforations.

The general appearance of the stepped punch is seen in Fig. 34, and the actual lengths of the perforations it produces are 0·15in., 0·30in., 0·45in., 0·78in., and 1·20in., so far as I can measure them, for I find there are slight differences in different specimens. (See Fig. 35 F.)

Fig. 36 is a sketch of the lever and link by which the punching arm is moved to and fro, in which A is the long arm whose index points to the required note on the divided scale; B is the short arm that, by means of the link C, moves the slide *D* of the punch-arm, and so places the punch in position. The pin on which the lever turns is conical, and every part is very exactly fitted to avoid shake or loss of motion—a necessary precaution where the punching has to be so accurate, owing to the closeness together of the levers that enter the perforations.

FIG. 36

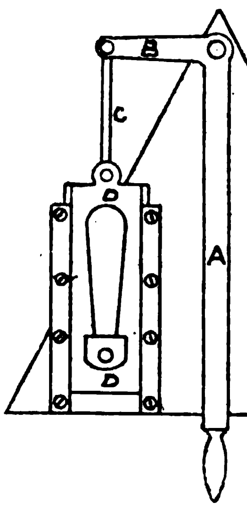
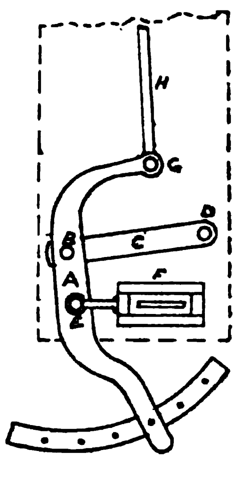


Fig. 37 is another sketch to show the connections of the lever which regulates the depth to which the punch shall descend, and at the same time adjusts the movable end of the die to suit the corresponding "step" of the punch. The front end of this lever lies a little above the lever that produces the traverse of the punch-arm, as seen in Fig. 34.

A is the peculiarly-shaped lever, connected by the pin B to the block or bar C, which is itself attached by the pin D to the main casting of the traversing-slide. At E is pivoted the link that moves the sliding die F already mentioned. The end of the lever is prolonged to G, where is a connection with the link H that moves the "stop pins" in the head of the punch-carrier. This shows more plainly in Fig. 38, which is a sketch of the punch and its support, seen sideways, and lettered to correspond with Figs. 36 and 37. K is a vertical lever, pivoted at its centre. The lower end is attached to the link H, and the upper end carries a similar link, L, whose other end is bent up at right angles, and slides the stop pins in and out, ready to check the block M fixed on the rod that carries at its lower end the stepped punch (seen "end-on") N.

FIG 37



I had intended suggesting several other modes of marking and punching the tune-bands with illustrative sketches; but I do not wish to extend this series of letters beyond the present one, as the number has far exceeded my original intentions, and I fear those of our "commander-in-chief" as well. Possibly such hints as I give may serve as suggestions for others who desire to construct apparatus of this description.

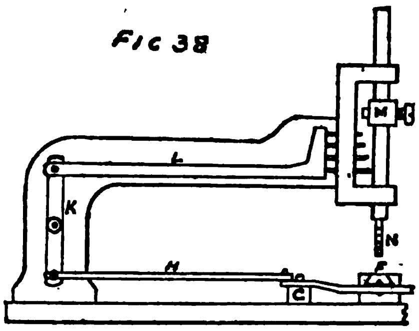
Let there be attached to each key of an ordinary key-board, an elastic arm carrying an indiarubber-covered roller, and let the depression of any key bring the corresponding roller into contact with the tune-band, but with an interposed band of black transfer paper or linen, as in a railway ticket printing machine. Let the tune-band be kept in motion either by a treadle and flywheel, or by a clock-train and weight, an electro-motor or otherwise as may be convenient. Evidently as the tune is played, the band will be marked with long or short strokes, according to the time the roller remains in contact with it. Being rollers (and not rigid stamps) the motion of the band is able to be kept up, whether they are in contact with it or not. Of course though the key-board is assumed to be of the usual width, the rollers are to be set to the "gauge" of the tune band, and the connections arranged accordingly. By using revolving cutters, it might be possible to cut the *sides* of perforations in a similar way, but the cross cuts at the ends would have to be done separately.

For actual punching, the keys might be employed to bring a movable block between an oscillating bar and the head of the punch, just as the block *t* in Fig. 30 is interposed between the plunger-bar and the piano-key, the oscillation of the bar being maintained by a treadle. In this case the perforations would *not* be of varying length, so that the tune-bands would resemble those punched by Mr. Wenham's apparatus. The forward motion of the band would have to be intermittent and regulated somewhat as in the machine shown in Fig. 34.

A somewhat different design would be the following:—A single punch-carrier slides to and fro on a strong bar extending across above the band to be punched, and can therefore be brought over any point where a perforation is required. This bar has a certain amount of motion up and down, its ends being guided in upright standards, and provision made for its motion being always exactly parallel to itself. The downward motion is given by a pedal worked by the operator's foot, and the return by means of a spring or balance weight. The punch carrier consists of a pair of cheeks, between which there turns on a horizontal axis a wheel consisting of, say, five punches of different sizes, so arranged that the *preceding* edge of each punch falls into the same vertical line when it is turned into the punching position. A spring catch secures the wheel in each of its five positions. The punch carrier is either simply slid along the bar, which is graduated to suit the gauge of the instrument for which the tune-band is to be punched, or it may be traversed by gearing along a toothed rack attached to the bar, and the position of the punch shown on a graduated disc.

The feeding forward of the band would be managed much as in Fig. 34. By thus throwing the work of punching on the foot, the hands are left free to manipulate the punch-carrier and the feed motion. It will be noticed that a die is *not* provided, the punching (or it may be used for marking only) being supposed to be done with hollow sharp-edged punches cutting on a solid block of wood or other suitable material admitting of easy renewal.

FIG 38



For punching through a die it would be necessary to form a part of the bed of the machine with a kind of turn-table perforated with five openings, and in this case it would be easier to have the punch fixed in position, and let the tune-band be movable to and fro beneath it. The punch-wheel and the die-wheel could then be so connected as to move simultaneously.

It would be also possible to use a single punch only, and obtain longer perforations by taking successive "bites." This might perhaps be arranged to be done by a supplementary "feed" motion, irrespective of that of the general feed rollers. I fear, however, this would render the machine too complicated to stand hard work, and the process would be much slower than when a *set* of punches is employed.

I may here suggest that if "Constant Reader" (December 11th) will please refer to my earlier letters, he will find "scales" suitable for various numbers of notes.

And now a word in conclusion. Out of the 27 patent specifications that I have dealt with (and no doubt there are many others that I am ignorant of) *only three are English*, viz., Dawson's (the first to employ perforated tune-bands), Wenham's (for his Pianista), and Britain's (illustrated in Fig. 19). English Mechanics, how is this? **A. S. L.**

PINK STREAMERS AFTER SUNSET.

[33041.]—CAPT. BATTERSBY, in paragraph five of letter 33026, has described the phenomenon of pink or roseate lines of light radiating from the sun's place shortly after sunset. I have described the same thing in several places in this journal (see Vol. XLIV. p. 171, XLIX. p. 282, L. p. 137, and LI. p. 60), and it was always an interesting object of observation to me when stationed in South Africa, where it was frequently seen in all its intensity.

I take it to be that the only possible cause must be irregularly disposed masses of clouds which admit the sun's rays through certain apertures. The rays or columns so admitted look bright against the rest of the unilluminated sky in the same way, or much the same way, as a cone of the electric-light reveals itself by reflection from the air particles within that cone, the surrounding mass of air (not directly illuminated by the beam) appearing dark by comparison. This comparison, I think, will be appreciated by those who have seen the electric search light at work, either from a man-of-war or a fortress. In Cork Harbour I have often watched these majestic electric beams, miles in length, sweeping over the water at night, and revealing every nook and cranny in the coast; then the beam has been suddenly flashed upwards into space, and we have a miniature representation of our solar beam, except, of course, as to colour.

The phenomenon is often seen in this country. It was only on the 23rd inst. that a pretty pink glow appeared in the S.W. sky after sunset; it appeared first as an amorphous cloud, but soon after split up into four or more pink rays, radiating upwards from the sun's place. On Oct. 21st two fine pink streamers were seen over the sun's place after sunset. They were wide and ill-defined at the borders. One was nearly perpendicular to the horizon, the other inclined about 50° or so. On Oct. 7th there was a beautiful pink glow, quite brilliant. It was divided into two parts, the larger and more brilliant being over the sun's place. This was separated by a rift from a pinkish streamer stretching away to the left, and inclined at a somewhat small angle to the horizon.

Again, somewhere about Sept. 4th last (not quite certain as to the date), when in England, I saw two pink convergent streamers meeting in the east just after sunset. Although I often noticed this abroad, I do not remember having seen the convergent streamers in England.

Night after night, in the dry uplands of South Africa in the winter season, these lovely rays were seen, and what always puzzled me was "where were the clouds which caused the rays?" At that time of the year the weather used to be brilliantly clear for days and weeks at a time over a very large extent of country, and so far as one could judge no clouds were in existence within some hundreds of miles. I would ask anyone versed in meteorology at about what height the clouds are which cause these rays, and what distance horizontally from the spectator.

A few days ago I observed the sun's rays diverging in almost all directions from the sun through cloud-apertures, this being in the morning. This was a capital illustration of really parallel lines, converging apparently to a focus.

E. E. Markwick, Lieut.-Col.
Haulbowline, Queenstown, Ireland,
25th Dec., 1891.

PROJECTILES AND THE ROTATION OF THE EARTH.

[33042.]—I BEG to assure "J. R. C." (letter 33011) that I had no intention of casting a slur on his ability. I was much interested by his letter (32969) of Dec. 11. His particulars were new to me, and I was curious to have an explanation of the difficulty; this his letter afforded.

"J. R. C." is, of course, right in assuming that at low-angle fire the deviation is greater near the Poles than near the Equator; but it is not only the difference of the tangential velocity of the two ends of the range that affects the deviation, the elevation has much to do with it; in fact, there is an elevation for each point of latitude, at which the deviation would be *nil* when firing due north in the northern hemisphere. For London, latitude 51° 30', this elevation would be about 75° 9'. Of course, the reason is obvious. If the shot were fired vertically, it would fall to the west; if fired horizontally, it would fall to the east, and 75° 9' is about the elevation at which these two deviations would cancel each other. The elevation for any latitude may easily be found by making the tangent of the angle of elevation equal three times the tangent of the latitude; thus for 51° 30', taking radius as 1,000,000, tan. 51° 30" = 1257173, and three times this equals 3771519, which is the tangent of 75° 9', the required elevation.

I notice a mistake in my letter (33006, p. 375, par. 3). I should have said the distance the shot would fall west would be *double* the difference between an arc measured on the earth's surface, &c. The reason is that the horizontal direction in which the shot is travelling at the time it is fired is only at right angles to the action of gravity; consequently, for the whole of the time after the shot has left the gun, the impulse it has received is in reality carrying it westward as well as upward.

The formula I gave applies to other latitudes than 0°, if multiplied by the cosine of the latitude; thus,

$$\frac{16\,h\ \ \pi\,t\ \cos.\,\lambda}{3\,P} = D,$$

In taking the value of g at the Equator as 32 I was not quite exact, but wished to curtail calculation. **H. Wake.**

[33043.]—IN my last letter (No. 33011) the omission of the words "difference in" in the last sentence but one renders the latter part of the letter utter nonsense. The sentence as, until I saw it in print, I felt confident I had written it, ran as follows:—"As I understand the question, supposing the length of the range constant, the amount of deflection due to the earth's rotation is measured by the difference in tangential velocity of the two ends of the range." By "ends of the range" I mean the position of the gun and that of the first graze of the projectile. Hence, in the neighbourhood of the Pole the deflection would be more appreciable than near the Equator.

The deflection from the rotation of the earth has nothing whatever to do with *drift*—the deflection caused by rifling; but it may *sometimes* happen that one deflection partially, if not wholly, neutralises the other, as, e.g., in the case of a projectile fired northward or southward from a position sufficiently *south* of the Equator. The reason why there is no drift with a round shot is not simply because of its form, but primarily because spherical projectiles are fired only from smooth-bore guns. I may here observe that "Samothes" will find a theory of drift, almost identical with that he offers, in Mackinlay's "Textbook of Gunnery" (date 1883), page 67; and the reasons are there given why such a theory cannot be the true one.

Charing. J. R. C.

DEVIATION OF PROJECTILES.—CLEARING LONDON OF SOME OF ITS DISCOMFORTS.

[33044.]—Some fifteen years ago, when heavy, long-range ordnance were first introduced, I remember asking in your query column whether, as a matter of fact, any allowance was made for deflection of shot caused by the rotation of the earth when such guns were fired north or south.

In reply, one correspondent ("O.M.S.") inquired whether I was labouring under the delusion that the easiest way to get to India is to ascend in a balloon, and wait till India comes round? The query led to a most voluminous correspondence, and if "Samothes," or any other interested correspondent, cares to refer to Vol. XXIV. of the "E.M.," he will find letters throughout nearly the whole of that volume, exhaustively treating the subject.

This deviation is quite apart from "drift," occasioned by rifling, and is the same with smooth bore guns and round shot, as it is with grooved ordnance and conical shot.

In letter 33017 Mr. Love propounds a method of clearing London of some of its discomforts by cutting a tidal waterway from the Bristol Channel to the Thames. He does not appear to realise that to accomplish what he desires, the bed of this channel would throughout require to be beneath sea level, and its length more than three times that of the Manchester Ship Canal.

The main water supply of London would be at once cut off if the channel were connected with the Thames above any of the present intakes, and the question of ways and means renders the scheme chimerical even if serious objections on other grounds did not present themselves on all sides.

H. B. F.

ESTIMATION OF THE DIATONIC INTERVALS.

[33045.]—Mr. Hardie's letter (33000) on this subject is somewhat misleading, and, I fear, needs a little correction. I can imagine no channel of reasoning that would lead a thoughtful mind to some of the conclusions that he arrives at, and I can only suppose that he is to a certain extent labouring in the dark when he tells us that "the intervals between the successive notes of the musical scale must be in reality progressively smaller as we ascend the scale." There are only three kinds of interval in the *diatonic* scale—viz., 8 to 9, 9 to 10, and 15 to 16, and these do not get smaller, but are in the same relations wherever you find them in the Harmonic series, so that the interval 24 to 27 is precisely the same as the interval 8 to 9, only removed one-twelfth higher in pitch.

I gather from Mr. Hardie's letter that his ear is not satisfied with the conclusions he has arrived at. I feel sure his ear is right, and until he makes further inquiry into the subject he may safely trust to his musical ear.

The difference between the ratios 8 to 9 and 15 to 16 can only be arrived at approximately through the medium of vulgar fractions; but it is an error to suppose that there is only the difference of $\frac{7}{120}$ or $\frac{1}{17}$. In an octave placed between the figures 1 and 2 the notes are as follows:—

C	D	E	F	G	A	B	C
1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{3}$	$1\frac{1}{2}$	$1\frac{2}{3}$	$1\frac{7}{8}$	2

and the difference or interval between the notes is consequently—

$\frac{1}{8}$ $\frac{1}{9}$ $\frac{1}{15}$ $\frac{1}{8}$ $\frac{1}{9}$ $\frac{1}{8}$ $\frac{1}{15}$

respectively.

In the ratio of 120 to the octave, the first interval would absorb $\frac{14}{120}$ the second interval $\frac{13\frac{1}{2}}{120}$ and the semitone $\frac{7}{120}$, which is just slightly over the half of the interval with 8 to 9 ratio.

This is as correct as the problem can be solved through the medium of vulgar fractions; but it is not by any means correct, as by continuing the process up the whole series within the octave, only $\frac{87\frac{2}{3}}{120}$ will be absorbed by the various intervals. The only correct way to measure the intervals is by logarithms. By this means it is quite possible to make an exact comparison between the vocal scale (that derived from the harmonic series and which I take Mr. Hardie to allude to as the harmonic scale) and the scale of equal temperament.

Following the illustration given of 1200 to the octave for the equal-tempered instrument, I make the comparison of the two scales to be as follows:—

Instrument.	Voice.
C	C
200	203·91
D	D
200	182·405
E	E
100	111·73
F	F
200	203·91
G	G
200	182·405
A	A
200	203·91
B	B
100	111·73
C	C
1200	1200

In giving the above figures I have followed the illustration given in the former letter; but as some of your readers may wish to make use of them, I append another set of figures without remaining fractions on either side, which will be more easily manipulated. In this series the octave is divided into 3684 parts, and the figures given are the lowest that represent the intervals on both sides without remaining fractions.

Voice.	Instrument.
C	C
626	614
D	D
560	614
E	E
343	307
F	F
626	614
G	G
560	614
A	A
626	614
B	B
343	307
C	C
3684	3684

In this series the size of any interval can be found by addition, or the difference between the voice and instrument may also be found, whatever difference there is, being so many 3684's of an octave. Thus the interval of a skisma (the smallest musical interval) is the difference between the instrumental fourth and the voice fourth. The voice fourth interval is represented above by $\frac{1529}{3684}$, while the instrumental fourth is $\frac{1535}{3684}$, the difference $\frac{6}{3684}$, or $\frac{1}{614}$ being the skisma. The instrumental fourth is therefore a larger interval than the voice. The same experiment with the interval of a fifth will show that the voice is a skisma higher, or larger, than the instrumental fifth. S. Fingland.

INDEX FOR LATHE.

Fig 4

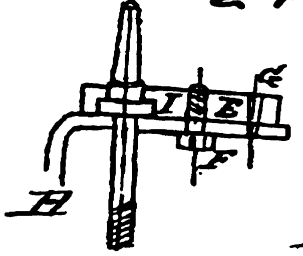


Fig 2

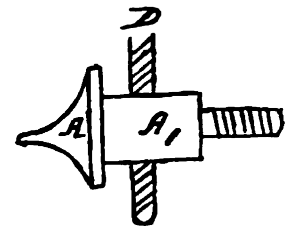


Fig 1

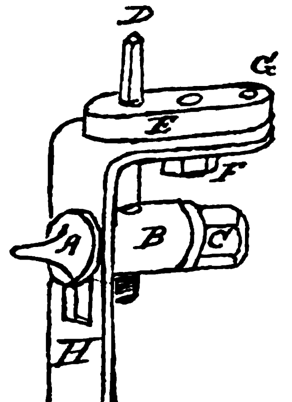
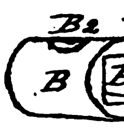


Fig 3



[33046.]—The accompanying sketches show an index I fitted to my lathe about a year ago. The spring is fitted to the lathe-head in the usual way. Fig. 1 represents the top of spring H, which is bent as shown, at right angles. The index pin A moves in a vertical slot cut in H. The back of pin A_1 is filed up square to fit this slot, and prolonged to fit sleeve B; the vertical screw D is tapped into A, as shown. The hole B_2, in Fig. 3, is filed out oblong, so as to allow sleeve B to be tightened up against H with nut C. The adjusting-screw D is fitted with countersunk collar, as shown in Fig. 4, held in place under the steel plate E by the screwed stud F and steady-pin G. I use a sort of large watchkey on screw D, so that it can be removed out of the way when the index is fixed. About a quarter-turn of nut C enables the index to be moved readily either up or down; and as soon as in place it can be locked fast. The slot only requires to be long enough to allow the pin to travel the distance between the widest-spaced holes in the division-plate. Should anyone wish further particulars, I shall be glad to send them. Bod.

Technical Education.—Some public speakers have not yet learned that the stale old babble about technical education for our workmen and the connection between this and the trade of this country, is a pricked bladder from which nearly all the gas has leaked out. Last Saturday, at Newcastle-on-Tyne, Mr. C. Fenwick, M.P., said:—"There never was a period when the working classes of this country needed so much to be well educated, having regard to the competition of foreign countries with our trade and commerce. Mr. Forster saw the necessity of the times when he said, 'Henceforth artisans without education will be useless; their strong thews and sinews will not enable them to contend successfully against their Continental competitors. On education will depend our national safety and our national power.' These words were more true to-day than ever, when great attention was being paid to technical education in France and Germany. By increased technical knowledge the Continent was trying to compete with us in the markets of the world, and it behoved this country not to let her neighbours get ahead of her in this respect." Can Mr. Fenwick show a dozen carpenters, or smiths, or weavers, or fitters on the Continent who can do more or better work than a dozen Englishmen, or as much? It is rather the masters and managers who need the education, than the workmen. The technical teacher has much to learn from the workman.—*The Engineer.*

Pancreatic Juice.—No exact analysis of the pancreatic juice in the healthy human subject having been published, advantage has been taken by Dr. Zavadski of a case recently operated on in Warsaw to obtain such an analysis. The patient was a young woman with a cystic tumour of the pancreas. This tumour was removed by Prof. Kosinsky by means of the thermo-cautery. On the seventh day the tampon which had been put in was taken out, and a drainage-tube inserted. At first the discharge was purulent, and then for a time watery; but subsequently it consisted of the pancreatic juice alone. Before the wound healed, which it did in about seven weeks after the operation, the secretion of twenty-four hours was collected and examined. It was a somewhat tenacious, yellowish, turbid liquid, with a marked alkaline reaction. On analysis it gave—water, 86·405 per cent.; organic compounds, 13·251 per cent.; albuminoid bodies, 9·205 per cent.; extractive matters soluble in alcohol, estimated as nitrogen, 0·827 per cent. Salts: carbonates, chlorides, phosphates, and sulphates of sodium, potassium, calcium, and iron, 0·344 per cent. At a temperature of 100° Fahr. the juice actively converted starch into maltose, egg-albumen into peptone, and olive-oil into an emulsion. On the whole, the human pancreatic juice was found, on comparing it with that of other animals, to resemble most nearly that of the dog, according to Schmidt's analysis.

REPLIES TO QUERIES

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75521.]—**G.N.S.R. Locos.**—The latest type of express passenger engines working on this line are those designed by Mr. Manson, and constructed by Mr. Stephenson, under the superintendence of Mr. James Steele, and similar to No. 77. They were required to run 4,000 miles without showing defect in workmanship, and that distance was in every case completed satisfactorily. The dimensions are: Four-coupled driving and trailing wheels 6ft. 6½in. in diam., and a leading four-wheeled bogie with wheels 3ft. 9½in. in diam.; inside cylinders 18in. by 26in.; heating-surface, 1,193sq.ft. (tubes 1,087sq.ft., and firebox 106sq.ft.); grate area, 18sq.ft. The boiler is fed by two No. 8 Gresham and Craven's injectors, and sand is delivered in front of the driving wheels by Gresham's sanding apparatus. The weight of the engine in working order is 42 tons; distributed, 13 tons 2cwt. on trailing wheels, 14 tons 10cwt. on driving wheels, and 14 tons 8cwt. on bogie wheels. The tender is carried on eight wheels, the four leading wheels being connected to a bogie of the same size as the engine bogie. The tank carries 3,000 gallons of water, and about 3 tons of coal. The weight of the tender when loaded is 36 tons.

Battersea, S.W. H. W. ARMSTRONG.

[75750.]—**Tests for Tin.**—Add H_2S to solution, wash precipitate, and add to it yellow ammonium sulphide; filter, acidify filtrate with HCl, digest with solid Na_2CO_3 to remove arsenic sulphide, if any; heat residue with HCl, dip in some platinum foil with piece of zinc on it—tin deposits on this in spongy form; dissolve this in HCl. Then $HgCl_2$ (mercury perchloride) gives first white, then black precipitate. Ammonia and caustic soda give white precipitates with tin. Stannous salts dissolve in excess of KOH; stannic salts in excess of either reagent. Stannous salts dissolve in yellow amm. sulphide, not in colourless. *Quantitative.*—Precipitate from solution with H_3N (if stannous, oxidise with chlorine, or with HCl and $KClO_3$). The gelatinous precipitate is dissolved in HCl (as little as possible), heated with conc. solution of Glauber's salt, and the hydroxide is precipitated as before, but not gelatinous. Wash, and estimate. *Strength of Solutions.*—Ammonium sulphide. Saturate H_3N with H_2S, then add equal bulk H_3N (this soon turns yellow). HCl, 1 acid 3 water. H_3N, dilute ·880 with 4 parts water. $HgCl_2$, 3·5 grains in about 100c.c. of water. CHEM.

[75787.]—**Curves.**—For 36in., Crown + 13, and + 17; Flint − 14·5, and 0, or flat. They should not be ground less than 50in., for which you might try: Crown + 18 and + 24; Flint, 20 and 0. Or, to do with three moulds: Crown, both sides, + 20·5; Flint − 18 and + 140.

Fulham. J. M.

[75835.]—**Maquay Battery.**—Perhaps it may interest your readers to know that great improvements have lately been made in these batteries, which can be used for arc or incandescent lighting and motive power. The light, when required, can be regulated as easily as gas or oil. There is no trouble of amalgamating the zincs, which is a great advantage. The lamps have been used with great success in this town, including the works of the Board of Health and Rifle Camp. See advertisement. E. R. DALE, A.I.E.E.,

Secretary, Sherborne Electric Installation.

[75868.]—**Check-Valve.**—This check-valve being below the level of the coals in a firebox 14in. high, is just as well placed as it can be. Those who told the querist it was too near the fire for safety should have told him where to place it; but perhaps there is some other reason not stated in the query. As a rule the "feed" should enter a boiler a few inches below the water-level, but should be kept clear of any tube junctions. L. M.

[75871.]—**Division Plate.**—The recent letters on the Index Plate will assist this querist; but it would perhaps be better for him to procure a division plate from the makers. It would, however, be interesting to hear the opinions of readers on this matter, as "division" is an important matter in cutting watch and clock wheels.

T. L.

[75877.]—**Bicycle Fitting.**—I say ditto to the request of "Bike." An article or two on the fitting-up of bicycle parts would, I think, be useful to many readers who have a workshop or a few tools.

R. S.

[75890.]—**Siphon.**—If the siphon is so arranged that the water or other liquid rises above the bend, it ought to discharge completely until air enters the shorter limb; but as soon as that takes place the water left in the shorter limb will flow back.

N. B.

[75891.]—**Indiarubber Cement.** — Is this a rubber cement, or a shellac cement, or what is it? The query should be put to the editor of the work referred to, or the querist should look up his back volumes for a recipe that will suit him. E. M.

[75903.]—**Incandescent Gas-Lights.**—The querist asks for personal experience, which I cannot give; but the following may be useful, as it is a lecture (or the substance of one) given by Mr. Moeller, who referred to the devices of Dr. Auer, who, some years ago, made zirconium and lanthanum his special studies, and he soon found out that the heat-resisting property of these earths was enormous; and he worked out a combination by which several of them used in a hood of cotton produced, with a small Bunsen flame, a brilliant light. It was in this form that the incandescent light was introduced into England. When first supplying the English public with a mantle or hood, the mantle was saturated with a fluid made out of the above-mentioned rare earths in such a proportion that these mantles gave a brilliant white light for about 800 hours. One of the chemicals used at that time, however, could only be obtained in very small quantities, and in supplying lamps in England for about three months, Dr. Auer ran out completely the stock of that material. So the company had to fall back upon a combination of rare earths which would give a perfectly good light for 200 to 300 hours; but after that time the light was only very little better than that given by an ordinary argand burner. It has since been found that the metals required are so plentiful that any amount can be obtained. Under the auspices of the Incandescent Gaslight Company a sure advance has been made, as may be judged from the fact that from September to December last year nearly 20,000 lamps were sold. The mantles now supplied have a capacity of 25 to 28 candle power, and they would burn without much decrease in light for about 800 hours. Mr. Moeller then drew attention to an invention by Dr. Auer, which will make the system one of the most economical and efficient amongst the various ways of illumination. Dr. Auer has succeeded in finding a rare earth whose fire-resisting power is so great that no known heating agent is able to melt it, and this material, in connection with the mantle, produces an incandescence that is absolutely startling. The new burner, according to Mr. Moeller, passes 3ft. of gas, like the old Welsbach burner, and the candle-power obtained on the photometer is equal to 60 candles with 1in. pressure. The mantle that is on this burner will give this light for from 2,000 to 3,000 hours. "I have," he said, "compared up to now our light only as regards illuminating power, and if you consider the cost of the same you will find that though, at first, the expense for putting up our lights is considerably more than, for instance, Argand or Bray's burners, or any other gas-burners in the market, yet the saving of gas is so enormous that the first outlay pays itself in a very short time indeed. . . . If the light were generally adopted to-day all over England, it would certainly mean an enormous falling-off in the revenues of the gas companies; but this fear is groundless, because the demand for light would increase, and for this reason gas companies would ultimately be the gainers." On the other hand, there is at the present moment a very strong feeling among all those who are acquainted with its capabilities to introduce the so-called water-gas. Up to the present moment water-gas has not been successfully worked in England, on account of the various accidents which have occurred with it. But the electric light will ultimately force gas companies to supply the public at a cheaper rate, and the only way of doing this is by introducing water-gas. M. H.

[75907.]—**Damp Cellar.**—If this cellar cannot be drained properly, the best thing will be to have it thickly covered with concrete or asphalte. From the description it appears that the house must be in a very damp position, and is obviously not exactly a healthy dwelling. Perhaps it would be the best plan to have it well drained, so as to carry the water away, if there is a fall in any direction away from the house. How came the house to be built in such a situation? N. W.

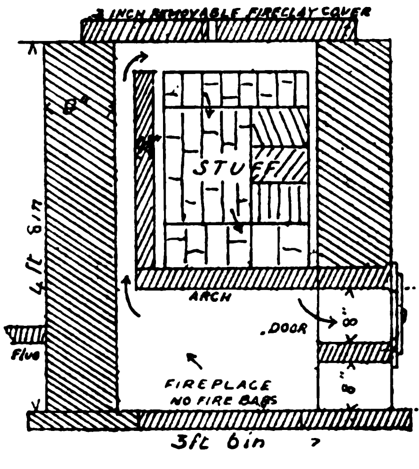
[75934.]—**'Scape Wheel.**—There is no mistake. When a pendulum is hung from a heavy cast-iron bracket securely bolted to a strong wall, the amount of force required to make it swing 2° from the vertical is surprisingly small; and you will find that if you make the lifting pins a 40th of E.C. it will be difficult to make the pallets light enough. Lord Grimthorpe's gravity escapements are, therefore, unsuitable for light pendulums, and I would advise you to make the pendulum 40lb. or more. I have had some experience in making these escapements, and if you meet with any more difficulties, write again, and I will endeavour to assist you.

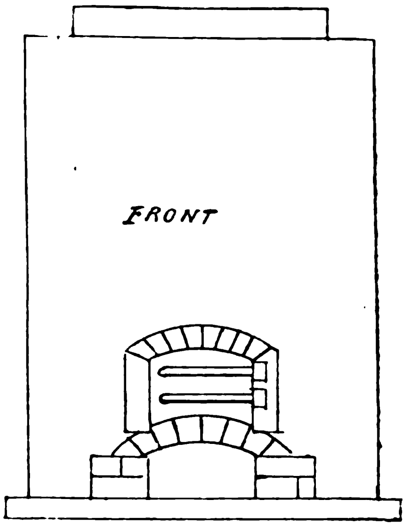
G. T. C.

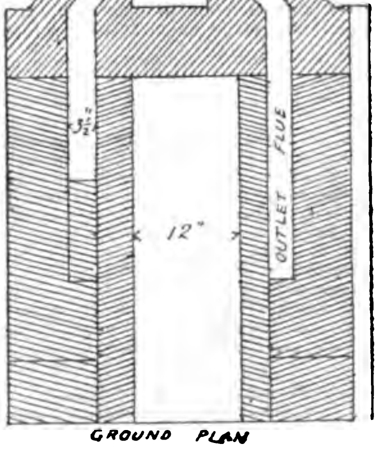
[75943.]—**Brick.**—I don't think it would be superior to pug-mill. But how do you get clay watered without mixer? I have seen no machine, without mixer, to work clay direct from pit.

FRASER.

[75983.]—**Kiln.**—As I promised, I send sketch of small kiln to "Experiment"; but, to begin with, I may say I have had no experience with kilns so small; but sketch is same principle as large ones that work well. I have designed kiln to be quick-heating, and to be filled at top by removing cover, and must be firebrick for inside. I think sketch will explain itself. Heat, after leaving fire, goes up a vent to top of kiln, passes down through stuff that is to be burned (fired, I should say) out at bottom of kiln into flue that leads to chimney. Make holes at bottom of kiln 2in. by 8in.; put a damper at bottom of chimney. FRASER.







[76028.]—**Ellipse.**—When the mathematical "doctors" (i.e., textbooks) disagree, how is the "patient" mechanic to decide? Three formulæ are given for this problem, each of which differs from the next by nearly 4 per cent., or over an inch. Now, to test a doubtful formula it is well to take two opposite extreme cases, and see how they agree with known facts. Therefore (not repeating the formulæ) take a and b as major and minor axes, and P = perimeter, as one extreme; let $a = b$, which gives a circle. Then all the formulæ are correct, for they all give $P = a\pi$. But now take the other extreme, and let b be infinitely small; in this case P is obviously $2a$. Now, none of the three formulæ give this result, for the first gives $\frac{a}{2} . \pi$, the second $\frac{a}{\sqrt{2}} . \pi$, or $\frac{a}{1·414} . \pi$; and the third $\left(\frac{a}{4} + \frac{a}{\sqrt{8}}\right)\pi$, or $\frac{a}{1·65} . \pi$; which last is the nearest, hence $2a = \frac{a}{1·5708} . \pi$. To try it mechanically I described an ellipse as accurately as possible by scale and compass to "Vector's" given dimensions, and then measured the perimeter by a peri-ambulator, the mean of four trials (differing only in the decimals) gave a mean of 27·8, which agrees with "W. S.," but not to four places of decs. Perhaps "F.R.A.S.," or some other of our astronomical friends will give us a solution, since the elliptical orbits of comets and planets are most accurately determined by them. F. G. LL.

[76028.]—**Ellipse.**—The following gives the length of an elliptic quadrant (see Todhunter's "Integral Calculus"), viz.:—

$$s = a\int_0^{\frac{\pi}{2}} \sqrt{1 - e^2 \sin.^2 \phi} . d\phi$$

$$= a\int_0^{\frac{\pi}{2}} \left\{1 - \tfrac{1}{2} e^2 \sin.^2 \phi - \frac{1.1}{2.4} e^4 \sin.^4 \phi - \frac{1.1.3}{2.4.6} e^6 \sin.^6 \phi - \&c.\right\} d\phi$$

$$a = 6. \quad b = 2\tfrac{1}{2}. \quad e = \sqrt{1 - \frac{b^2}{a^2}} = ·9091 \text{ nearly} = \text{excentricity.}$$

If n be even $\int_0^{\frac{\pi}{2}} \sin.^n \phi . d\phi$

$$= \frac{(n-1)(n-3)(n-5)\ldots.1}{n \quad (n-2)(n-4)\ldots.2} . \frac{\pi}{2}$$

$$\text{Periphery of ellipse} = 4 \times 6 \times \pi \left\{\frac{1}{2} - \frac{e^2}{8} - \frac{3e^4}{128} - \&c.\right\} \quad \ldots\ldots(1)$$

$$= 24 \times 3·14159\ [·5 - ·10330 - ·01600 - ·00551 - ·00249 - ·00129 - ·00073 - ·00044 - ·0002 - ·0001 - \&c.]$$

The last two terms are not calculated results. *Periphery of ellipse* = 27·8in. This is exact to one place of decimals. By continuing the process, which is laborious, and by being more exact with the decimals, the length can be found true to four or to any desired number of places of decimals. The numerical value of the periphery cannot be stated exactly. The method is true for all values of e. If e be a maximum, its value is unity; and if a minimum, zero. In the latter case the length from (1) $= 4 \times 6 \times \pi \times \frac{1}{2} = 12\pi$. In the former case the length from (1) $= 4 \times 6 \times \pi \left\{\frac{1}{2} - \frac{1}{8} - \frac{3}{128} - \&c.\right\}$, which, by continuing the series, will be found to approximate to twice the length of the major axis. It is evident, by the aid of letter 33012, that the series $\left\{\frac{1}{2} - \frac{1}{8} - \frac{3}{128} - \&c.\right\} = \frac{1}{\pi}$. J. H. TRUSCOTT.

[76062.]—**Projectiles.**—The ball in the cannon's mouth has a velocity of 1,518ft. per second eastwards. Therefore, if it is to travel vertically upwards, the cannon must be pointed nearly 45° westwards of the vertical line (the velocity of projection being 2,000ft. per second). In this case, however, the ball will never leave the vertical, whilst the cannon will travel eastwards of it. But if the cannon be pointed vertically upwards, the ball will describe a parabola (gravity being supposed to act parallel to the original vertical throughout), and the ball will fall to the east of the cannon. WRANGLER.

[76102.]—**Paraffin Oil.**—The "flashing point" of oil is that temperature at which it is capable of emitting into the atmosphere a vapour in such proportion as to constitute an explosive mixture, which, having exploded, would be exhausted. The "burning point" is that at which the flame will remain on the surface of the oil itself, which continues steadily to burn. If the temperatures you mention refer to Fahrenheit's scale, as I suppose they do, the oil answering to them would be unsafe. A. E. B.

[76105.] — **Siphon.**—Although working many large siphons myself, hundreds of yards in length, I have never gone in for a 3in. diam. pipe; but I believe there is no limit to size if you have a fair fall at your outlet. If your pipe be sound right through, and the water on leaving the pipe falls perpendicularly—i.e., the pipe outlet to deliver a full-size stream—the higher the head the quicker the flow. WM. HOSKEN.

[76105.] — **Siphon.** — There is a relationship between the diameter of a siphon and the relative length of the two limbs. The greater the difference between their lengths the larger may the bore of the siphon be. The question, I should think, is one of velocity, which increases directly as this difference. I will endeavour to explain the matter familiarly. The water in the long limb, by its weight, has a tendency to produce a vacuum at the bend of the siphon, which, when the siphon is working satisfactorily, is filled by the water rising in the shorter limb; but suppose the bore to be of such magnitude that air-bubbles can make their way up the limb with sufficient velocity to anticipate the water rising in the shorter limb, then the siphon will rapidly discharge itself from both limbs. Now, if the water travelled with sufficient velocity, such an inrush of air would be prevented. That the bore of the tube affects the tendency to an inrush of air is obvious, from the fact that in a small tube filled with water air would rise very slowly, and if still smaller, not at all. You do not state the length of your 3½in. pipe; but plainly it is not sufficient to give such a velocity as to keep the atmospheric pressure at bay. Make it longer, and you will get sufficient velocity, or smaller, and under the given circumstances a sufficient obstacle will be presented to the air and water passing each other in the pipe, and the air will be carried out of the pipe before it has time to reach the head of the siphon. A. E. B.

[76106.]—**Problem.**—The equation, worked out, would be as follows:—

$$x = a' \frac{a^3}{l^3 - a^3}$$

$$= a' \frac{27,000}{29,791 - 27,000}$$

$$= a' \frac{27,000}{2,791}$$

$$\frac{x}{a'} = \frac{27,000}{2,791}$$

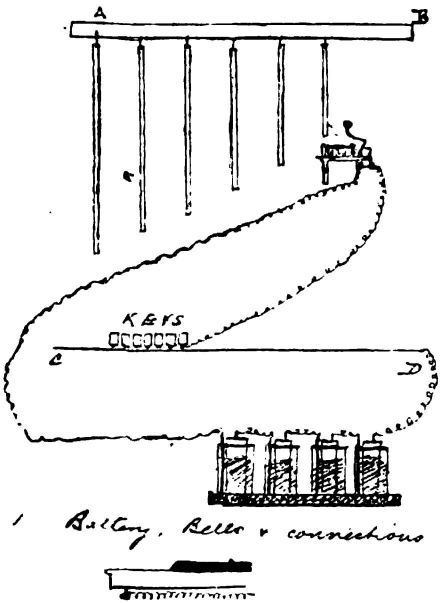
$$a' = \frac{2,791}{27,000} x$$

which would be the required answer. HALITE.

[76109.]—**Steam-Pump.**—Asbestos packing is the best to use with hot water. HALITE.

[76109.]—**Steam-Pump.** —To remedy glands leaking, try Wilcox's patent cork-core packing. Have tried it, and find it superior to any I have used. Their place is in Southwark-street. J. BUSH.

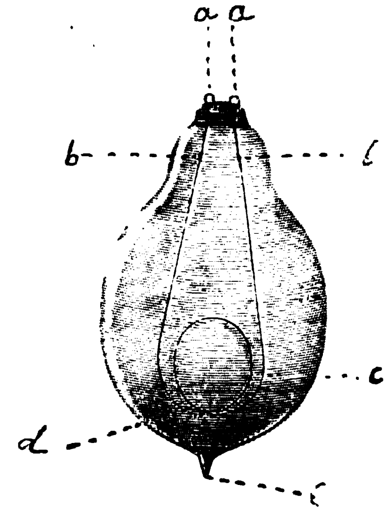
[76112.]—**Organ.**—In reply to this query, I inclose a rough sketch of a plan I intend to adopt to play a set of steel bars from the keys of an organ. The bars are hung as and where required, and in front of each is placed a "single-stroke" electric bell (gong removed) in such a manner as to strike the bar instead of a gong. The wire from one terminal is carried to one pole of a battery (placed where convenient), and the wire from the other is carried to a metal stud fastened under the key corresponding to the note of the bar. Under the keys (as near the front as possible) is fixed a copper rod or wire, in such a position that when a note is pressed down the metal stud will make contact with the rod, and the bell corresponding to that note will strike its bar. The copper rod is connected to the other pole of the battery. The "carillon" may be put into action either by an electric switch, or the copper bar may be made movable. Perhaps the sketch will help to make it clear. The bars may be obtained, ready tuned, from Messrs. Gray and Davison, of London, and the bells are the ordinary Edison "single-stroke" type. T. R.



[76112.]—**Organ.**—I think in one or two back numbers there are devices by which bells or "tuning-forks" were attached to A.O. actions—one, I think, worked out for the late Mr. Gower by the late Mr. M. J. Matthews, in which the action was electric. I do not think the idea worth adopting in any American organ; but the action can be seen to perfection in one of the instruments made by Imhof and Mukle, of Oxford-street, who take the lead in this branch of work. ORGANON.

[76110.]—**Electric Lighting.**—You would require a 30-light dynamo and 2H.P. gas-engine. Cost of dynamo about £25 to £30, according to workmanship; engine, about £100. Probable cost of complete installation about £150. F. C. ALLSOP.

[76116.] — **Carbon Filaments of Lamps.** — Under the rapid molecular motion set up in the mass of the carbon filament during the passage of the current, the carbon gradually disintegrates, and is carried in the form of an impalpable powder to the inner surface of the glass, which after some time becomes so obscured as to prevent, or almost prevent, the passage of light. This effect is specially noticeable if the lamps are "forced"—*id est*, if the current forced through them is greater than they are constructed to carry. I inclose sketch of an incandescent lamp, in which d represents the hollow glass bulb from which the air has been exhausted at the point e which is then sealed; $a\ a$ are two platinum wires terminating outside the bulb in loops, and connected at $b\ b$ by means of a carbonaceous cement to the carbon filament c. S. BOTTONE.



[76116.]—**Carbon.**—The carbons in the lamps last from 500 to 5,000 hours, according to how the lamps are treated. Almost everything depends on this. See the articles "Practical Electric-Light Fitting," where you will find illustrations and descriptions of the lamps. F. C. ALLSOP.

[76116.]—**Carbon.**—Yes, it is true that the carbon filaments break down after a certain time. The life generally of an incandescent lamp is 1,000 hours; but this is sometimes exceeded. On the contrary, some last but 400 or 500 hours; others have been known to go after a few hours' use. The longevity of a lamp depends to a great extent on the way it is treated; sudden rushes of current proving very fatal. If "W. E. S." will write me, I shall be pleased to send him sketches in the various stages of incandescent-lamp manufacture. The subject being so well known, would probably be of little interest to the majority of readers.

St. Paul's-road, Southsea. F. ASKEW.

[76118.]—**Accumulator.**—Since the voltage of an accumulator, no matter what size, is 2 volts, a 5-volt battery would be out of the ordinary—in fact, it could not be constructed to discharge at exactly 5. But you can probably meet your difficulty by placing a resistance in circuit. This does not decrease the voltage, but the current in ampères, and this for lighting lamps will answer nearly as well. From this you will see it is impossible to increase the voltage by reducing the current in ampères, or vice versâ, for the voltage remains constant, no matter what the current flowing may be.

Southsea. F. ASKEW.

[76124.]—**Photography.**—Here is a formula for hydrokinone developer, such as is used for Marion's dry plates, &c.:—Hydrokinone solution: hydrokinone, 40gr.; sodium sulphite (pure), 120gr.; potassium brom., 5gr.; citric acid, 5gr.; water to make up to 10oz. Alkali solution: potas. hydrate (pure), 80gr.; water to make up to 10oz. Equal parts of the hydrokinone and alkali solution to be mixed together at time of using. Fixing bath, ¼lb. of hypo. to 1 quart of water, and plates should be left in twice as long as it takes to fix them visibly.

REBMA.

[76133.]—**To Mr. Allsop or Others.**—It is immaterial which way the bobbin is connected to the line wires, or which pole is used. Wind the bobbin with No. 40 B.W.G. double silk-covered wire to a resistance of 80 ohms, a little under ¼oz. See my book, "Telephones: their Construction and Fitting," for scale drawings of the receivers.

F. C. ALLSOP.

[76134.]—**Magneto Bells.**—To MR. BOTTONE, MR. ALLSOP, AND OTHERS.—The armature of the generator will always remain with its iron core from pole to pole when released. Perhaps you mistake this for sticking. See "Electric-Bell Construction," where you will find detailed drawings of the magneto generator and bell. F. C. ALLSOP.

[76134.]—**Magneto Bells.**—The core of the coil to which the armature of your bell sticks is harder than the other, and consequently retains some of the magnetism imparted to it when the current passes through the coils. A simple method of rectifying is to gum a small piece of paper to the end of the core between it and the armature. By regulating the thickness of the paper, you can make your bell ring perfectly well, and keep good for several months. J. MADEN BEESLEY.

[76136.]—**One-inch Spark Coil.**—"Induction" does not seem to have insulated his primary and secondary from each other; if so, the latter sparks into the former, and the coil is committing suicide. His primary should have been placed in either a tube of ebonite ⅛in. thick, or one of brown paper ¼in. thick, well soaked and surfaced with paraffin; and the secondary wound over that. His large break spark appears to show his condenser is not large enough, and yet its given size should be sufficient. I have never tried rice-paper as an insulator myself, so cannot speak as to its fitness for the purpose. Either over or under insulation will shorten the secondary spark; the former by removing the secondary too far from the primary for full inductive effect, the latter by permitting the layers of secondary to spark into one another. A break should have a good lump of iron (not a mere metal wafer) for a head, and its diameter should correspond with that of the core; its steel spring should be stiff enough to keep contact with the screw-point until the core is fully magnetised; and it should fly back suddenly from the core on the magnetism ceasing. For my own part, I should have employed two (or three) rows of No. 16, instead of four of No. 18, for primary.

B. HARCOURT.

[76137.]—**Stamping Letters on Wood.**—Large box-ends are branded in a machine like a screw-copying press, the brand-plate being heated from below by gas, or otherwise; the wood is placed on brand, and the upper plate screwed down. For small articles, a small screw-copying press or a lever embossing press could be fitted with brand and heating arrangement.

CHAS. R. HALL.

[76141.]—**Deafness.**—Refer to my recent replies to "Troubled Throat," and to "Noises in the Head"; both relate to present query. The aural specialist at the London Homœopathic Hospital is now engaged in the good work of hunting up old medical records (up to, say, 2,000 years ago) of plant-lore, as to their action curative on the human body, Calendula being one which he is now using often curatively in aural diseases, as described in recent numbers of the *Homœopathic World*. Acting on his initiative, I am putting Calendula on its trial. I find it possessed of very great power, medicinally, on various organs and spheres, and of a wide range as to effects in degree. The time will come when, in the immediate future, the (newly-fledged) young doctors of the day will regard, with equally contemptuous scorn, the gross drugging of 1892, as do the present *noviciates* the blood-and-thunder and purgative teatment of their predecessors of the previous century. I have reason to conclude that, applied to the nostrils in 1-drop doses of a dilute form of the tincture made from the green plant in such a manner as to admit of the tincture flowing down that passage (naso-pharyngeal) between the nose and throat, and thus coming in contact with the Eustachian (aural) tube's surface, Calendula (as well as other plants medicinal) has a grand future, with or without assistance from and by other medicines homœopathic, in deafness of throat origin and complication. LYDNEY DISPENSER.

[76141.]—**Deafness.**—Having suffered much with my ears during my younger days, I sympathise with "One Almost Despairing." It is about fifteen years ago since, by the recommendation of a friend, I sought for, and obtained, a letter to attend the University College Hospital, before a Dr. Barker, I think his name was. There they have a special department for treatment of ear diseases, and I should strongly recommend him to endeavour to get advice there, as I believe I derived much benefit from their treatment. The advice I there received, so far as I can remember it, was (1) do not wear plugs of wool in your ears; (2) if your ears discharge, wipe them out with cotton wool: this is done by taking a small pledget of cotton wool, and holding it between the finger and thumb; now take a small piece of wood (I generally used a match), and, putting it into the wool, turn it round (this will give a kind of little elongated cap to the match); insert into the ear gently, and turn it round, but stop directly it begins to hurt you. This cleaning-out I found of the greatest benefit, for the discharge drying inside the ear is often alone the cause of deafness. I also had to syringe my ears with an injection supplied at the hospital, with a particular form of syringe which prevented the liquid from escaping, and compelled it to escape through the nostrils: but this kind of thing, of course, you would not venture upon, except under the highest supervision. Syringing with warm soap-suds is good. And finally, especially in your case, do not "try" your nervous system. A. E. B.

[76142.]—**Hydrometer.**—Specific gravity by immersed volume is the same in all three cases. Let V_0 V_1 V_2 be the volumes immersed in water, ·95 liquid, ·9 liquid. Then

$$1 \times V_0 = \cdot 95 \times V_1 = \cdot 9 \times V_2;$$

Required length: 5in. $= V_1 - V_0 : V_2 - V_0;$

$$= \tfrac{100}{95} V_0 - V_0 : \tfrac{10}{9} V_0 - V_0;$$

$$= \cdot 9 : 19$$

∴ Required length = $\frac{45}{19}$in. = $2\frac{7}{19}$in.

A. A. B.

[76142.]—**Hydrometer.**—

Let unit of vol. = 1 division of stem.

„ x = vol. of hydrometer to zero mark.

∴ when instrument sinks to 6th division,

weight of hydrometer $= (x + 5) \times \cdot 9$, and

„ „ „ $= (x + 0) \times 1$ (in water).

$$\therefore \cdot 9x + 4\cdot 5 = x. \quad \therefore x = 45.$$

Then the density D, corresponding to another division y, can be found thus:—

$$D(x + y) = x.$$
$$\therefore \cdot 95(45 + y) = 45.$$
$$\therefore \cdot 95 \times 45 + \cdot 95y = 45.$$
$$\therefore 42\cdot 75 + \cdot 95y = 45.$$
$$\therefore \cdot 95y = 2\cdot 25.$$
$$\therefore y = \tfrac{225}{95} = 2\tfrac{7}{19}.$$

IOTA DASH.

[76153.]—**Distilled Water for Domestic Use.**—All that is required for distilling water is a vessel in which the water can be converted into steam, and a coil of pipe immersed in cold water, in which the steam is to be condensed. That may be of glass, compo, or tin-lined pipe, but it must be remembered that pure water acts on most substances, and also that it will be necessary to get permission from the Excise, as anything in the shape of a "still" is looked upon with much suspicion, and there may be some "inconvenience" in that direction. An ordinary glass retort, with a receiver, will produce enough distilled water for most "domestic" purposes. It is only necessary to boil the water, and condense the steam that comes over.

NUN. DOR.

[76156.]—**Motor for Boat.**—To MR. BOTTONE.—For your purpose, a small double horseshoe-type motor, such as figured and described in my book, "Electro-Motors," at p. 46, § 16, *et seq.*, will suit you admirably. This weighs about 1lb. when finished, and would give sufficient power to drive your boat, if supplied with current from three chromic acid or accumulator cells. Of course, if your boat is wide in the beam, and could carry a greater weight, you might use a more powerful motor—say a Siemens, or a drum-type motor, with armature 1¾in. diam. by 3in. long. This would take more current—say six cells. The price of the former motor need not exceed 10s.; of the latter, £1 10s. The specific gravity of the fluid in an accumulator should not be allowed to fall below 1·130, which should rise to 1·21 when fully charged.

S. BOTTONE.

[76157.]—**Barley Bread.**—In several of the Welsh counties, owing to their geological formation, much of the soil is prohibitory to the growth of wheat, so that previous to the repeal of the Corn Laws and to the extension of railways, the Welsh farm class generally were fed upon rye bread and upon barley bread, made of a mixture of rye, wheat, and barley flour, &c. Little do the present town residents appreciate what that triad, Cobden, Bright, Gladstone, has done as to bread for the great town centres of England; nor yet to what the motive force of that triad will in the immediate future lead, *in re* British Agriculture, its Shipping, and its Church. I question if an instance can now be found throughout the Principality of either barley or rye being used as or in bread-making; but a small percentage of malt is a wholesome addition. There is a sale for it in Clifton, Bath, &c. Originally it was the subject of a patent, as to which make a search in the Patent Office Records, Chancery-lane, London.

THE LYDNEY DISPENSER.

[76158.]—**Gums Receding.**—If alum-water is not sufficiently active, get a pennyworth of tannic acid, and rub that on with the finger. I saw putty-powder recommended recently as a dentifrice for the purpose, but I should not like to use it, and certainly should not recommend it. Charcoal-powder would probably do all that is required, if the "constitution" is kept in as good a state as is possible. Put the question to the dental editor of the *Weekly Times and Echo*. NUN. DOR.

[76160.]—**Coil.**—The dimensions given, though rather large for a medical coil, will give good results for that purpose if wound with suitable wire. Owing to the presence of the sliding brass tube (for graduating the strength of the secondary currents), there is much space wasted between the core and the primary, and this will militate against its performance as a sparking coil. Besides, for a spark coil there must be a condenser, which you have not mentioned. The following weights of wire will suit the dimensions given by you: Cheeks of coil, 4in. diam.; wire for primary, two layers No. 16 d.c.c., well paraffined; secondary, 1lb. No. 40 single silk-covered, built up in six equal sections side by side, well insulated layer by layer with paraffined bank-post paper. There must be a switch to throw the different sections in or out of series with each other, as required. The condenser should consist of 100 sheets of tinfoil, interleaved with paraffined paper. Battery power required for medical purposes, one chromic acid cell; for experimental work, anything up to six pint chromic cells.

S. BOTTONE.

[76161.]—**Wimshurst Machines.**—To MR. BOTTONE.—The machine described in my book, if well made, with suitable glass, will give sparks from 2in. to 3in. in length, according to the weather. The machine described by "J. W." (James Wimshurst himself) is perfect; but it is an alternating machine, not a direct current. The sectors must not be stuck on both sides of the glass plates; only on the outsides. S. BOTTONE.

[76162.]—**Phonograph.**—The glass diaphragm should be fixed to the under side of the spectacle frame, as follows:—First place a rubber ring (the size of the glass) on the holder; next put the diaphragm on, and then another rubber ring; over that a brass ring, and clamp all together by four screws with large heads. I have made a phonograph with the glass diaphagms clamped in the way described, and get very good results. Only one glass has ever broken, and the machine has had some rather severe tests. H. G. SUGGETT.

[76163.]—**Manchester Dynamo.**—Such a dynamo driven at 1,800 to 2,000 revs. per minute, should furnish enough current to light easily five lamps of 48 to 50 volts, taking about 1 ampère of current each, and giving 16c.p. Being shunt-wound, there would be no danger of injuring the armature by shutting off the lamps. S. BOTTONE.

[76167.]—**L. and N.W.R. "Precedent" Class.**—The dimensions of above are as follows: Wheels, diam. of driving, 6ft. 7½in.; diam. of leading, 3ft. 7½in.; wheel base, leading to driving, 7ft. 5in.; driving to trailing, 8ft. 3in.—total, 15ft. 8in.; cylinders, 17in. diam., and 24in. stroke; boiler, length of, 9ft. 10in.; diam. of, 4ft. 1¼in.; pressure 140lb. per square inch; thickness of plates, $\frac{9}{16}$in.; No. of tubes, 198 of 1⅞in. diam.; firebox, length (top), 4ft. 9⅝in.; bottom, 4ft. 10⅝in.; breadth (top), 3ft. 5¼in.; bottom, 3ft. 6in.; height, 5ft. 9¼in.; heating surface, tubes, 1,013sq.ft.; firebox, 89sq.ft.—total, 1,102sq.ft. Total weight in working order, 32 tons 19cwt.; tractive force, 87·8lb. The first engine built of this class was 2175, "Precedent," Dec. 1874, and the last 789, "Breadalbane," Oct. 1882; but lately Mr. Webb has been rebuilding Ramsbottom's "Newton" class, and assimilating them to his "Precedent" type. I will make a drawing of "Greater Britain," and forward. NORTH-WESTERN.

[76170.]—**Tinning Copper Utensils.**—Some years ago I wrote a lengthy article on this subject, and in a rather recent number of "E. M." described pewterer's solder (2 parts pure tin, 1 part lead) as the only wholesome alloy for coating copper cooking-pots. I have never known old residents in India to suffer by metallic poisoning, and of these some men had been 50 or 60 consecutive years in India. The Anglo-Indian of experience overhauls his kitchen arrangements frequently, and keeps a watchful eye on the solder. Very hot pro-

cesses of native cookery, such as baking poultry and game over a charcoal fire in the usual dengchee (or utensil with a hemispherical bottom) result in the speedy disengagement of solder globules, which fall to the bottom of the gravy, and are quite harmless. Besides this destructive operation, the daily scrubbing of the tinning in the crude native way with sand and wood-ashes abrades the soft alloy, and great is the wasteful loss thereby. Worse far is the use of vegetable acids in curries, &c., if the utensils be badly cleaned and put away for a period; acetate of copper being the poisonous product of such negligence. For the sake of my family I invested in a stock of enamelled saucepans; but owing to the primitive ignorance of my cook, who constantly poured cold liquids into the heated vessels, the enamel was rapidly split and annihilated, my expenditure being fruitless, so I was forced back to the old system. There are beautiful little saucepans now sold in England, silver-lined by electro-deposition; very nice for the nursery or apothecary's decoctions, but beyond the reach of most individuals.
Eos.

[76171.] — **Electro-motor: English and American Wire Gauge.**—The gauges are not the same. No. 18 A. is No. 19 B.W.G., and No. 16 A. is No. 18 B.W.G. I have given comparative tables of the wire gauges on several occasions in the English Mechanic.
S. Bottone.

[76172.]—**Recharging Pitkin Lamp.**—To Mr. Bottone.—Make up some fresh sulphuric acid, strength sulphuric acid one part, water five parts. The specific gravity of this mixture should be 1·130. Charge the cells with this, and place the battery in series with your other cells. Charge until the cell boils up well, or until the specific gravity of the acid has risen to 1·21.
S. Bottone.

[76173.]—**Dancing-Floor.**— Powdered boracic acid is first-rate. For a few pence and very little trouble you will get your floor as slippery as you want it. I sprinkle it from a tin pepper-castor. Do not put much on.
F. G. S.

[76174.]—**Steam Generator.**—To Mr. H. J. Clark.—I have not heard anything of the generator you mention in your letter, but I will send you a sketch of a very good one, if you like. It would be too large to publish in the "E. M."
C. G. M. Bennett.

[76177.] — **Voltmeter.**—To Mr. Bottone.—The tube for the sucking solenoid may be made out of any convenient material, such as pasteboard, sheet zinc, sheet brass, vulcanised fibre, &c., not of iron or any other magnetic metal. I generally make mine from thin sheet brass, two pieces for the sides of this shape)) about 1¼in. long, ¼in. wide, and then two pieces soldered above and below these, so as to form a curved tube. After being dressed with silk to prevent leakage, it is to be wound with wire just as any other bobbin.
S. Bottone.

[76178.]—**Galvanometer.**—Yes, the galvanometer described is sensitive; but of course it is not so sensitive as a properly constructed astatic galvanometer, with needles suspended by silken fibre. But it is quite sensitive enough for what it is intended—viz., a lineman's detector.
S. Bottone.

Heating of Cargoes.—At a recent meeting of the Shipmasters' Society a paper was read by Captain A. G. Froud on "The Heating of Ships and their Cargoes, and the Waste of Heat in Steamers." Captain Froud stated that, to some extent, the heat of ships depended on the materials of which they were constructed, and was influenced by the colour of these materials. It was also influenced very much by the condition of the cargo carried, and by interior and superficial arrangements largely under the control of those having charge. Some minerals, notably coal; animal matter, such as wool; also cotton, jute, flax, esparto, coffee, sugar, copra, rice, seeds, and grain of all sorts, oil and cotton-seed cake, &c., if not well dried, generated heat. A few kinds of manufactured goods, matches, oil cloths, &c., were dangerous, as were some chemicals. An official caution, dated August last, warned shipmasters against the sulphides of sodium and potassium. A recognised authority on Australian cargoes stated that, amongst other articles, copper and antimony ores were specially liable to sweat, and this circumstance should be borne in mind when stowing other goods above them. He advocated the free surface ventilation of coal and other cargoes especially in dry weather, and always, excepting when signs of liability to burn were apparent. The course then was—shut up the holds closely, or act according to the special circumstances of the case. It was the captain's duty to check the shipment of damp cargoes of all kinds as far as possible. Ships should be painted either white, buff, or grey, passenger ships more particularly, and those carrying frozen meats and petroleum would reap great advantages. In fact, according to Captain Froud, everything should be painted a light colour.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75608.	Biunial Lantern, p. 206.
75626.	Shunt Formula, 206.
75652.	Gramme Dynamo, 2 7.
75660.	Fan Blast, 207.
75661.	Fruit Farming, 207.

75872.	Sleep Disease, p. 294.
75886.	Dissecting Leaves, 295.
75897.	Stove, 295.
75898.	Plane Mirror in a Newtonian, 295.
75906.	Spongy Gold, 295.
75917.	Pressure-Gauge and Thermometer for Hot Air, 295.
75918.	Hot-Air Back Pressure Valve, 295.

QUERIES.

[76180.]—**Accumulators.**—Can any reader tell me what I can put on the brass thread, nuts, and washers that connect up my accumulators to keep them clean and free from the effects of the acids?—Young Engine-Driver.

[76181.]—**Electric Lighting.**—Would Mr. Bottone kindly say if the fumes from an accumulator when charging would be objectionable in the house if placed in the cellar, or if placed in a wood-shed? Would the acid water be likely to freeze, and if it did, would it stop the working of the same? I should also like to know how many volts and ampères I may expect from the following dynamo, shunt wound:—Field-magnets are 3½in. by 4in. on the part wound by the wire, and each magnet is wound by 2½lb. 22 wire; the armature is 3½in. long by 1⅝in. diameter; it is wound by ½lb. of 24.—H. W. S.

[76182.]—**Small Steam-Boiler.**—I have a small boiler 2ft. 6in. long, 15in. diameter, central hole or flue, 11½in.; water-space all round, 1⅝in.; outer plate ⅛in. thick, inner one ⅛in. I would feel grateful if some of our practical friends would be kind enough to give me a little information as to capabilities of same in regard to safe limit of pressure, and the full power I may expect to get from it. It will hold about six or seven gallons. It is a wrought-iron boiler all in one piece.—Moonlight.

[76183.] — **New Optical Glass.** — On p. 223, Vol. LIII. occurs the following paragraph:—"An immense improvement has recently been effected in the manufacture of glass for optical instruments by means of the addition to the ordinary materials of phosphorus and chlorine, which, in some as yet unexplained way, cause the glass to be very much more transparent, and enable it to receive a much higher degree of polish than any other optical glass hitherto manufactured. Thus microscopes can be made which will render objects of the diameter of only one-eighth millionth of a millimètre visible, whereas with the best microscopes new in use the diameter of the smallest object that can be seen is one-sixteenth thousandth of a millimètre." This is revolutionary, and yet optical instrument makers' lists contain no allusion to it. Perhaps they have a lot of old glasses to sell which will be worthless almost when this invention becomes a manufacture. Can Mr. Nelson, or some others of your erudite and accomplished contributors give me any information on the matter?—Lancastrian.

[76184.] — **Boring and Turning Engine Cylinders.**—What would be the best machine for a small shop for boring and turning engine cylinders up to, say, 25in diam.? I favour a slide lathe of 16in. or 18in. centre, but I am advised by some to have a mill, and by others to have a turning head. To me this last article is only suited for flywheels.—A. F. Shakespear, London.

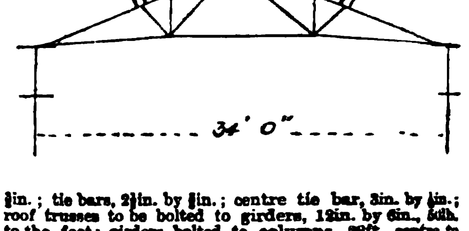
[76185.]—**Proportions of Steam Cylinders.**—What proportions does the thickness of the covers and flanges bear to the bore or diameter of cylinder?—A. F. Shakespear, London.

[76186.]—**Serpollet Steam Generator.**—It is about two years since a description of Serpollet's flattened tube steam generator appeared in your columns, and on p. 48, Vol. LIII., you have a plate and particulars of a steam carriage propelled by a Serpollet generator, and allusion to a tricycle similarly driven. I anticipated many applications of this kind when I first read the account of the boiler if practical experience disclosed no unforeseen drawbacks. I have wondered what happens to the Serpollet tube when the engine it moves is at a standstill. What prevents the tube from becoming red-hot and rapidly burning away? Can anyone tell me any defects discovered in the practical working of the invention up to date?—Lancastrian.

[76187.] — **Sulphuric Acid Manufacture.** — Roscoe gives the chamber crystals as HSO_3NO_2—i.e., H_2SO_4 or $SO_2(OH)_2$, in which one (OH) group is replaced by NO_2. Am I correct in taking this as produced by oxidation of sulphur dioxide by nitric acid in absence of water thus, $SO_2 + HNO_3 = HSO_3NO_2$, and that the crystals decompose with steam, form hydric sulphate and nitrogen trioxide thus, $2(HSO_3NO_2) + H_2O = 2(H_2SO_4) + N_2O_3$? Prof. A. H. Sexton gives the crystals as $(SO_2)_2(NO_2)_2O$, which decompose with water thus, $(SO_2)_2(NO_2)_2O + 2(H_2O) = 2(H_2SO_4) + N_2O_3$. Which is right, Roscoe or Sexton? Is it probable that both are correct, and that the former is the reaction at the entrance to the chamber before the crystals can meet with steam, and the latter the reaction within the chamber in absence of water? Any information on these points will oblige.—Chemicus.

[76188.]—**Violoncello.**—I am about to have my 'cello repaired. I have been advised to have it taken to pieces, also to have some blocks put in. Is this advisable, and will it alter the tone materially? The stamp on the back appears to be "Goulding and Co., London." How old is it likely to be?—J. W. P.

[76189.]—**Roof.**—I should be much obliged if a reader would kindly let me know if the following sizes are sufficiently strong for an iron roof:—Span, 34ft.; rise, ¼ span; to rest on iron girders, covered with Duchess slating on 4½in. by 3in. rafters; purlins, 9in. by 6in., and ventilator with three louvres on top; trusses to be placed 10ft. centre to centre; principal rafters, double bar iron 4in. by ⅜in., kept 1½in. apart by distance pieces; struts, 3in. by 3in. by ⅜in.; tie bars, 2½in. by ⅜in.; centre tie bar, 3in. by ⅜in.; roof trusses to be bolted to girders, 12in. by 6in., 50lb. to the foot; girders bolted to columns, 28ft. centre to centre? Also is girder heavy enough? The roof to be trussed as per inclosed sketch.—M. N.



[76190.]—**Resilvering Glass.**—It is stated that Dr. Common has discovered a new method of silvering mirrors cheap, rapid, and certain. May we hope he will publish the same for the benefit of others, or if any reader has learnt the process, will he send it to "E.M."? I have seen a simple, cheap, and easy process to-day, but was asked £8 for particulars.—E. Holmes.

[76191.]—**Portable Telescope.**—If this should meet Mr. E. M. Nelson's eye, might I trouble him to give some particulars of his small telescope, vide Vol. XLIV. p. 12, which seems to possess extraordinary defining power? Would he please give the focal length, diameter, and form of eye-lenses, with the distance between 1 and 2, 2 and 3, and 3 and 4, counting from eye-lens, also the diameters and positions of diaphragms. The weight appears to be excessive, and the draw a long one for its focal length. My portable telescope with 1⅝in. o.g., and 19·6in. focal length, weighs only 26oz., and is 23in. long when focussed.—Inquisitive.

[76192.]—**Phonograph.**—I have just completed a phonograph, electro-motor, &c., to instructions which have appeared recently by Mr. Gillett in your columns. In trying the instrument with "carriage candles" for wax cylinder, I find that after turning with the tool on supporting column, the wax is slightly ribbed. I cannot get it perfectly smooth; also, on account of the difficulty of properly fixing the recording stylus on the ferrotype plate without piercing. I have made the recording diaphragm of vellum. For taking a record I have made a conical tube of stout paper 17in. long. The instrument is perfectly fitted, but I cannot get a distinct pronunciation; the impression left on the cylinder by the recording stylus is very slight, which, I think, is the cause of failure. Would be obliged if Mr. Gillett could find it convenient to suggest any alteration.—W. R., Glasgow.

[76193.]—**Alcohol.**—Will Mr. Bottone or others kindly explain the action which takes place when equal parts of alcohol and water are mixed together, and which results in a reduction of volume? Also, what would be the reduction in volume when, say, 1 pint of proof spirit and 1 pint of water are mixed?—W. Fairbairn.

[76194.]—**Safety Bicycle.**—I have a safety bicycle, but the cogs are all worn off the hub. Will any kind reader please say if the hub can be repaired, or must I get a new one?—Bike.

[76195.]—**Harmonium, Manual Coupler.**—May I trouble our friends who kindly answered my query (75926) if it is advisable to have one stop to couple the swell to great, or two, one each to treble and bass, and what combination of reeds would form a complete swell added to the 8ft. set in use? As the case is 8ft. high, there is plenty of room, and the wind is more than required.—Hampton.

[76196.]—**Gilding Resist for Transferring from Plates.**—Will some reader who knows give me instructions for making and using suitable resist of cyanide solutions that can be used on steel and copper plate engravings for re-transfer therefrom to the articles to be partly gilt?—Bellcamp.

[76197.]—**Electric Light.**—To Mr. Bottone.—Will you kindly advise me in the following matter? I work in a small office about 10ft. by 8ft., and require a good light for my work, which is principally drawing. The heat of the gas near my head is very great, besides the general unhealthiness of the atmosphere, so I wish to substitute electric light if not too expensive. What size of dynamo, and what power would be required to light one 16c.p. or one 20c.p. lamp, whichever you advise? I have an ¾in. water pipe in office, minimum pressure 40lb., maximum 60lb.; could put any size in, but do not want to alter unless absolutely necessary. Also size, &c., for three lamps? Please give an estimate of cost, including water motor.—Borderer.

[76198.]—**Bunsen v. Daniell Batteries.**—Which battery is the best for electro-gilding, plating, &c., and why? Please describe the proper form of Daniell, and solutions for same. Does this battery require to be dismounted after using same as a Bunsen?—Borderer.

[76199.]—**Battery Cells.**—Will some of the readers of the "E.M." kindly assist me in the following: I have an earthenware pot that I should like to use for a Daniell cell with sulphate of copper, &c., but there is no glaze inside. What is a cheap and effectual substitute? Also what can I saturate a brown-paper and paste tube with for forming a chloride of silver cell? Have tried paraffin wax but it does not answer well, becoming a little soaked with the liquid placed in it.—Resma.

[76200.] — **Accumulators.** — To Mr. Bottone.—I have several accumulators similar to the "E. P. S."

type with lead plates, pasted with a mixture of red lead and sulphuric acid, both positive and negative being pasted the same. The plates are 3in. by 3in., and ¼in. thick, and there are 15 to each cell. Would you kindly tell me how many ampère hours I should get out of each cell, also voltage? Would you also kindly say what current and E.M.F. would be required to charge them? Could this be done by two one-quart Bunsen batteries, and how can I tell when they are fully charged? How many cells should I require to light a 10 c p. lamp? I should not want to charge more than this number at once.—H. R. M.

[76201.]—**To Mr. Bottone.**—On page 124 of your book "Electric Bells"—kindly explain fully how connection between hour-hand, battery, and bell is made in Fig. 62, as it seems to me any contact made between hour-hand of watch would stop latter.—G.

[76202.]—**Teeth and Smoking.**—How can the black oily deposit which comes on the inside of smoker's teeth be cleaned away?—A. C. G.

[76203.]—**Growth after Death.**—Is it a fact that hair and nails can grow after death, and how is this explained?—A. C. G.

[76204.]—**Electric Lamp for Safety Bicycle (Singer's Special Apollo).**—Will "E. L. P.," Mr. Bottone, or any other gentleman well versed in matters electrical be kind enough to give me his opinion as to probable cost, together with rough sketch, of proposed arrangement of electric lamp to be driven by dynamo suitable for a Safety Bicycle, and should I save much by making the various parts myself? I have read two replies to a similar question to that I am now asking in issue of April 3, '91, and it seems to me that a current furnished by a battery is out of the question on account of the liability of the acid getting upset on machine and self, while one cannot think of carrying accumulators owing to the tremendous loss of waste of energy, as I understand only about 50 per cent. of the energy with which they may be charged can afterwards be made use of. I am aware, however, that if the dynamo be driven by the motion of the cycle (as I think would be advisable unless anything better can be suggested) that the light will disappear so soon as one dismounts, and that the power of the light will vary as the speed at which the machine is being driven, unless some regulating arrangement could be attached. Kindly give dimensions of the various parts required, and say number of revolutions per minute (and other particulars) necessary to maintain a light of not less than double that of the best oil lamp at present in use, say, 2½c.p.; therefore it should not be less than 5c.p.—6 volts, is it not? I presume the lamp itself could be placed within the ordinary cycle lamp if reservoir be taken out. Does anyone know anything of an electric lamp about to be brought out (but like many other good things, is too long in coming) by the Gowlands Syndicate Ltd.? If so, it would be interesting to see rough sketch of this arrangement. It is said that by working a small lever on the handle-bar, the lamp can be charged with sufficient current to last half an hour (this by moving the small lever some 30 seconds), that the whole thing, with lamp complete, only weighs about 28oz., and does not depend on any acids, battery, or accumulators. It is to be placed on the market at the price of a good first-class cycle oil lamp—i.e., about 16s.; but I forget the c.p. of the lamp in question. The above is rather a long question, but I am convinced it is one of universal interest, and that there are thousands who, like myself, would pay any price within reason for a good and practical cycle lamp to be lighted by electricity, so soon as it appears on the market, but there must not be any bother with it.—MORE LIGHT.

[76205.]—**Gas Governors.**—About eight years ago I procured a Stott gas governor advertised in your columns, and one of those recommended. Lately it has failed to act satisfactorily, and does not prevent the burners upstairs from blowing. The gas has always been turned on full at the meter. Can any of your readers inform me if its governing power can be restored, and by what means?—R. S.

[76206.]—**Arc Lamp.**—Would some reader kindly tell me whether it is best to connect the solenoid of an equilibrium arc lamp in shunt or in the direct circuit? 2. Is the solenoid of a Brush lamp connected in shunt or direct? 3. What amount of wire, and of what gauge, ought I to put on a solenoid for an arc lamp to take about 3 or 4 amps. and 50 volts? Any particulars about the making would be most acceptable.—T. TAYLOR.

[76207.]—**Sun Distance and Paaallax.**—Referring to the paragraph on the distance of the sun from the earth in the letter of "F.R.A.S." in the "E. M." of Dec. 25, 1891, will he kindly inform us what really is the sun-distance and parallax brought out by Prof. Auwers, of Berlin, from the 1874 and 1882 transits of Venus? Also, the mean distance by all the best observations throughout the world of those two transits, and, in addition, what he considers a good-weighted mean of the same. The present state of ignorance of the general public on the subject is unfortunate.—F. G.

[76208.]—**Electrical Experiments.**—Will one of your readers kindly enlighten me as to the reason of my failure in three experiments in electricity described in "Ganot's Physics" (13th ed., p. 882)? 1. I connected a soft iron wire with the two poles of a bichromate battery of 30 cells, and I could get no iron filings to adhere to it. 2. I can get no indication of magnetism (as tested with a compass needle or with iron filings) in a needle when held in close proximity and at right angles to an insulated copper wire through which a 30-cell current is passing. 3. Neither can I get any negative indications when the needle is placed in a spiral of insulated copper wire. I have tried the latter of very fine wire, and also of wire of moderate thickness, containing perhaps 8 or 10 coils, and the needle projecting slightly at either end.—TYRO.

[76209.]—**Chicken Rearer.**—Will any reader give me instructions how to make a foster mother for rearing chickens, I should prefer it heated by a lamp.—W. E. T.

[76210.]—**Torsion Balance.**—Will any reader kindly reconcile for me the difference which exists in the two subjoined answers to the following question:—"A bar magnet suspended by a fine wire points north and south magnetic, when the wire is not twisted. When the upper end of the wire is turned through 100°, the magnet is deflected 30° from the magnetic meridian. Show how much the upper end of the wire must be turned to deflect the magnet 90° from the meridian." 1. The forces are proportional to $H \times ml \times \sin.\ \theta$, and as H and ml are constant.

$$\therefore \text{Force } 90^\circ : \text{Force } 30^\circ :: \sin.\ 90^\circ : \sin.\ 30 :: 1 : \tfrac{1}{2} :: 2 : 1$$
$$\text{But Force } 30^\circ = 100^\circ - 30^\circ = 70^\circ$$
$$\therefore \text{Force } 90^\circ = 2 \times 70^\circ = 140^\circ$$

But angle of deflection $= 90^\circ \therefore$ torsion head must be turned $140^\circ + 90^\circ = 230^\circ$ (α). II. Force of torsion is proportional to angle of torsion $\therefore$ 2nd force : 1st force :: 3 : 1, since three times as much force must be required to deflect needle through 90° as is required to deflect it through 30°.

$$\text{But 1st force} = 100 - 30 = 70^\circ$$
$$\therefore \text{2nd force} = 210^\circ$$

and torsion head must be turned $210^\circ + 90^\circ = 300^\circ$ (β). It is the divergence between α and β that puzzles me, and I shall be glad of a reader's kind assistance.—STUDENT.

[76211.]—**Devil Insect.**—To ROS.—What is the devil insect of the jungle? To what order does it belong, and what is know of it?—KANBT.

[76212.]—**Wheel Cutting.**—How am I to find the diameter of a wheel which is to have a given number of teeth, e.g., I want to cut three wheels having 12, 18, and 24 teeth ⅛in. pitch? What is their diameter?—TREDAGH.

[76213.]—**Selenium Cell.**—Can any reader inform me how I can render glass a conductor of electricity without losing its transparency? There is some process by electro-plating with gold or platinum, but the difficulty is to retain the transparency, which is essential to the sensitiveness of a selenium cell.—W. B. B.

[76214.]—**Dynamo.**—Will Mr. Bottone or one of your experienced readers assist me in the following? I have a dynamo giving 75 volts 9 amperes. What size and quantity of wire will I require to get best result with Manchester motor having 6in. ring armature at 300ft. distance, and what power I may expect?—FITTER.

[76215.]—**Gas-Engine.**—Is the system of firing a gas-engine by electricity of any advantage or otherwise? —E. P. H.

USEFUL AND SCIENTIFIC NOTES.

THE latest addition to shorthand serial literature is *Pitman's Shorthand Weekly*, which begins in 1892. Many attractive features appear in the first number, in the shape of entertaining reading, humorous illustrations, and prize competitions.

Do Lenses Deteriorate?—Why do portrait lenses deteriorate by use? was the query put to us when calling on a professional portraitist a few days ago. Our friend told us he had a cabinet and *carte* lens by a leading optician that used to give good pictures with the full aperture; now neither would unless it was considerably stopped down. On focussing the lenses on the ground glass, the definition was perfect with each. On examining the camera, however, the cause of the trouble was at once seen. This apparatus, of excellent workmanship, was of the old-fashioned type, made in the wet-collodion days, and the dark slides were fitted with carriers having silver wire corners. By constant abrasion by the sharp edges of the plates the wire had become much worn away, and then, by its thinness, bent. Careful measurement showed that the sensitive plate was sufficiently out of register with the focussing screen to throw any well-corrected lens, when worked with its full aperture, quite out of focus, though not sufficient to do so when tolerably well stopped down. This is not the first time that we have known lenses to be suspected of deterioration, when the camera has been unsuspectingly at fault, even by experienced workers. —*British Journal of Photography*.

Pipe Shafting.—A correspondent, writing to *Power* on pipe shafting, says:—"I have had occasion to put up several lines of shafting, and where pipe is used and run in the direction to screw the thread into the coupling it will hold fast enough. But where they run in a direction to unscrew, you must put a short piece of iron inside the pipe with a hole in each end, and a hole in the pipe to match it. Get flange couplings, and screw each half on tight; then bolt fast, and put bolts through pipe and inside pin, and you will have a solid coupling which will last and hold tight. In putting up bearings where a pulley comes, there must be a bearing close to the pulley, and another not far off. On one shaft which I put up, I had a bearing 1ft. off, and the other one 6ft., and it sprung enough to crystallise and break in a year. In another case, the nearest bearing was 2ft. off, and the other side 6ft., and it broke in six months. In another case, I had a pulley in the centre of an 8ft. shaft, and not transmitting over 2H.P., but it soon crystallised and broke. In all cases, the shaft broke at the hub of the pulley. Since then I have put the bearings close, and for more than two years I have had no trouble. For short lengths the pipe works splendidly. The journals run smoothly by taking the scale off with an old file, and the circulation of the air inside the pipe seems to keep them cool."

THE Austrian Minister of War has issued orders for dogs to be trained for service as messengers and sentinels, and also to assist in discovering the wounded on the field of battle.

ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, December 30, and unacknowledged elsewhere:—

C. D. DAVIES.—E. du Boulay.—Capt. Saunders.—Gyp.—York and Son.—E. M. Nelson.—R. Cornthwaite.—H. Hippisley.—Dr. Aveling.—D. D. K.—D. Blackburn. J. Vinnicombe.—A. Gadd.—T. B.—Richard Brown.—Thermopile.—G. H.—Ex Midland.—H. B. S.

ENGINEER. (The matter is explained in the textbooks, and the questions appear to be taken from examination papers. Why not try the experiment? Is "salt water" merely water containing table-salt in solution, or sea-water?)—APPRENTICE. (Works of the kind you ask for are not published, for the simple reason that the sale would not pay expenses. You might find much information on the subject in back volumes in the form of replies to specific questions; but as a rule information that partakes very much of what are called "trade secrets" is not published in book form except at a high price.)—EDINA. (A surgeon must examine the patient and see what requires to be done. That can be managed in Edinburgh with little trouble.)—VAUXHALL. (Apparently the system is out of order. Put the question to Dr. Allinson, medical editor of the *Weekly Times and Echo*. A complete change of diet and habits would probably prove beneficial.)—ALMA. (There seems to be some misconception. The questions have been answered recently.)—KARL. (We do not know, but, to use your term, we should decidedly think they are "bogus.")—A SUFFERER. (For about the *n*th time we state that water on assuming the solid form (ice) expands, and that if it is confined in lead pipes it will, when it so expands, burst the pipes if the metal has already been stretched to its full limit. The plumber was quite right, and as to your "idea of theory," please see fifty-three back volumes or any textbooks of physics.)—ROGER BACON. (Depends on the quality of the lenses; but see any manual on the magic-lantern, if it is impossible to make the experiment.)—AMATEUR. (Depends on the quality of the glass. As a rule it melts before becoming incandescent.)—A SUFFERER. (That variety of eczema generally accompanies varicose veins. There is really no cure for it but careful attention to diet, and rest of the leg in a horizontal position. We should advise you to wear a Martin's rubber bandage, drop all intoxicants, and live as Dr. Allinson directs in the *Weekly Times and Echo* medical column.)—L. R. (The profit is a hundred per cent., of course. 2. Better use Judson's gold paint; or, better still, buy gilt card or paper and cut the mounts out of that.)—SHORTHAND. (Pitman's.)—G. J. B. (In type).

Caution to Invalids.—The unparalleled success which has attended the efforts of Mr. C. B. Harness and the Medical Battery Company, Limited (of which he is president) to supply the public with genuine curative electrical appliances and perfect methods of treatment, has led to the most bare-faced piracy of their goods, and also to the unscrupulous imitation of their title and advertisements. The Company consider it necessary, therefore, to warn the public against purchasing bogus toy appliances, which have nothing "electric" about them but the name, and are utterly useless for curative purposes. Harness' Electropathic Belts are the only genuine Electric Belts which are guaranteed to imperceptibly generate mild continuous currents of Electricity, and are recommended by the highest living authorities. Every appliance can be seen scientifically tested before being purchased, and, if any of our readers are at all sceptical, they are cordially invited to call at the Company's Electropathic and Zander Institute, 52, Oxford-street (at the corner of Rathbone-place), London, W., and thoroughly satisfy themselves Consultations and pamphlets free.

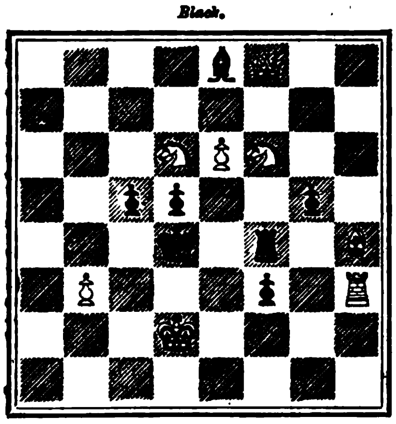
Elastic Oil-Proof Enamel.—The following recipe is said to make a good elastic oil-proof enamel:—Take 1lb. good clear glue, 1oz. oxide of zinc (commercial) 1oz. precipitated chalk, ½oz. dry white lead, 3oz. glycerine. Make a paste of the four ingredients named in the formula by rubbing them up into a cream, then stir them through the liquid glue, while the glue is heated to about the consistency of syrup. Stir thoroughly, and it is ready for use in the white. Colour if necessary with aniline any shade you fancy, or if you can use any dry bronze powders just enough to give it a bronze cast, and then add the aniline shade you fancy; or you can use any dry colours, such as vermilion, chrome, or ochre, by first rubbing them up in a little methylated spirit or wood alcohol. You then get the benefit of them. This composition must in all cases be used warm, and can be reheated any number of times in a body, but in using with a brush, after using allow the brush to remain in the composition or in water to prevent it drying, as it is difficult to cleanse the brush again."

CHESS.

All communications for this column to be sent to the Chess Editor, at the office, 332, Strand.

PROBLEM MCCLXXXVII.—By J. Nield.

Black.



White. [8 + 7.

White to play and mate in two moves.

Solution to 1285.

White.	*Black.*
1. Kt-Kt 5.	Any.
2. Mates.	

NOTICES TO CORRESPONDENTS.

Correct solutions to 1285 by W. F. Smith, L. Pfungst, Alex. Anderson, C. S. Bright (Genoa), J. Kistruck, A. G. Fellows, H. P. Hosken, F. Slade, and G. H. Inson; to 1284 by H. P. Hosken (a beautiful little problem) and C. S. Bright; to 1283 by C. S. Bright.

A. G. Fellows.—We have destroyed both the problems.

R. Inwards.—Too obvious; the idea, moreover, has been well worked, and is, after all, only a trick.

W. L. Martin.—Your solution to 1284 is incorrect.

The Boden Kieseritsky Gambit —1. P-K 4, P-K 4; 2. B-Q B 4, Kt-K B 3; 3. Kt-K B 3, Kt takes P; 4. Kt-B 3, Kt takes Kt; 5. Q P takes Kt, P-K B 3; 6. Castles, Q-K 2; 7. R-K sq, P-Q 3; 8. Kt-K R 4. We will now discuss Black's rejoinder P-K Kt 3. (1) 9. P-B 4, B-K 3; 10. B-Q 3, Kt-B 3; 11. P-B 5, P-K Kt 4; 12. P takes B, P takes Kt; 13. Q-R 5 (ch), K-Q sq; 14. R-K B sq, Q takes P; 15. R takes P, &c. (2) 9. P-B 4, P-K B 4 (?); 10. P takes P (!). Q takes Kt; 11. P takes P (dis ch), K-Q sq; 12. B-Q Kt 5, B takes P (or P-B 3; 13. P-K Kt 3, Q-B 3; 14. B-K B 4, P takes B; 15. B-K 5. Q-B 2; 16. B takes R, &c.); 13. P-K Kt 3. Q-B 3; 14. Q-Q 4, Kt-Q 2 (!) (if Q takes Q; 15. B-Kt 5 (ch), B-K 2; 16. B takes B mate. And if 14. . . . R-K B sq; 15. Q takes Q (ch), R takes Q; 16. R-K 8 mate); 15. B-K Kt 5, Q takes B; 16. Q takes R (ch), B-B sq; 17. Q takes B (ch), Kt takes Q; 18. R-K 8 mate. (3) 9. P-B 4, P-K B 4 (?); 10. Kt-B 3 (?), P-K 5; 11. Kt-Kt 5, B-Kt 2; 12. B-B 7 (ch), K-B sq; 13. B-Kt 3, and white appears to have a good game.

TERMS OF SUBSCRIPTION.

PAYABLE IN ADVANCE.

5s. 6d. for Six Months and 11s. for Twelve Months, post free to any part of the United Kingdom. For the United States, 13s., or 3dol. 25c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (viâ Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

The remittance should be made by Post Office Order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 4d. each to cover extra postage.

Messrs. James W. Queen and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 3d. each copy, to cover extra postage.

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All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post free from the office (except index numbers, which are 3d. each, or post free, 3½d.)

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Holloway's Pills overcome all obstructions tending to produce ill-health, and institute regular actions in organs that are faulty from derangement or debility. The dyspeptic, weak, and nervous may rely on these Pills as their best friends and comforters. They improve the appetite and thoroughly invigorate the digestive apparatus.

USEFUL AND SCIENTIFIC NOTES.

The New York *Engineering News* says that prehistoric irrigation canals in Arizona are "really worthy of more notice than is usually given them. The Salt and Gila River valleys are intersected by a vast network of these canals, which antedate, at least, the arrival of Coronado in 1552, for he mentions these ruins and the traditions of the Indians regarding a once dense population in this region. Modern engineers cannot improve upon the lines of these canals, nor in the selection of points of diversion from the rivers. The first irrigation canal in this section, the one that has made Phoenix, with its present population of 20,000, simply followed the lines of one of these old canals. Their extent may be appreciated when it is said that in the Salt River valley alone the land covered by these canals once aggregated over 250,000 acres, and the canals themselves, with their laterals, must have exceeded 1,000 miles in length. This country is filled with prehistoric ruins, with walls of stone or adobe, and almost every acre contains fragments of pottery, steel ornaments, stone implements, and other remains of a population which can only be estimated in its aggregate."

At a recent meeting of the Royal Society, Prof. Dewar read a paper on "Oxygen and Magnetism." He has resumed the investigation of the properties of liquid oxygen. Faraday, more than forty years ago, proved that oxygen alone among known gases is magnetic, and Prof. Dewar sought to determine what effect a temperature of 180° Cent. below zero would have upon its behaviour in the magnetic field. Having previously ascertained that liquid oxygen does not moisten or adhere to rock crystal, and consequently maintains in contact with that substance a perfect spheroidal condition, he poured the liquefied gas into a shallow saucer of rock crystal, and placed it between the poles of a powerful electro-magnet. He expected some such result as the total or partial arrest under magnetic stress of the violent agitation caused by the ebullition of the spheroidal mass. But on the magnet being excited, the whole mass of liquid oxygen was literally lifted through the air, and remained adherent to the poles until dissipated as gas by the heat of the metal. The feeble magnetism of oxygen at ordinary temperatures had become a force to which no solution of a magnetic metal offers any parallel.

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The address is included as part of the Advertisement, and charged for.

Advertisements must reach the Office by 1 p.m. on Wednesday to insure insertion in the following Friday's number.

OUR EXCHANGE COLUMN.

The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.

Chenies Street Exchange and Purchase of all kinds of Scientific Apparatus on which something can be earned. Description first.—A. Caplatzi.

Wanted, good useful **Exchange** and part cash for following goods. Bradford's Vowel Y Washing Machine and Wringer, equal to new.—Below.

Two handsome plated brass Duplex **Lamps**, 29in. high to burners, cut glass vases, never used; Tangye's Pulley Block, 10 cwt., and chains.

Bench Drilling Machine, with 22in. flywheel; welded iron bath boiler, 12in. wide, never used; Mechanical Telephone, and 50 yards wire.

Seventy Magnetic and other **Indicator Movements**, Magic Lantern, 2in. condenser, 50 slides, Mechanical Chromatrope, &c.; portable Electric Bell, ordinary Electric Bell, wire, battery, and push.

Gramme Series Dynamo, 50a. 50v., splendid machine, two double carbon Brush Arc Lamps, hangers and globes, quantity second-hand cable.

2H.P. **Horizontal Engine**, with vertical 3H.P. boiler and all fittings, good maker, in good order guaranteed, four pairs quite new Acme skates.

Flywheel, 5½ft. by 6in. face, with 3in. crank-shaft, &c, cast iron Saddle Boiler, 20in., Kelley's "Engineer's and Iron Trade Directory" 1886.

2H.P. portable **Vertical Engine** and **Boiler**, Hindley, on four wheels, and shafts, recently overhauled and painted, thorough order.—W. Clifford, Charlbury, Oxfordshire.

New **Ediswan Lamp**, brass holders, switches, roses, brackets, bought for cash or exchanged.—Bowron.

Any kind of small **Electric Apparatus** bought.—G. Bowron, 93, Praed-street, London, W.

Ten **Mesmeric Discs**, 52in. Bicycle (Special Club), and a few Books. Exchange for anything. Stamp for reply.—J. Taylor, 309, Bury-road, Rochdale.

Charles Cook's exchange accepted.—Write, John Sayer, Mechanic, Bowes, via Darlington.

Hand-sewing **Machine** (Jones). in thorough working order. Exchange for revolvers or pistols with ammunition.—A. Archer, Chesterton, near Bicester.

Wanted, pair Ader **Telephones**, give in exchange Bicycle, tyres good as new, value £3.—Alfred Stent, Jun., Havant, Hants.

Spon's "**Workshop Receipts**," 5th series, new, and unmarked; also 120 numbers of "Work." Exchange best on Anatomy or Physics, or offers.—R. Woodforde, The shrubbery, Weston-s-Mare.

Text and School Books on Divinity, Science, History, Geography, English, Languages, Mathematics, in exchange for fossils, shells, minerals, slides. — List, 5, Venetia-road, Harringay, N.

Walking Stick Air Gun, complete; pair new Binoculars. Wanted, small Lathe or offers mechanical. No post cards.—B., 38, Roberts-street, Manselton, Swansea.

Powerful **Medical Battery**, also Horizontal Engine. Exchange quarter-plate Camera and stand, complete, to value, £3.—Halliwell, 54, Sandal-street, Newton, Manchester.

Oscillating **Marine Engine**, cylinders each 1⅛in. by 1in. Exchange for small lathe, tools, or offers.—Brockhurst, Church Stretton, Shropshire.

Will exchange **Whole or Part of Following** Goods for good ½-plate Lenses. Electrical Lantern, or Engineering Apparatus.—Morley, Norton, Tenby. No cards.

½-plate mahogany sliding **Camera**, two slides, portrait lens, Jerome; 7½ by 5½ mahogany front-sliding Camera, one slide, Horne; three tripod stands.

Framed mahogany **Printing Frames**, plate-glass fronts, 6½ by 5, 7½ by 5½, 8 by 6, 9½ by 7½, 10½ by 7½, 13½ by 11½.

Plate Boxes, 6 by 4¾, 6½ by 6; whole plate glass Bath, ½-plate do., deal case, Argentometer, Pestle and Mortar. Details stamped wrapper.

Important notice.—100 gross of **Whitworth Taps**, Plug, and Taper, made of best cast steel, from 1-16, 3-32, 1-8, 5-32, 6-32, 7-32, new.—Below.

Six large size **Ebonite Leclanche Batteries**, Fletcher Gas Furnace, Hot-Air Engine, Simplex Dynamo, laminated armature wound, 30c.p.—A. King, James-street, Sheerness.

Dynamo, Manchester 100c.p., "Bourne on Steam-Engine," Engine and Boiler, about ½-horse. Offers invited, or exchange for 2H.P. Engine and boiler combined and cash, or Oil Engine.—A. J. Pool, Chipstable, Taunton.

Halse's **Medical Coil**, cost £8; brass Lever Safety Valve, and Brass Steam Whistle. Exchange anything value £2 for lot.—Halmshaw, 76, Orchard-street, Bradford.

Half-horse vertical **Boiler**, thick iron, 18 tubes, best fittings, as new, worth £10. Exchange gold watch or offers.—Charles Walter, Springfield, Wellington, Somerset.

Wanted, Steam Engine and **Boiler** about 4H.P. Exchange below.—Address, Vyvyan Pittar, 48, Hungerford-road, London, N.

Primary Battery, in solid mahogany case, with regulating gear, suitable for lighting or working motor, current 10 amp., 50 volts. Exchange for above.

Leading Screw, 3ft. 9in. by ⅞in. diameter, ¼in. pitch, double thread. Offers. Anything wanted, four-jaw or other good chuck, suit 3½in. lathe.—Below.

Wanted, set Model **Engine** Castings and Forgings in their ordinary metal (not all brass). Offers.—H. Goulding, 31, Marine Approach, South Shields.

Pocket Voltmeter, 1-140 volts, cost £2 10s.; Accumulators, Launch Engine, 2½in. stroke, 1¼ bore; Adjustable Brasses, or sell separate. Wanted, 1½-horse Launch Boiler, with fittings.—C. A. Vauderveli, 28, Aldridge-road, Westbourne-park.

Lathe wanted. Exchange 50in. Rudge **Ordinary**, to value £3.—Robinson, 231, Hornsey-road, Holloway, N.

Cowper **Printing Press**, Weston's ½-ton Blocks, Carpenter's Bench, with parallel vice, new; Copying Press, Square Thread Screw, 1½in. by 33in. long.

Wanted in exchange for any of **Above**, 4½ or 5in. back geared Lathe or Drilling Machine.—Alfred, 129, Lordship-lane, East Dulwich.

Lathe, 4½ or 5in., wanted in exchange for **Safety** Bicycle, genuine Rover, and cash to value.—Alfred, 129, Lordship lane, East Dulwich.

Wanted, exchange **Headstock**, Face-plate, Poppet-head, T-rests, 7in. centre, for smaller, about 4in. centre, must be in good condition.—Scott, 21, Walmsley-street, Fleetwood.

Rhumkorff Coil, 2in. spark; Phonograph, good order, new; Stott Gas Governor. Exchange Camera, Lantern, or offers.—75, Church-street, Littleborough.

7in. centre Compound **Slide-rest**, good as new. Exchange to value of 50s. Also four-jaw Chuck, 14in. dia. Exchange to value of 55s.—James Underwood, Leighton Buzzard.

"**Amateur Mechanics**," Vol. I., by Paul Hasluck, illustrated, 46 full-page plates and 300 cuts, condition as new. What offers?—J. W. Dear, Baldock.

"**Notes on Building Construction**," Rivington's, part I., for elementary stage, with 325 woodcuts, in new condition. Best student's book. What offers?—J. W. Dear, Baldock.

Magneto-Electric Machine, good order, invaluable for invalids, with adjustable current to suit. Cost 15s., in box complete. What offers?—J. W. Dear, Baldock.

Vertical Engine, 2½ bore, 4in. stroke, spring piston oil cup, drain cocks, &c., steel forged crank shaft, G.M. bearings throughout, with pump complete.—Below.

Vertical Boiler, 2ft. 6in. high, 1ft. 6in. diam., ¼ plate, internal fire box, massive set of G.M. fittings, smoke, steam, exhaust, and feed pipes fitted.—Below.

Exchange **Above**, ½ Engine and Boiler, in working order, for H and Planer, Gas Engine or Organ. Must be good. Particulars, stamp.—Below.

Magic Lantern (good), 4in. condensers, new, suitable for oil or lime light, retort jet, purifier, limes, &c, value 50s. Part exchange. Seen any time.—Below.

Breast Drill, gear wheels, 6 drills, complete, new; value 10s.; also Ratchet Drill, value 10s.; small fret saw, machine with drill, 6s. Part exchange. Stamp for details.

Horizontal **Feed Pump**, new, ⅝ ram, value 10s. Castings for same, value 2s. 6d.; Copper Boiler, riveted, suit 1½ bore Engine, all fittings, value 25s.

Dynamo, with 3 lamps, value 50s.; several model Engines, all good. Exchange offers and inspection invited. Stamp for reply.—Mechanic, 75, East-road, West Ham, E.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, JANUARY 8, 1892.

PROGRESS OF ASTRONOMY IN 1891.

WITH the advent of another year we give, as is our annual custom, a concise summary of the astronomical events and discoveries during the one which has just closed: a summary which, as on former occasions, will be found to contain a record of real and enduring progress.

Beginning, as usual, with the Sun, we may remark briefly that the two Solar Eclipses of June 6th and Nov. 30th being, even where visible, annular and partial respectively, presented no phenomena worthy of being chronicled. Two very important memoirs on the subject of the Solar Parallax have appeared during 1891. The first was the Appendix III. to the "Washington Observations" for 1885, by Prof. Wm. Harkness, of the United States Navy, who, under the title of "The Solar Parallax and its Related Constants, including the Figure and Density of the Earth," has produced one of the most masterly discussions of the whole question that has, so far, appeared at all. No student of Physical Astronomy can afford to dispense with a careful and deliberate perusal of Mr. Harkness's book, which forms an encyclopædic repertory of the entire subject. The second Memoir to which we have referred was published by Dr. Auwers in No. 3066 of the *Astronomische Nachrichten*, and gives the results of the reduction and discussion of 754 measures of the distance of Venus from the Sun's Limb during the Transits of 1874 and 1882, made by the German observers with the Heliometer: the result from the 1874 Transit coming out as 8·877″ ± 0·043; and that from the Transit of 1882 as 8·879″ ± 0·037″. A most important advance in the study of the Solar prominences has been made by Prof. G. E. Hale, Director of the new Observatory at Kenwood, Chicago, U.S. This very able and rising young spectroscopist has succeeded in photographing prominences on the H and K lines of the Spectrum, and has further obtained a series of bright lines in the Spectrum of a prominence, which with practical certainty correspond to the dark hydrogen lines which Dr. Huggins discovered in the ultra-violet region of stars of the Sirius and Vega type.

The Transit of Mercury of May 9th—10th was observed at several Continental stations and in South Australia; but nothing worthy of record appears to have been noted.

We last year made brief reference (Vol. LII. p. 409) to an alleged astonishing discovery by Signor Schiaparelli that the periods of rotation and revolution of Venus were (as in the case of our own moon) identical. The conclusions of the great Milanese astronomer, which were naturally received with much caution, have been since most gravely assailed and seriously shaken by those two skilled observers and admirable draughtsmen MM. Niesten and Stuuyvaert, of the Belgian Royal Observatory: who find that a period of 23 hours suits their own observations from 1881 to 1890 so well, that they furnish what might almost be described as an elaborate map of Venus founded on them. Comparison of this map with drawings by Schiaparelli and Perrotin on specified dates "establish beyond criticism," as they themselves say, the correctness of de Vico's classical determination of the period of Venus's rotation.

From observations of Vesta, M. G. Leveau assigns masses to Mars and Jupiter differing from those ordinarily accepted. The following are his values:—Jupiter $\frac{1}{1045·6}$, and Mars $\frac{1}{3700000}$.

VOL. LIV.—No. 1398.

Up to October 15 no less than 22 new Minor planets had been discovered, by some observers with plenty of idle time on their hands. This, we imagine—but we speak with some hesitation—raises the number of known planetoids to 321; but as there are doubtless 3,210 or 32,100 (varying from the size of the Piccadilly Circus down to that of a cricket-ball) yet undiscovered—the precise number is of but little consequence, indeed.

Notable indications of activity and disturbance have been visible upon Jupiter's disc during the year which has just come to an end; and Mr. A. Stanley Williams has called attention to the intensification of the colour of the well-known Great Red Spot. MM. Niesten and Stuuyvaert have been making a careful series of observations to determine the relative altitudes of the various Jovian details; with the result that the Red Spot would seem to be an actual prominence on the body of the planet itself, the grey and reddish belts being very near the surface, and the white markings and spots higher up in the ambient envelope of the planet. M. Belopolsky has published a memoir on the rotation of Jupiter, in which he seeks to show that while the surface of the planet—taken as a whole—rotates at a constant speed (about 9h. 55m.), the equatorial belt spins round in only 9h. 50·5m. This region of more rapid rotation is not symmetrical, but extends farther into the northern hemisphere.

Two new Comets were discovered during 1891, both by Prof. Barnard—one on March 29th, the other on October 2nd. Both were moving rapidly southward at the date of their discovery, and soon travelled out of sight. Of periodical ones, Wolf's of 1884 was rediscovered by Dr. Spitaler on May 2nd, and by Prof. Barnard two days later. Mr. Barnard also rediscovered Encke's comet on August 1st; as he did also the Tempel-Swift one of 1869 and 1880 on September 28th. The latter was picked up in this country two nights later by Mr. W. F. Denning, of Bristol. It may be remarked that its position differed widely from that given in Bossert's ephemeris.

That indefatigable observer, Prof. Swift, continues his original discoveries of Nebulæ (already amounting to some 800!), and is engaged in the preparation of a catalogue of those last detected.

The Photographic Chart of the Heavens continues to be talked about and written about. Meanwhile that real and earnest servant of science, Dr. Gill, Her Majesty's Astronomer at the Cape, has practically brought a preliminary photographic survey of the Southern Heavens to a conclusion. Presumably he was his own committee, and so absolved himself from the necessity of speechifying and passing resolutions.

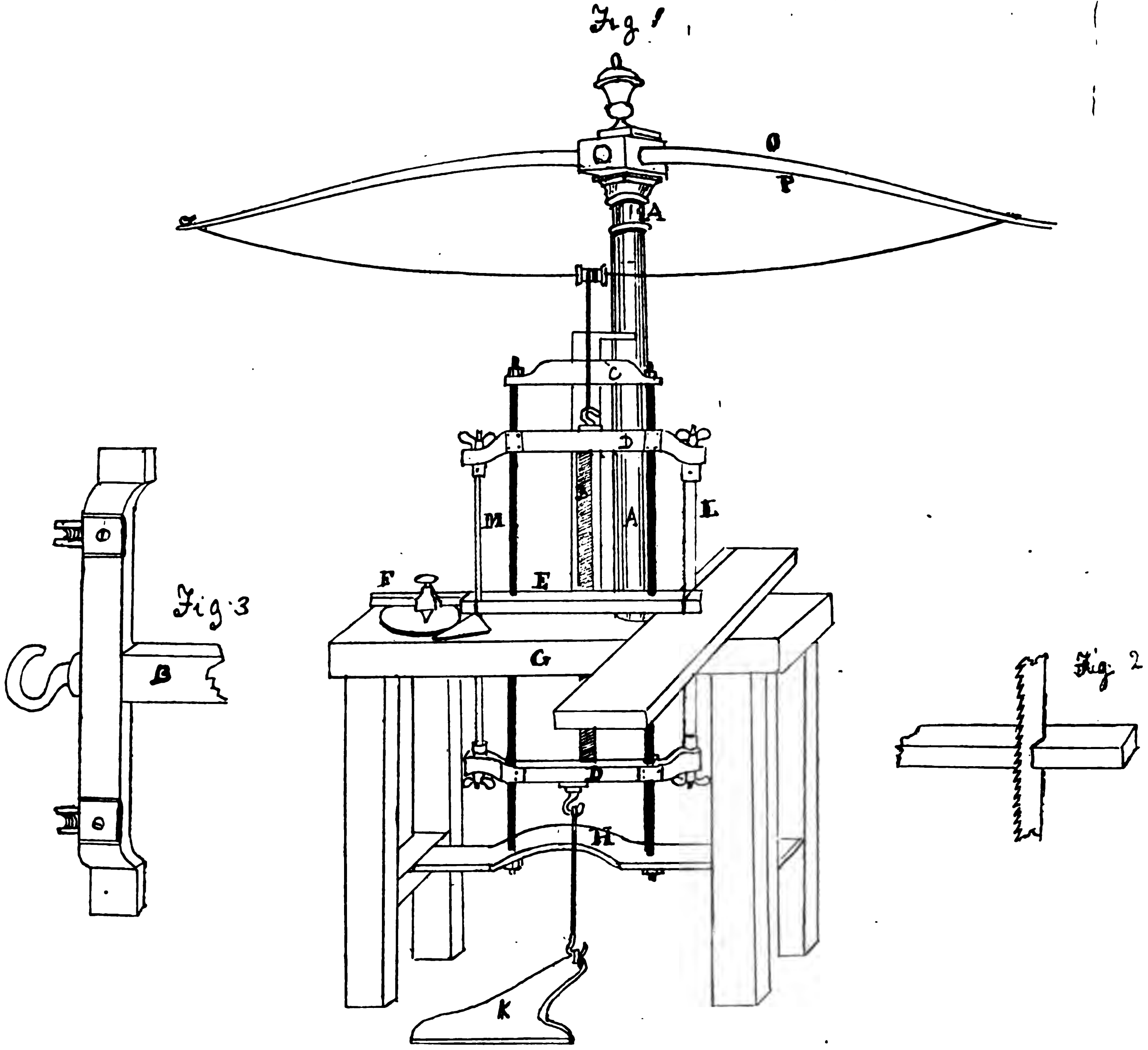
Stellar photography has, at any rate, most materially modified our views as to the structure of the visible Sidereal Universe. Conspicuous among those who have thus aided in advancing our knowledge of the shape and dimensions of our surrounding star system must be mentioned Mr. Russell, director of the Sydney Observatory, N.S.W.; Dr. Max Wolf, of Heidelberg; and Prof. Barnard, of the Lick Observatory. We referred last year to Miss A. M. Clerke's splendid work "The System of the Stars," in which the subject of the construction of the Sidereal Universe was treated at once with that charm of diction and rigid scientific exactness which characterise all the work of its gifted author. We may here add that the whole subject, illustrated by reproductions of the original photographs, has been lucidly explained to the general reader in the columns of our contemporary, *Knowledge*, by its editor, Mr. A. Cowper Ranyard. Mr. Roberts continues sedulously to work at those astonishing transcripts of the sky, which have long placed him at the head of our English stellar photographers.

Some most remarkable results in Stellar Spectroscopy have been obtained at Potsdam by Prof. Vogel and Dr. Scheiner, who have employed photography to register the very minute displacement of Stellar spectral lines, as compared with those of terrestrial elements. By using the hydrogen line near G, and, later, certain iron lines near it, the rates of motion in the line of sight of some 50 stars have been recorded with hitherto unapproached accuracy. How accurate Prof. Vogel's method is may be gathered from the fact that his measures of the motion of Venus in the line of sight (an independently and, of course, thoroughly well-known quantity) differed just 0·4 mile! from those calculated. It is known how the photographs of the spectrum of ζ Ursæ Majoris taken at Harvard showed a duplication of the K line at irregular intervals; and how further investigation revealed the fact that this star was a binary with a period of some 105 days; as also how the duplicity of β Aurigæ was similary detected, and that star shown to be also a binary, but with a period of four days only. These results have since been confirmed by Prof. Vogel, who has further deduced from his photographs of the spectrum of Algol that the dark compenent, nearly as large as our Sun, but only one quarter of his mass, revolves with a velocity of 55 miles a second; and the bright or visible companion, with double the mass, with a velocity of 26 miles per second. α Virginis and Mizar have, in like manner, been shown to be binary systems. Mr. Keeler, at Lick, too, with the dispersion obtained in the 3rd, and even the 4th order of spectrum, in a grating containing 14,438 lines to the inch, has made eye observations of the spectra of Arcturus, and of the nebula Σ 6, which are comparable in accuracy with the Potsdam photographic ones. Happily, no more suppositious spectra of Vega, or any other star, have been "communicated" to the Royal Astronomical Society; which has not again been made the laughing-stock of German and American astronomers by its publication of South Kensington spectroscopic results.

It will be remembered how M. Loewy, of the Paris Observatory, devised an ingenious method of determining the Constant of Aberration by a reflecting prism-shaped double mirror, placed over the objective of a telescope so as to throw the images of two stars widely separated in the heavens simultaneously into the field of view, and enable their distance to be measured—a process repeated after a considerable interval. In the *Comptes Rendus* for March 16 last, the preliminary results of the labours of MM. Loewy and Puiseux are given, the most important of which unquestionably is this, viz., that "Struve's value 20·445″ is very near the truth. It would, in our opinion, be premature to alter it."

Among the astronomical events of the year 1891 may assuredly be remembered the delivery of the address at the British Association at Cardiff by our greatest living English spectroscopist, Dr. Huggins. As an eloquent exposition of the existing condition of our spectroscopic knowledge, and as a tribute to those who have been instrumental in building it up, Dr. Huggins's address has never been surpassed, even if it has been equalled. A vulgar and spiteful attack on its gifted author by a private friend of a person, the omission of whose name from the address was but too obviously prompted by the highest chivalry, only excited an amount of contempt for the writer and disgust at his impertinence, which must considerably have astonished him. It is singularly unlikely to do his paper much good.

Prof. Keeler has gone to Allegheny as superintendent there. His loss to the Lick Observatory will be very great indeed, if not irreparable.



After forty years' service, Dr. Hind has retired from the superintendence of the *Nautical Almanac*, and Mr. A. M. W. Downing has been appointed his successor. It would have been difficult to select any one better qualified in every way for the position than he is. A man of his ability and attainments had no business in a comparatively subordinate position in Greenwich Observatory.

Among the most noteworthy Astronomical Publications may be mentioned Vol. XXIV. of the "Harvard Meridian Photometry," a work of reference for all time. Two other magnificent volumes, too (XXVI. and XXVII.), in connection with the Draper Memorial, consisting of an exhaustive catalogue of stellar spectra, and an elaborate explanation of its construction and composition will add, if that be possible, to the renown of Harvard. We have elsewhere spoken of Prof. Harkness's classical work on the "Solar Parallax, &c." Among somewhat less important works may be mentioned a most elaborate monograph of the well-known stellar cluster, ψ Persei, by M. Pihl, of Christiania; Mr. W. F. Denning's excellent vade mecum for the amateur astronomer, "Telescopic Work for Starlight Evenings"; the smaller edition of Mr. Cottam's invaluable "Star Charts"; and the Messrs. Cooke and Sons' little book on "Adjusting and Testing Telescopic Objectives."

Death has unhappily removed several astronomers who will be sorely missed. M. Gautier, the quondam head of the Geneva Observatory, and Mr. Henry Pratt, of Brighton, an amateur known for his admirable drawings of the planets, died during the earlier part of the year. On May 1 there passed away Dr. Schönfeld, who succeeded the illustrious Argelander at Bonn. There he commenced and carried through the "Southern Durchmusterung," the result of ten years' such incessant labour, as, it is feared, shortened his life. He was 62 at the date of his death. On June 23rd, in his 63rd year, died Mr. Norman Pogson, the Government Astronomer at Madras, a position he had held for 30 years. He discovered eight new minor planets and 20 new variable stars. He will always be remembered by those interested in stellar photometry as having suggested the factor whose log. is 0·4 (2·512) for stellar magnitudes, as the result of his photometric experiments at the Radcliffe Observatory, Oxford. On August 20th he was followed by Brünnow, who was originally Director of the Bilk Observatory. Later he became First Assistant at Berlin, and from Prussia migrated to the United States, where he was successively connected with the Ann Arbor and the Albany Observatories. He will be chiefly remembered in this country as having been Astronomer Royal for Ireland from 1866 to 1874, and as the author of a well-known work on "Spherical Astronomy." He died of heart disease at 70. On September 18 died, of consumption, at the early age of 34, that promising young astronomer, Dr. J. L. Lamp, who commenced his career at Bothkamp, and thence went to Berlin, where he became one of Dr. Auwers's most trusted assistants and coadjutors.

FOOT-POWER SAWS.—II.

THE second design of Bergeron affords some useful hints in the construction of this kind of tool, and I have therefore given here a fair copy of it. Taking the height of table as about 3ft., the scale is probably 1in. to a foot. It will be seen that we now have two saws—one being very narrow, for use in cutting out curved work, the other broader, but both thin, so as to produce, in cutting, as little friction as possible. We have a pillar, A, rising from a stout table, G. The upper part of this pillar carries the bow, which was then a common form of spring used in the pole lathe. Attached to this is an upright piece, B, which I have drawn as it is in the original; but its form is not very clear. From the description, however, it appears to be of triangular section, or dovetail, and that the upper frame C E and its iron rods slide up and down upon it, so that this complete frame can be adjusted for height, and clamped at any point desired. The object evidently is to enable the bar E to be set higher or lower, to accommodate different thicknesses of wood. It thus prevents such wood from being lifted by the upstroke of saw. It will be seen, therefore, that the iron rods which guide the saw frame are not continuous. The lower ones very carefully placed to be in a line with these upper ones, and needing no subsequent adjustment, are let into the under side of the table at one end, and at the other are fastened by nuts and screws to the board H. We may now turn our attention to the saw-frame. But I see that I have accidentally misplaced the two hooks by which the frame is attached to the cords above and below. These should have been placed in the centres of the cross-bars. The ends of the saw-frame or cross-bars D D are made as seen on a larger scale in Fig. 3, which shows part of two grooved pulleys let into the woodwork. These working on the upright bars reduce the friction, and prevent undue wear of the parts. There is a central bar to the saw-frames, shaded to distinguish it from the upright dovetailed bar behind it. This is clearly shown at B, Fig. 3. It is stout enough to bear the tension of the two saws without yielding in the least. The bar connecting the upright iron rods above the table is slotted to receive the back part of the saw-blades, as shown at Fig. 2, giving necessary support just where the chief strain occurs. The way in which circular work is done is rather ingenious, but is evidently suited only to work of small size; pieces of large curvature marked independently for sawing could, however, be done without difficulty. The lower bar of the guide is extended towards the left, but reduced in size, and this part receives a sliding-piece with a point below, similar to that of a pair of beam compasses. This point is made to pierce the centre of the circular piece to be cut, which is gradually revolved while the cutting goes on. In this kind of work it would probably be necessary to set the saw as a tangent to the circle, which could readily be done by means of its clamping screws. The treadle of this saw, it will be seen, is not fixed, but takes its bearing upon the floor. Probably it would need to be hinged to prevent slipping. Fig. 3 shows the cross-piece of the frame, which slides up and down upon the iron rods. Brass pulleys are let in to bear against these rods, reducing friction very considerably. Both cross pieces are thus fitted. Considering the date of this saw, 1816, and its many advantages over a circular saw, it is really a wonder that it is not now —so far as I know—made for sale. I am not aware, in fact, of any vertical saw being in the market, although everyone who has tried it knows that the labour of working a circular saw prohibits its use, except for the very lightest work. Fret saws we have innumerable; but we need a good workable tool, suited to the ripping up of, say, 2in. plank wood, and although a crank action and flywheel are easily arranged to increase speed, it is a question whether direct action, as in this saw of Bergeron's, is not preferable, as the weight of the workman is brought to bear upon it, instead of only the muscular power of leg or arm. **O. J. L.**

THE SERPOLLET INSTANTANEOUS STEAM GENERATOR.

IMPROVEMENTS in the Serpollet Instantaneous Steam Generator have been recently patented, and in the drawings accompanying the complete specification several modified forms are shown. Fig. 1 of the illustrations annexed shows a horizontal section of one form of tube or tubular piece constructed according to the invention; and 2 represents a vertical section on the chain line in Fig. 1. In a generator according to this invention the instantaneous vaporisation of the injected liquid is effected in the flat capillary space *a b* of

FIG. 1

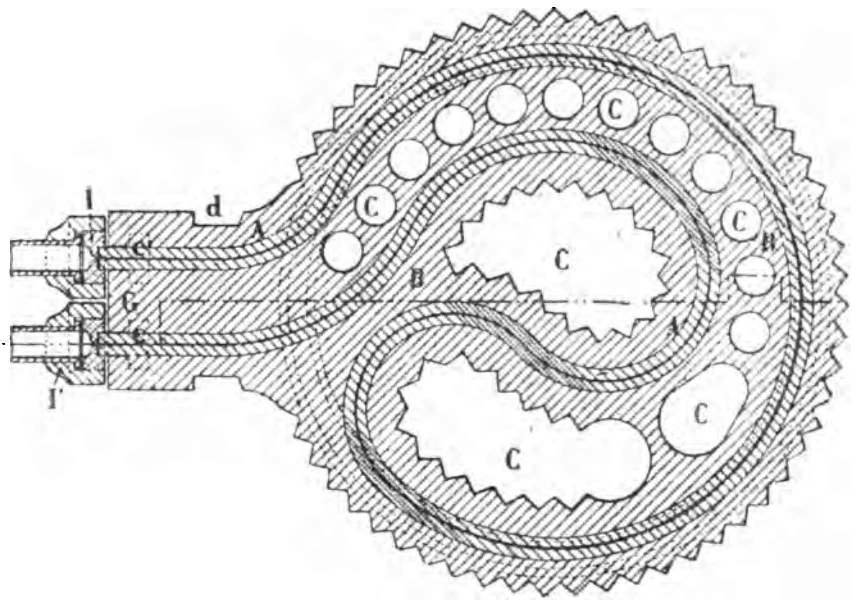
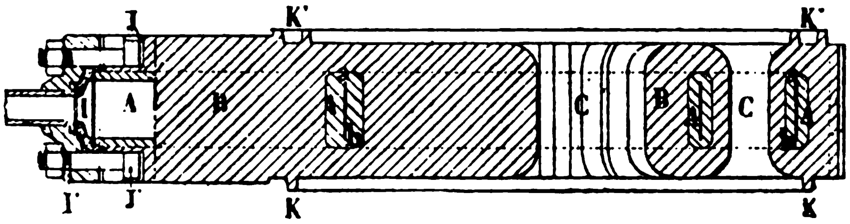


FIG. 2



a drawn metallic tube A which is coiled, undulating or straight, and which is prevented from altering its form by being suitably hooped or stayed, or by embedding the coils or tubes in a mass of cast metal. Figs. 1 and 2 show a flat capillary tube A, the convolutions of which lie between parallel planes, and having ends c c^1, one serving for the injection of the liquid to be vaporised, and the other serving as the outlet for the vapour. These ends are situated close to one another. The tube A is embedded in a casting B, through which are formed the apertures or passages C C for hot gases and products of combustion, which passages are separated by webs. The apertures C may be of any convenient size or form, and their surfaces as well as the external periphery of the casting may be either smooth or be furnished with projections as as shown. The casting B is provided with a projection or neck G through which pass the two ends c c^1 of the capillary tube, and is furnished with grooves *d* in which take the edges or sides of vertical slots in the cylindrical walls. Near the extremity of the tube are notches adapted to receive and retain the stem and the head of the bolts, the nuts of which act upon the cross-piece and cause the same to bear upon one of the corresponding ends c or c^1 of the tube A. The patentees say that they obtain for joining the several elements together a joint which is safe, easy to make, and without projections. This joint may be arranged on the two ends c c^1 at once when they are adjacent to one another; similarly the two ends $c c^1$, instead of being cleanly cut as in Figs. 1 and 2, may be made flaring, or rounded by means of a hammer. This hammer work may be effected before the formation of the envelope or casting B, or afterwards when the casting is of a malleable metal, as for example ingot iron or mild steel. As it is necessary for properly staengthening the capillary tube, and for transmitting the heat, that this tube should be in intimate contact with the casting B, care is taken before casting to clean or scour it carefully, and if necessary it is tinned or thinly coated with a weldable metal, which will assist the union of the parts. Intimate union is, however, effected when a casting B of ingot iron or mild steel is employed by reason of the high temperature at which the same fuses, which causes the outer skin of the capillary tube to partially melt or run, and in consequence effects an intimate welding of the tube and the metal of the casting. Mild steel in addition to being stronger than ordinary cast iron, has furthermore the advantage of great malleability; it enables vaporisers to be made of comparative lightness, and withstands changes of temperature in the furnace better than cast iron, and protects the imbedded tube to a greater extent.

The envelope or casting B allows of giving to the vaporising elements forms which being obtained by moulding, allow of easy erection of the generators and of interchangeability of the parts. It constitutes a large and economical reservoir of heat. The complete specification contains ten claims.

PRACTICAL MICROSCOPY FOR STUDENTS.—XIV.

By FREDERICK DAVIS, B.Sc.

THE spinal cord extends itself at the apex into a great nerve-centre, termed the "medulla oblongata," which is situated at the base of the brain. If this be injured, we find that life at once ceases. It has been proven by experiment that certain portions of the brain itself may be entirely removed from the living subject, but the moment the medulla oblongata is incised or injured, life becomes extinct. If we remove the medulla oblongata and harden its substance by immersion in spirit, we shall observe it presents under the microscope the appearance of an immense mass of nerve fibres; such is really the case. We observe also the grey matter and white substance occupy the same relative positions as in the spinal cord—that is, the grey matter is interior, and the white substance exterior. If the white substance of the cord be cut entirely through, leaving the grey matter intact, we shall find all voluntary action ceases; but the sensibility of the various parts in connection therewith will in no way be impaired. Such an experiment would therefore tend to prove that it is through the grey matter of the cord that sensibility is carried *to* the brain. In other words, the grey matter is afferent. The medulla oblongata, like the spinal cord, is capable of converting afferent impulses into efferent results; therefore demonstrating without doubt that the grey matter is sensory, and the white substance motor. But this statement does not hold good in every case—it has its exception. If we cut the *anterior* half in the thoracic region, we shall perceive all voluntary motion ceases below the section; but if the *posterior* half be cut in the same manner, voluntary motion will *not* be affected in any way. This tends to prove that the whole of the white substance is not equally concerned in the transmission of motor forces.

It is a curious fact that nerve-fibres of the sensory system—that is, the posterior roots—entering on one side of the cord pass entirely over to the other side of the cord. It is, therefore, apparent that sensory impressions entering on one side of the cord are conveyed to the brain by the grey matter upon the other side of the cord. This has been proven by cutting through the grey matter upon one side and watching the effect upon the other and *vice versâ*. The *motor* fibres do not decussate, however, in the spinal cord at all, but await until they arrive in the medulla oblongata.

We can with these data understand how it is in certain cases of paralysis, the right side of the brain being paralysed affects the left side of the body; and conversely, the left side of the brain affecting the right side of the body. For purposes of studying these peculiarities the student should obtain a complete sheep's brain, with the medulla oblongata and portion of the spinal cord attached. Any butcher will supply this; or if the butcher does not kill his own meat, any part may be obtained from a slaughter-house.

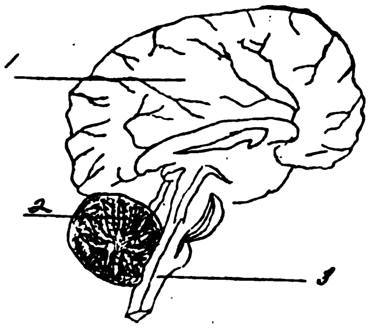
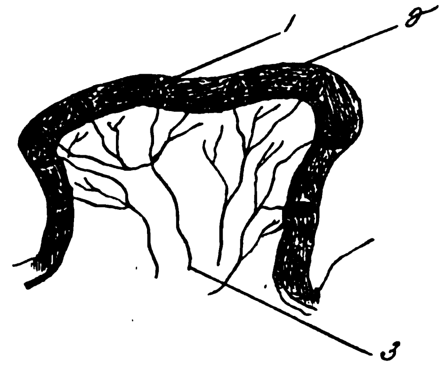


Diagram showing Position of Brain.

1, Cerebrum; 2, Cerebellum; 3, Medulla oblongata.

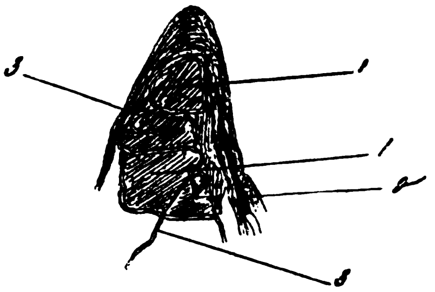
It will be observed the brain itself is not merely a globular mass of matter, but possessed upon its surface of a large number of depressions termed "sulci": these give it an undulating character called convolutions or gyri. The brain proper, or cerebrum, is divided into two parts, called respectively the right and left hemispheres. Beneath these we have a smaller portion called by some the little brain or cerebellum. We saw in the description of reflex action that the brain was the only part capable of really perceiving pain, and we find now that the brain itself is the great sense centre. The senses are all in direct continuity with the brain, and we have twelve pairs of so-called cerebral nerves regulating the senses in every respect. Certain parts of the brain are said to influence certain parts of the body; but at present very little is definitely known concerning this statement, and researches at this time are being conducted with the object of solving this problem. The student will notice in preparing a section of the cerebellum, if he cut completely through longitudinally—after, of course, the usual treatment for hardening the substance—that it is composed of nerve substance arranged very prettily in plates, and has when cut a foliaceous or arborescent appearance, it is therefore on this account called the "arbor vitæ." We saw in connection with the medulla oblongata that functionally it compared to a degree with the spinal cord; it, however, does more than this: to a great extent the regularity of respiration depends upon it. If certain portions of the medulla oblongata be injured, the respiration is at once stopped, the heart in its turn ceases to beat, and death results. In briefly reviewing the cerebral or cranial nerves, we will consider, as previously stated, that there are twelve pairs. I mention this the more particularly because some authorities consider the number to be nine only.



Circumvallate Papilla.

1, Taste goblets; 2, Epithelium; 3, Nerves in connection with taste goblets.

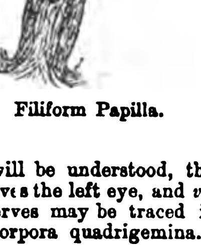
These nerves are given off by the brain and medulla oblongata. The first pair are those employed for the sense of smell, or olfactory nerves, and being prolongations of the brain—that is, the cerebral hemispheres—eventually form little bulbs, which extend to the upper portion of the nose. In man these bulbs are very small; but in animals which depend upon the sense of smell for obtaining food, we find they are well developed. Such domesticated animals as the cat and dog have larger bulbs than man, whilst their wild brethren, the fox, lynx, lion, tiger, &c., have larger olfactory bulbs still. The second pair serve the eye, and are called optic nerves.



Section of Tactile Papilla.

1, Tactile corpuscle; 2, an Artery; 3, Nerve.

They appear to arise from the optic thalamus, or receptacle of each side. They, however, cross and form a chiasma, termed the optic chiasma. It will be understood, therefore, the right nerve serves the left eye, and *vice versâ*.



Filiform Papilla.

The optic nerves may be traced in the brain as far as the corpora quadrigemina. The third pair, or oculo-moto, serve the muscles of the eyes. The fourth pair, or trochlear, influence the superior oblique muscle of the eyes. The fifth pair, or nerve trigemini, are more complex, and divided into three branches, supplying firstly a portion of the ophthalmic; secondly, the superior maxillary; and, thirdly, the inferior maxillary and gustatory nerve.

The sixth pair or abduceus oculi supply the external muscles of the eyes; the seventh pair the facial muscles; the eighth pair constitute the auditory nerves; the ninth pair constitute the nerves of taste, and are termed the glossopharyngeal; the tenth pair serve the vagus or pneumogastric nerves; the eleventh pair or spinal accessory serve the muscles of the neck; the twelfth pair are termed the hypoglossal, and influence the muscles of the tongue. The senses of touch, taste, smell, hearing, and sight are of paramount interest to the microscopist.

We will examine each in the order enumerated. The sense of touch is extensive; in fact, it exists upon the whole surface of the body. The parts of the body, however, differ very greatly in the degree of sensitiveness.

We find the parts where the sense is acute to be well supplied with bodies termed "tactile corpuscles." A mass of these form the papillæ, and may be seen as little elevations beneath the dermis; these papilla are largely supplied with blood-vessels and nerves. The nerves of touch are in connection with the posterior roots (sensory) of the spinal nerves. The sense of touch may, or may not, be connected with the sensation produced by the action of cold or heat upon the skin; but it is probable a different set of nerves altogether are brought into play; in any case, further information is required upon the point.

Although the sense of taste is generally considered to reside entirely in the organ known as the tongue, we have abundant evidence that such is not actually the case: the tongue is undoubtedly the chief organ in this respect; but a portion of the soft palate is also endowed with this power. It would appear that taste is dependent upon the presence of little bodies called respectively filiform, fungiform, and circumvallate papillæ; these are well supplied with nerves governed by the glossopharyngeal and the third branch of the fifth nerve. Many of these filaments or bodies are supplied with other bodies in their interior termed "taste goblets"; these latter resemble little capsules.

Fungiform Papilla.

The filiform papillæ may be found upon any part of the tongue's surface, elongated, and conical in shape.

The fungiform are, as it were, swollen at the apex, resembling a fungoid growth in shape, and may be found principally upon the tip and sides of the tongue. The circumvallate are comparatively few, numbering about eight, and are arranged in the shape of the letter V, at the back of the tongue. They are much larger than the other two forms, and have a space between the papillæ and the external covering. All three forms are covered with a thick layer of epithelium.

PRACTICAL HINTS IN BOILER DESIGN.—VII.

By W. C. Carter.

We will first assume that, after careful comparison with similar engines and boilers working under similar conditions, we find we shall require, to develop the needful power, a grate area of 63sq.ft., with a heating surface of 1,970sq.ft., the working pressure being 110lb. We will also assume that, having regard to the space available in which to place our boiler, we can best meet the requirements of the case by constructing a single-ended boiler to contain

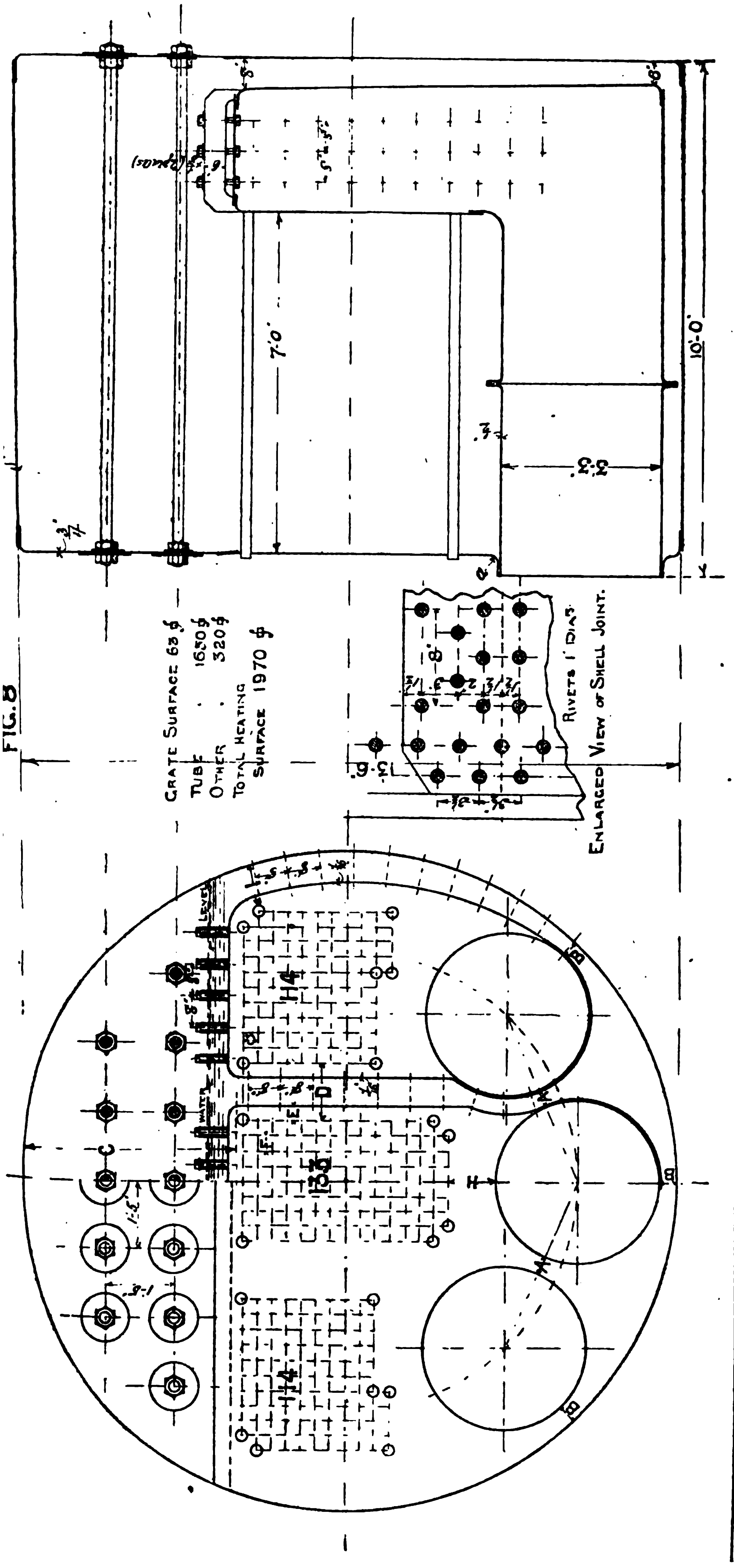


FIG. 8

these surfaces. Our problem now assumes a definite aspect, and we must first try out—as stated in Art. I. and in the manner to be now explained—various assumed sizes, until we find the smallest boiler that will meet the requirements while the relative values of D and L (see Art. I.) shall be suitable to the space in question. In fixing these sizes, it is necessary to remember that room must be allowed to enable the tubes to be drawn with ease, and all the fittings and manholes to be accessible. In fact, accessibility is one of the most important points in a boiler, both within and without.

The question is really—stated in another way—What is the smallest boiler, having a given ratio of D to L, that will contain the surfaces required, in addition to the clearances which are necessary at certain points? We know already the surfaces, and by referring to Fig. 8, the points where clearances are required will be seen indicated by reference letters, and below are given the respective amounts of the clearances in each case, or the method of determining them. We thus find the minimum contents of our boiler, and must try various sizes till the conditions are satisfied. It will be found that the longitudinal section varies little, provided that the size has been approximated with fair accuracy, and that it is usually only necessary to try out the arrangement of the end. The dimensions given in Fig. 8 will be found to satisfy the requirements, and we shall in our concluding article test the scantlings by means of the formulæ already explained. We take, then, our grate surface of 63sq ft., and having fixed upon 6ft. 6in. as a length of bar likely to suit the room we have, we find the size of furnaces (of which there are three) thus—

$$\frac{63}{6{\cdot}5 \times 3} = 3{\cdot}23\text{—say } 3\tfrac{1}{4}\text{ft.}$$

As this is a trifle more than we want, we will make the outside dimension of the furnace 3ft. 3in.

Assuming that we have room for a total length of 10ft., we shall find that 7ft. tubes will give us a good width of combustion-chamber, after allowing 8in. of water space at the top between the combustion-chamber and the boiler end. The furnaces and tubes (which we will make 2½in. diameter) must now be arranged in a trial circle representing the shell, and allowing all the required clearances, and it will be found that a boiler with a diameter of 13ft. 6in. will meet all the conditions. The tubes should be so distributed between the furnaces as to give a slightly greater number to the centre furnace.

List of Clearances.

A.—Clearance between furnaces measured on a line joining their centres. This should be sufficent to allow for the rounding of the end plates at the furnace mouth flange (see A, Fig. 8), with not less than 1in. of flat plate in addition. In this case the radius is 2in. Therefore—

$$2 + 2 + 1 = 5\text{in. for this clearance.}$$

B.—Clearance between furnaces and shell. As in our figure, the flange of the shell turns in and the furnace mouth out. These flanges do not interfere with each other, so that we may make this distance ½in. less than A—that is 4½in.—which is the least water space advisable. Had the furnace mouths turned in, then the distance B would have been determined by the room necessary to get the rivets in at the tightest place, and would probably have needed to be not less than 5½in. or more, according to the practice of the manufacturer in the matter of rivets and the kind of "dolly" used.

C.—Distance from top of tubes to crown of shell. This distance should not be less in ordinary work than one-third of the diameter of the boiler, and as it determines the steam space of the boiler, should always be kept as great as possible to reduce the tendency to priming engendered by a small steam space. Of course the higher the pressure and the smaller the cylinder, the less steam is drawn off at each stroke, and in such cases less space is required than in low-pressure boilers. Still, the limit givén is a safe one, and should not be much exceeded.

D.—Distance between the tube-nests. This should be sufficient to allow a man to pass down between the tubes—say 11in. plus the tube diameter.

E.—Distance from centre of outside tube-rows to front of side-plates measured in the plane of the tube-plate—that is, the apparent distance when looking at the tube-plate from the outside of the combustion chamber. This distance is equal to radius of flange of plate + ½ diam. of tube + ½in.

F.—Horizontal centres of tube = diameter + 1¼in.

G.— Vertical centres of tubes = diameter + 1⅛in.

H.—Clearance over furnace crown should not be less than 8in. to allow of a man being able to clean the furnaces when lying between them.

I.—Clearance at side should be sufficient to allow a man to pass down, say, 15in. outside of tubes.

This clearance must also be preserved at every point on the route from the manhole, the position of which must be conveniently arranged, preferably in the top of the boiler. The same consideration leads us to choose such proportions for the steam space staying as shall leave not less than 12in. clear between them.

Keeping the above points in view, the boiler must be arranged and rearranged until the correct dimensions are obtained. There is no "royal road," and nothing but practice will give speed in finding the final form. This will be, in the present case, a shell 13ft. 6in. diameter, and 10ft. long, with 361 tubes 2½in. diameter, arranged with 114 tubes in each wing nest, and 133 in the ecntre.

Determination of Scantlings.

Steam Space Staying and End Plate.—We find by trial that a pitch of 17in. suits our boiler very well, so we may call S (see formula xii.) 17 × 17 = 289. Formula (xii.) then becomes—

$$\sqrt{\frac{283 \times 110}{187\frac{1}{2}}} - 1 = 11\cdot8 \text{ sixteenths, say, } \tfrac{3}{4}\text{in.}$$

Combustion Chamber Staying and Plates.—By same formula, taking 8in. as a convenient pitch, and therefore making S = 64.

$$\sqrt{\frac{58 \times 110}{100}} - 1 = 6\cdot9, \text{ say } \tfrac{7}{16}.$$

The sizes of stays in each case can be easily found by following the method of Art. III.

Furnace.—We shall find, by trial of formula iv., that it would be necessary to use a very thick furnace, unless we use a stiffening ring of some kind. We therefore settle upon fitting one Adamson ring as shown in the figure, and thus place the strength of the furnace considered by formula iv. beyond question. We must now try it by formula iii., and we find that ½in. plate satisfies the equation thus:—

$$\frac{8{,}800 \times 1}{2 \times 39} = 112\text{lb.}$$

Shell Plating.—With such a joint as that shown in Fig. 8 we shall expect to obtain a joint strength of about 87 per cent., and starting with this approximation, we find the plate thickness by reasoning from the conclusions of Art. I. If the reasoning regarding the bursting strength of the shell in Fig. I. has been mastered, it should be clear that the plate thickness varies—

Directly as the Working Pressure;
" as the Diameter;
" as the Factor of Safety;
Inversely as the Strength of Material;
" as the Strength of the Joint.

And, as the thickness here referred to means the total thickness of both plates, we must divide the result of our reasoning by two.

Stating the above in algebraic form we get—

$$\frac{WP \times D \times F}{S \times \text{percentage} \times 2} = T$$

or—

$$\frac{110 \times 162 \times 5}{29 \text{ tons} \times 2{,}240 \times \frac{87}{100} \times 2} = \tfrac{13}{16} \text{ nearly.}$$

We take this result then as our plate thickness, and by the use of formulæ (XXIV.) we find that our pitch will be about 8in.

We have now determined all the important scantlings except the girder stays, and these can be obtained by formulæ XV. and XVI., and will be made of two plates, each 6in. deep and ⅞in thick, giving a total thickness of 1¾in. This is slightly above the requirements; but as so little extra weight is involved, there is no object in cutting them very fine.

In our concluding article we shall go through all our calculations in the form in which they should be kept for reference.

PRACTICAL ELECTRO-PLATING.—II.

By T. C. SMITH.

IN addition to the vat, several pans will be wanted to contain water for rinsing purposes; and as plenty of water is used, these pans should be large—about the same size as vat will be the most useful size.

Brushes.—There are at least three descriptions of brushes used in the plating shop—viz., the wire or scratch brush, the bristle brush, and the cotton or fibre brush, used with potash solution for cleansing purposes. Of the two former there are two distinctly different forms: circular for lathe or spindle work, and straight for hand work; the latter will meet all requirements at present. At least one wire scratch brush and two or three bristle brushes of different sizes will be required.

Before proceeding further, I must impress upon my readers the fact that absolute cleanliness is necessary in all operations connected with electro-metallurgy. The plater's greatest enemy is dirt of any description, especially grease, the least trace of which latter is very detrimental, if not fatal, to success.

Solutions.—Of the many methods of making silver solutions, the two following are amongst the best, and, if carefully made, equally good results can be obtained with either. Place 1oz. of fine (pure) granulated silver in a flask or Wedgewood cup, and carefully pour on sufficient diluted nitric acid (2 acid, 1 water) to a little more than cover the silver, place over a spirit-lamp or other source of heat until copious red fumes are given off, then remove to a cooler place, so that the chemical action is not too violent. The flask will want reheating once or twice, and if the acid used is not of good quality, it is very likely more will have to be added before the silver will be quite dissolved. Pour the nitrate of silver thus formed into a shallow evaporating dish (a photographer's developing dish does admirably), and gently heat until the acid has sufficiently evaporated for the nitrate to crystallise; stand aside to cool, then pour off the uncrystallised liquor, and repeat the process in another dish until all the nitrate has crystallised. Well drain the cystals, and place in an earthenware jar, capable of holding about a gallon. pour on about a gallon of clean cold water, which will at once dissolve the nitrate. Now make a saturated solution of common salt in water, and pour this slowly into the nitrate solution, stirring meanwhile, until there is no further white precipitate formed. It is advisable from time to time to put a little of the clear solution into a test tube, and add a few drops of the salt solution. If it turns milky, there is more silver in solution, and more salt should be added; but, on the other hand, if the salt produces no effect, the operation may be considered completed. Allow the chloride of silver thus formed to settle to the bottom of the jar, then carefully pour off the liquor. Fresh water should then be added, the precipitate well stirred, allowed to settle, and the water carefully poured off. This should be done several times, so as to thoroughly wash the chloride. Now make a strong solution of good cyanide of potassium (about 2oz. to 1 quart of water), and pour on just sufficient to dissolve the chloride of silver;—be careful not to use more cyanide than is necessary, as too much "free" cyanide in a new solution is very likely to cause an irregular deposit of silver, which will "strip," or blister, during the finishing process. When the solution has been worked for some time, it acquires a certain amount of organic matter, and is then able to bear more cyanide, with improved results.

Solution No. 2.—Dissolve 1oz. of fine silver, and crystallise as before. Dissolve the crystals in about a quart of water, and precipitate with a strong solution of cyanide. Be careful not to add too much cyanide, or the precipitate at first formed will become redissolved. Allow the precipitate to subside; then wash several times, as before. Lastly, add sufficient strong cyanide solution to dissolve the precipitate. Both these solutions should be made up with water to one gallon for each ounce of silver used. It is more satisfactory to use distilled water for making solutions when practicable. Failing this, use water that has been freed from some of its impurities by being boiled. Solutions made like the last of the two given are generally used; but I find that with careful manipulation and scrupulous cleanliness, No. 1 solution will give quite as good, if not better, results.

Most platers use what is termed a "quicking" solution, the object of which is to give the articles that are to be silvered a slight coating of mercury. It is very useful where the work has not been carefully prepared; but, personally, I have not, up to the present, met with any work that, with careful preparation, I have been unable to plate well without the aid of "quick," and I do not recommend its use. Mercury is a very good friend in its place, but if not kept there is a very strong enemy, and is, in my opinion, best kept as far away from vat, &c., as possible. For the benefit of those who believe in the "quicking" process, and who wish to use it, I will give directions for making both the acid and cyanide solutions.

Acid Quicking.—Dissolve 1oz. pure mercury in dilute nitric acid (about one acid, two water), do not use too much acid at first; it is better to have an excess of mercury than of acid. When dissolved, add to the nitrate of mercury thus formed about one gallon of water, acidulated with 2oz. or 3oz. of sulphuric acid.

Cyanide Quicking.—Dissolve 1oz. of mercury as before, and dilute the nitrate with about a quart of water, slowly add to this a strong solution of cyanide until all the mercury is precipitated, drain, and well wash the precipitate and dissolve with cyanide. A slight excess of cyanide should then be added, and the whole made up to one gallon with water for each ounce of mercury used.

As it is necessary for good work that all the silver should be removed from old work before replating, the following solution is used, which, besides removing the silver more thoroughly and quickly, obviates the waste of silver there would be were it removed mechanically. Fill an enamelled iron or earthenware pan large enough to hold the articles to be "stripped" with strong sulphuric acid, heat over a gas-stove or in a water bath to about 150° F., then add a few crystals of saltpetre (about ½oz. to each gallon of acid). The articles are placed in the above while hot for a short time, and must be carefully watched so that they may be removed directly the silver is dissolved, if they are left too long the acid will eat into and, of course, roughen the surface of the metal, thereby causing a lot of unnecessary labour in polishing. When spent the silver can be recovered from the above solution as follows: —Place the acid in a large pan in a well ventilated room, or, better still, in the open air, and dilute with about its equal of water. Next, drop in a few pieces of zinc, which will precipitate the silver in form of a fine metallic powder. When all the silver is precipitated, throw away the acid, pick out any pieces of zinc that may not have been dissolved by the acid, well wash, and dry the silver and run into a button, with a little saltpetre, in a furnace or crucible.

(*To be continued.*)

GEOLOGY FOR STUDENTS.

By EDWARD AVELING, D.Sc. Lond., Fellow of University College, London.

Chapter XXI.—The Lower Silurian Formation.

THE Cambrian formation, the lowest of the three divisions of the Silurian system, has been considered. In the following chapters the two other divisions of that system, the Lower Silurian and the Upper Silurian formations, will be considered.

Lower Silurian Formation.

A. DERIVATION.—The ordinary name, after the explanation of the word "Silurian" previously given, calls for no comment. Sometimes this formation is known as the Ordovician. The Ordovices were a British tribe living in what is now Merionethshire. Bala, one of the chief places where Lower Silurian rocks occur, is in Merioneth.

B. WHAT.—(1) *Structure.*—Slates, sandstones, grits, shales, with limestone bands in some places interstratified. They are often accompanied by eruptive, igneous rocks of felspathic nature. The Lower Silurian rocks were deposited so long ago, and so many changes, so many upheavals and subsidences, have occurred since, that these rocks have themselves been much changed. They are often inclined, contorted, fractured, folded upon themselves, and, occasionally, have undergone metamorphosis by the action upon them of igneous rocks.

(2) *Composition.*—In table XIII. the British groups of the Lower Silurian formation of the Silurian system are shown. The student should look at Fig. 99, the diagram section of the whole Silurian system.

TABLE XIII.
Lower Silurian: Ordovician.

Lower Silurian { Lower Llandovery.
Caradoc and Bala.
Llandeilo.
Arenig.

Taking these groups from below upwards, the Arenig group is named from the Arenig mountain in Merioneth, to the west of Bala. It has a thickness of some 4,000ft., and consists of dark slates, shales, flagstones, with bands of sandstone. Sometimes this group is known as the Stiper stone group. The Stiper stones are close to the Longmynd, in Shropshire (Chap. XX.). The Arenig group are represented at A, Fig. 99.

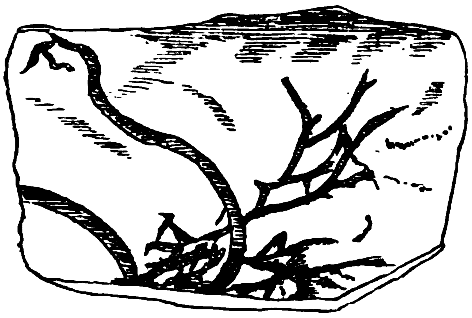


FIG. 115.

The Llandeilo group are especially well seen at Llandeilo, in Caermarthen, on the river Towy, to the north-east of the county town. Thickness, about 2,500ft. Dark argillaceous rocks, occasionally calcareous; sandstones, flagstones, shales. L, Fig. 99.

The Caradoc and Bala groups. Caer Caradoc, or Cradock Hill, is in Shropshire, near the confluence of the Clun and the Teme. It belongs to the Caradoc range, that runs from south-east to north-west, between the vale of Church Stretton on the east, and Apedale on the west. It is about 1,200ft. in height. Bala is in Merioneth. The Caradoc beds are mainly sandstones; those of Bala are sandstones, grits, and slates, with two important limestone bands. Thickness, about 6,000ft.

The Llandovery group is named from Llandovery, a town in Caermarthen; also on the Towy, and lying north-east of Llandeilo. Grits, with a thickness of 1,000ft.

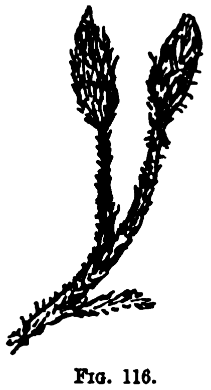


FIG. 116.

C. WHERE.—1. Europe. *a.* British Isles. (i.) England. Caer Caradoc, Coniston in the Lake District, Skiddaw, and Saddleback Mountains.

(ii.) Wales. The Lower Silurian rocks are met with through Wales generally. Beginning at St. David's in Pembroke, they run through Caermarthen (Llandeilo and Llandovery), Cardigan, form a rock island in Radnor, between Builth and Llandegley, form also the mountains of Cader Idris, the Arans and Arenig in Merioneth, appear at Barmouth and Harlech on the coast of that county, and inland at Bala, and in the Berwyn Mountains, north-east of Bala. They run through Caernarvon, forming Snowdon and the other mountains of North Wales. These mountains, it should be noted, are volcanic. They have not come to the surface by intrusion from within, but have been exposed by the wearing away of the slaty rocks that were deposited upon them after they had been formed.

(iii.) Scotland. The Lower Silurian rocks appear most to the south and west at Ardwell, in the south-west peninsula of Wigtown. Then in the south-west of Ayrshire, notably in the valley of the Girvan. Working east, we meet them at Carsphairn, in Kircudbright, in the Lowthers, or Leadhills, between Dumfries and Lanark (well seen in the Dalveen Pass over them); in Queensberry Hill, just where the southern corner of Lanark juts into Dumfries; at Moffat, seven miles north-west of this; in Peebles; in the Moffatt, Carrick, and Lammermuir hills. They are seen in the island of Arran. In midland Scotland, the lower Silurian, dive under Devonian and Carboniferous rocks, reappearing in the Grampians (they form Ben Nevis), and in Ross. In the outer Hebrides there are outliers of them, and in Sunderland, notably at Durness, in the extreme north-east, they occur again.

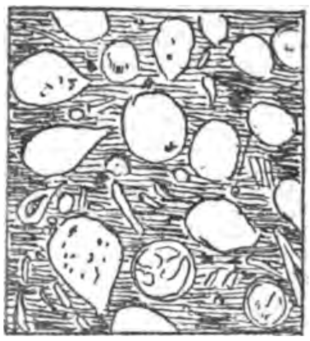


FIG. 117.

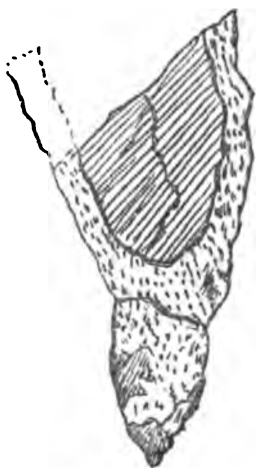


FIG. 118.

(iv.) Ireland. The most southerly appearance of Lower Silurian rocks is at Dungarvan, in Waterford. Thence they can be traced round the south and east coasts, especially in county Wicklow, to Belfast Lough. Inland they can be traced from Roscommon and Longford to the coast of Down, and they are here identical with the Lower Silurian of Scotland, just across the Irish Sea and the North Channel. They are well seen, especially as far as their fossils are concerned, at Kildare, Portrane near Dublin, Lisbelean in Fermanagh, and Pomeroy in Tyrone.

b. The Continent. In the table-land of Spain and in Asturias; the eastern Pyrenees; Hérault, Anjou, Brittany (Ille et Vilaine), Maine, Normandy, in France; South and North Brabant, in Belgium; around the flanks of the Eastern Alps, especially from Kitzbüchel in the Tyrol, through Carinthia to the south end of the Vienna basin; also, as far as Austria is concerned, in Styria, Bohemia (an important area 100 miles by 44), Silesia; in the Fichtelgebirge, Thuringerwald, and Harz of Germany; at Bergen, Christiania, and on the Mjösensee in Norway, and generally in central and northern Norway and Sweden; lastly, over a very extensive region in Northern Europe, beginning with the basin of the Baltic; then through the islands of Gothland (between Sweden and the Gulf of Riga), Oesel and Dagoe (at the mouth of the gulf), across Northern Livonia, and Esthonia, past St. Petersburg to Lake Ladoga, and then, under the plains of Northern Russia, to the Ural Mountains.

FIG. 119.

2. Asia. In Asia Minor; north of Kumaon, Simla, the salt range of the Punjaub, Kashmir, in India; the Himalayas; in Sze-chnen in China; the Altai mountains; Southern Siberia.

FIG. 120.

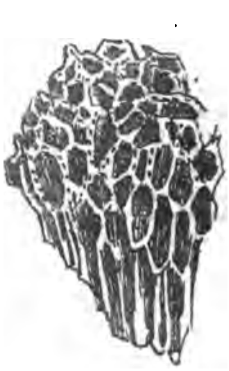


FIG. 121.

3. Africa. In Cape Colony and Natal; along the east coast, opposite Madagascar, between latitudes 28° and 15°—this tract is probably the Ophir of earlier times; between Cape Palmas, on the Ivory coast of Guinea, and the mouth of the river Senegal; and between Darfour and Abyssinia.

4. *a.* North America. The Silurian rocks appear in the United States, in the Mississippi Valley, and the Alleghanies, in Ohio, in the Hudson River and Lake Champlain districts, and generally in New York State; in Massachusetts and Vermont. In Canada they are met with along the river St. Lawrence, notably at Beauharnais, just south of Montreal, and at Quebec. They occur in New Brunswick, Nova Scotia, and Newfoundland. They stretch into Polar regions, appearing in Boothia and Parry Island, and forming the shores of Barrow Strait, Smith Sound, and Kennedy Channel. This distribution holds generally of both the Lower and Upper Silurian formations. The Lower are very typically seen at Cincinnati in Ohio, and at Trenton Falls and Utica in New York State.

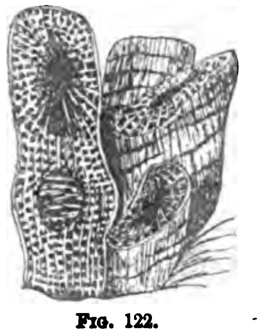


FIG. 122.

4. *b.* In the Andes.

5. Oceania. *a.* Australasia. In New Zealand and in Victoria, and at Mount Arthur in Australia.

D. PALÆONTOLOGY.—(1) *Palæophytology.*—The plant remains in the Lower Silurian formations, are mostly traces of fucoids, i.e., Algæ allied to our bladder seaweed (*Fucus*). It is, in many cases, questionable whether the markings are really those of plants or are due to worms. Buthotrephis (Fig. 115) appears to be undoubtedly vegetable. *βυθος* (buthos), depths; *τρεφω* (trepho), I congeal—from the fact that the plant has been, as it were, congealed in the depths of the rocks. In the Bala beds occur fossil plants, allied to our Lycopodiums or Club-mosses (Fig. 69, p. 255), and known as Lycopodites (Fig. 116).

(2) *Palæozoology.*—The lowest form met with is Saccammina (Fig. 117), one of the Rhizopoda, and one of the order Foraminifera in that class. It takes its name from the sacs or chambers of its perforated calcareous shell.

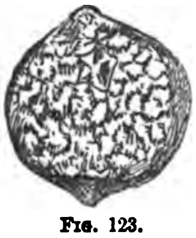


Fig. 123.

The Calcispongiæ of the Porifera are represented by Archæocyathus (Fig. 118). ἀρχαιος (archaios), ancient; κυαθος (kuathos), a cup.

The Hydrozoa are very conspicuous in the shape of the various species grouped under the general name of graptolites. γραπτος (graptos), written; λιθος (lithos), a stone. Fig. 119 shows one of the forms in which occurs a single row of cells, each of which was in the lifetime of the animal colony inhabited by a hydra-like polyp. This form is Monograptus. μονος (monos), alone. In Fig. 120 is represented Didymograptus, with two rows of cells. διδυμος (didumos), a twin. These graptolites only occur in Silurian rocks. They are at their maximum in the Lower Silurian, and of this formation Didymograptus is most characteristic. The allied class, Actinozoa, appears now in the form of many corals, one of which, Halysites (the chain coral), is figured in Fig. 121. ἁλυσισ (halusis), a chain.

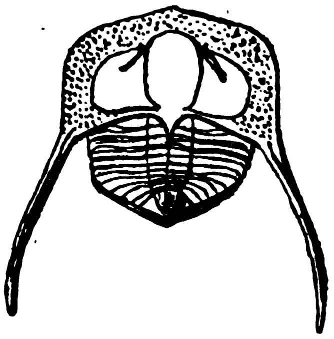


Fig. 124.

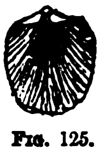


Fig. 125.

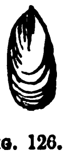


Fig. 126.

Of the Echinoza we have in Lower Silurian times of the Asteroidea, Palæasterina again (Fig. 106, p. 409); of the Crinoidea, Cyathocrinus (the cup croinoid), (Fig. 122); of the Cystoidea, Echinosphærites (Fig. 123).

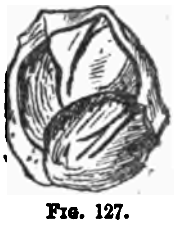


Fig. 127.

The trilobites of the class Crustacea, already met with in Cambrian rocks, appear now in great numbers. Trinucleus (Fig. 124) is a typical form. Here it will be well to give a brief account of this group of fossils, represented altogether by more than 1,500 distinct species. In size they varied from ¼in. to 1ft. long. They were, probably, most nearly allied to our woodlice of living Crustacea, and had, like them, the power of rolling themselves up into a ball, with their hard protective shield or carapace without. The head was of one single piece; the body of many successive rings, and divided lengthwise by two approximately parallel lines into three lobes (trilobite). The position of the eyes is marked by two spaces, one on each side of the head. In the Trinucleus these are of the same size as the centre space (hence the name Trinucleus); but generally these "cheek pieces" are smaller than the central space. The Trilobites underwent metamorphoses as they developed, and fed on other animals by a suctorial mouth. They were sea-dwellers; but whether they were surface-swimmers or lived on or near the sea-bed is not quite clear.

Quite recently, at Jurques in Calvados (North France), the earliest trace of the class Insecta has been met with in the shape of a fragment of insect wing, Palæoblattina. Blattina is the diminutive of blatta, an insect genus including the cockroach.

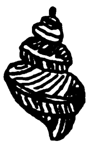


Fig. 128.

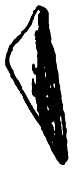


Fig. 129.

Turning to the Molluscoida, we have, in the lower Silurian formation, Fenestella, again of the Polyzoa (Chap. XX.). The Brachiopoda are represented by Rhynconella (Fig. 93, p. 365), Orthis especially (Fig. 125), Lingulella (Fig. 100, p. 408), Lingula (Fig. 126), and Pentamerus (Fig. 127). Rhynconella, from ρυγχος (rhuncos), a beak, with a diminutive ending; Orthis, from ορθος (Orthos), straight; Lingula and Lingulella have already been explained; Pentamerus, from πεντε (pente), five; μερος (meros), a part. Each of the two unequal valves is divided into two by a central septum, and in one of the septa themselves is a small chamber, making five chambers in all.

Of the Gastropoda we have notably Murchisonia, Fig. 128, Bellerophon again, Fig. 13, and Theca (Fig. 129). Theca, now classed with the Gastropods, was, with its allies, made into a special class, the Pteropoda, on account of the wing-like expansions of the foot acting as fins. See Fig. 130, which represents a pteropod. Theca, Fig. 129, is of course only the shell of one of these Gastropods.

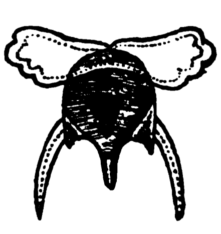


Fig. 130.

Lastly, there are many Cephalopoda, Orthoceras again, Fig. 114, p. 410, being very abundant.

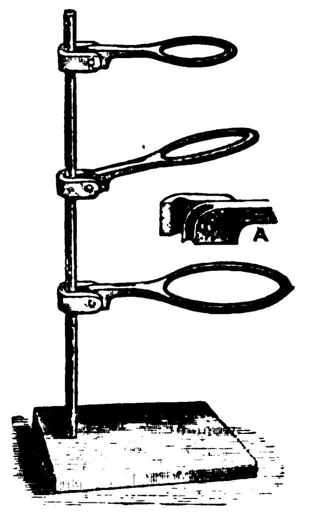
E. How. The Lower Silurian strata were deposited in sea-water. Scotland and Cumberland was under sea in those days. Where Wales now is there was also a sea stretching to and over part of Ireland. In this sea there were many volcanic islands, the Cader Idris, the Arans, the Arenigs of to-day. In Cumberland, also, after the Skiddaw slates had been laid down, there was much discharge of volvanic ash and lava, and, later, much more powerful eruptive action, and the formation of the volcanic cones of Cumberland, which, later on again, sank under water.

And after the Lower Silurian rocks had been formed, there came upheaval, contortion, denudation of them before any of their successors, the Upper Silurian, came.

F. Products. Slates, many metallic ores of copper, lead, mercury, silver, zinc, gold, also occur. Alum in Sweden. Phosphorite (calcium phosphate) in the Berwyn mountains.

MOOR'S SELF-LOCKING RETORT STAND.

THE retort stand shown in the annexed engraving is the invention of Mr. C. G. Moor, of Penistone, and is manufactured by Mr. J. J. Hicks, of Hatton-garden, E.C. As will be seen from the illustration, the new patent retort stand can be instantly adjusted to any height required, by raising the ring slightly, and then sliding up or down as required. On the ring being pressed down, it will automatically lock and remain perfectly steady. This arrangement possesses the following advantages over the ordinary form:—1. When hot, the rings are easily moved, by lifting them with the end of a file, &c. 2. In the old form, if made of brass, the thread of the screw is liable to wear out and "slide"; whereas, if the set-screw is made of iron, the acid vapours of the laboratory will soon rust the thread, and make it difficult or impossible to use. The rings in this instrument being made of cast iron, are very strong, and being of considerable thickness, no fear of burning away the metal need be entertained, as a Bunsen flame may be directed on them for any length of time without the slightest action.



DEATH OF SIR G. B. AIRY.

ONE of the most distinguished of the seven deceased Astronomers-Royal at Greenwich passed away peacefully on Saturday evening last, after a few months' illness, or, in reality, after a surgical operation necessitated by an accident last summer. Although for a period of sixty-five years his name has been familiar and honoured in the world of science, not merely in this country but also abroad, Sir George Airy was little known to the public, though his "Popular Astronomy" was at one time in considerable demand. His mind was of a rigidly scientific bent, almost confined to mathematics, though occasionally Sir George wrote papers on antiquarian subjects, and on one occasion at least—"Notes on the Earlier Hebrew Scriptures"—he diverged into theology. He contributed to mechanics two important papers on "The Forms of the Teeth of Wheels" and on "Escapements," and he also wrote treatises on Sound and Magnetism—the last a subject which concerned him in his official capacity.

Sir Geo. Biddell Airy, K.C.B., M.A., LL.D., D.C.L., F.R.S., F.R.A.S., was born at Alnwick, Northumberland, on July 27, 1801; he was educated at private schools, and passed in 1819 to Trinity College, Cambridge, as sizar. He was elected scholar in 1822, graduated as Senior Wrangler in 1823, and was elected a Fellow of his college in 1824. His love for mathematics was developed at a very early age, and he began at once to apply his knowledge to astronomy and to certain branches of physics. In 1826 he was elected Lucasian Professor of Mathematics at Cambridge, and in 1828 Plumian Professor of

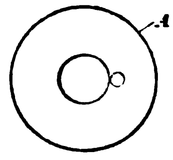


Fig. 1.

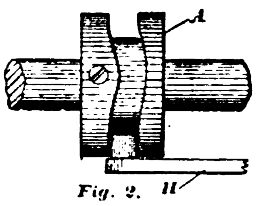


Fig. 2.

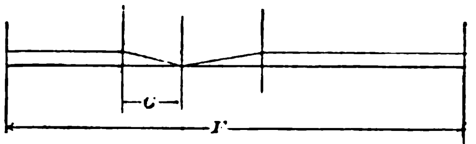


Fig. 3.

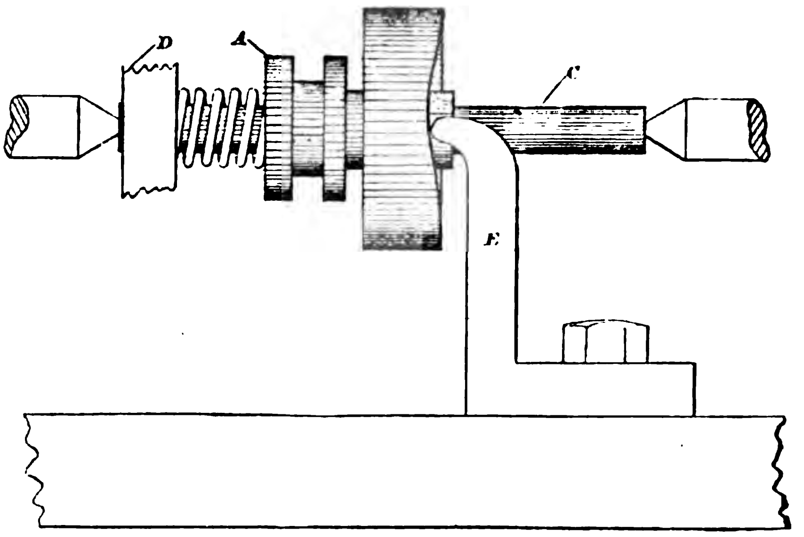


Fig. 4.

Astronomy, to which was attached the direction of the Observatory. In that position his peculiar genius as an observer and as a director of astronomical observations at once manifested itself. From this time onwards Sir George Airy's activity was ceaseless, and its results were of the highest moment to the particular branch of science with which his name was so intimately associated. He devised a perfect routine for taking the various classes of observations, which greatly contributed to their scientific and practical value. At the same time he continued to give diligent attention to the theoretical departments of his science, and in 1831 published a paper of great importance "On the Inequality of Long Period in the Motions of the Earth and Venus."

On New Year's Day, 1836, Prof. Airy commenced the great work of his life as Astronomer-Royal, in succession to Mr. Pond, the appointment being in the patronage of the First Lord of the Admiralty. How he set to work to renew the equipment of the Observatory, designing the instruments himself, and how he brought the *personnel* of the establishment up to the highest point of efficiency, are well known to all astronomers. During Sir George's long tenure of office the observations were made with absolute and uninterrupted regularity, and were carefully reduced and placed freely at the disposal of all who could make use of them. These observations, with the annual reports which he presented to the Board of Visitors, form a collection of astronomical data of great bulk and of the highest value, which in themselves will form a permanent monument to his genius as an observer and organiser.

At a very early period of his career he introduced magnetical and meteorological observations at Greenwich, and at a later period he recognised the new astronomy so far as to organise heliographic and spectroscopic services at the Observatory. Besides the routine work of the Observatory and his own special studies (mostly in connection with the Lunar Theory), Sir George devoted much time to subjects outside of his work, but still to a certain extent connected with it. For instance, he made experiments on the deviation of the compass in iron-built ships; researches on the density of the earth by observations in the Harton Colliery; and gave useful services in fixing the breadth of railways, and in introducing a new system for the sale of gas. He was chairman of the Commission appointed to consider the general question of standards, and of the Commission intrusted with the superintendence of the new standards of length and weight, after the great fire which destroyed the Houses of Parliament in 1834. He conducted the astronomical observations preparatory to the delimitation of the boundary line between Canada and the United States, and aided in tracing the Oregon boundary. He retired from his post at Greenwich in 1881, after forty-five years of service, and has since resided at The White House, Croom's Hill, Greenwich Park. As director of the Observatory his discipline has been described as severe, and he was not easily approached; but to those who had some pretensions to demand them, his vast stores of knowledge were always accessible, and his skill was freely given. Of simple, not to say austere, nature and habits, his whole heart was in his work, and many who may from experience have considered him unkind, or even uncourteous, have perhaps only themselves to blame.

Sir George was President of the Royal Society from 1871 to 1873; he was made a C.B. in 1871, and a K.C.B. in 1872. He was medallist of the French Institute, of the Royal Society (twice), of the Royal Astronomical Society (twice), and also of the Institution of Civil Engineers, for suggestions on the construction of bridges of very wide span. From Oxford, Cambridge, and Edinburgh he received honorary degrees; while of many scientific societies at home and abroad he was an honorary member. On his retirement in 1881 he received a pension of £1,100.

CUTTING A CAM.*

As cam-cutting is rather an unusual operation in a jobbing shop, a description of one way in which such a job was successfully accomplished may be the means of bringing out the methods of others which are simpler and better.

The cam required is shown in Figs. 1 and 2. The conditions of the case called for a cam which would give a horizontal movement of ⅛in. to a flat bar carrying a roller which ran in the cam groove, this movement to take place while the cam was making ⅛ of one revolution, and then return to its normal position in a little more than ⅛ of its revolution, and then remain stationary during the balance of the time. Fig. 2 shows the relative positions of bar H and cam A when completed and in place. Fig. 3 shows the way in which the lines necessary to make such a movement were laid out. First, two parallel lines ⅛in. apart. The length F of each being equal to the whole circumference of the cam A and the distance G being ⅛ of F, a diagonal line drawn between these two points, as shown, gave the angle for the first movement. The return movement was drawn in the same manner, with the exception of its being lengthened out about ⅛ more than the distance G, Fig. 3. Now if the lines shown in Fig. 3 were followed, and the cam cut according to them, we would have rather sharp turns at three points in the groove; but this was helped by making the lines curved instead of straight from point to point, and was left to be done afterward on the former, which will be described further on. Fig. 4 shows the cam *a* fitted on an arbor *c*, but free to slide on same. The pulley B was fitted in the same manner also, but in addition had a key in it which fitted a keyway in *c*, so that, although B was free to slide back and forth on *c*, it was compelled to revolve with *c*. A small hole was drilled into the side of the cam blank A, Fig. 1, into which a pin was driven and allowed to project about ⅛in.; a notch was then filed in the hub of B, into which the pin fitted, thereby furnishing a means for driving A by B. The spring between the dog D and cam *a* being compressed, held B tightly against the guide E, which was bolted to the platen of the milling machine, the arbor *c* being carried on a pair of ordinary centres, one of which could be revolved by a crank in the ordinary way.

To more clearly explain the action of this device, let us suppose that the edge of the pulley B which runs against E was faced up perfectly true, the centre of our end mill being on the same plane as the centre of the arbor *c*, and we move the platen in until the mill begins to cut a little on the periphery of A; then, by revolving all the parts on the centres, would simply form a shallow groove in A, the same as would be done were A driven on a mandrel tight and the groove turned out on a lathe. If, however, a part of B is filed away, say ⅛in. deep from the edge which runs against E, we would find, when the depression reached the point E, that the spring acting against *a* and B would cause them to slide on the arbor ⅛in. in the direction of E, which, being stationary, will force the parts back to their normal position as they continue to revolve. From the foregoing it will be readily seen that, in order to produce the form or path of groove called for, all that is necessary is to form a part of the edge of B in the proportions given in Fig. 3. The circumference of the edge of B being greater than A, the irregularities which might exist from filing the curves on B will be reduced proportionately in the cam A. Two end mills were used, the finishing cut being about $\frac{1}{64}$in. In conclusion, let me suggest to those who may never have thought of it, that a wide groove in a roller may, in some cases, be milled out to better advantage than it can be done in the lathe in the usual way.

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* By F. H. Treacy, in *American Machinist*.

ELEMENTARY PRINCIPLES GOVERNING THE EFFICIENCY OF SPECTROSCOPES FOR ASTRONOMICAL PURPOSES.—I.*

By James E. Keeler.

The exact determination, by analytical methods, of the size and disposition of the parts of a spectroscope which shall best adapt it to any one of numerous purposes for which this instrument is used in astronomy is not generally possible, since practical considerations, not amenable to mathematical treatment, materially modify the results of theory. As in many other instruments, the adopted form is frequently a compromise between conflicting requirements. Nevertheless, sufficiently broad principles may be stated, which will serve as guides in estimating the efficiency of any form of spectroscope for its intended purpose. The effect of the practical considerations which have been allnded to can best be studied by seeing how they effect the several requirements deduced from purely theoretical considerations. The object of the present article is to state the principles of efficiency in an elementary manner, and illustrate their application, for the benefit of students who are beginning work in astronomical spectroscopy. It may seem as if they are too obvious, from well-known laws of optics, to require explanation, but examination of printed descriptions of spectroscopic observations will show that they have not been entirely understood, or, at least, not always borne in mind by many practised observers.† Little apology seems necessary, therefore, for setting forth these principles for the benefit of beginners.

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* From the *Sidereal Messenger*.

† See Prof. Hastings' review of the spectroscopic observations printed in Vol. XLI. *Memoirs* of the R.A.S., in the "Report of the Eclipse Expedition to Caroline Island," May, 1883. I may perhaps be also allowed to instance certain criticisms of my own spectroscopic work, at the meeting of the Royal Astronomical Society on May 8, 1891, as reported in the June *Observatory*.

In considering such matters relating to instruments as are not theoretically determinate, I have had to rely largely on individual experience, which may be at variance with that of other observers. Statements to which this explanation applies will generally be easily recognised.

With a few exceptions, which will be considered later, the spectroscope for astronomical purposes is always used in connection with a telescope. The simplest possible combination is a prism placed in front of the object-glass of a telescope. This form of instrument has great advantages for certain kinds of work, as everyone who is familiar with the wonderful results obtained at Harvard College Observatory will recognise, but it is limited in its application, and it is expensive, since the prism, if no light is lost, must be large enough to cover the full aperture of the telescope objective. Its greatest disadvantage is that it does not allow the use of a comparison spectrum. As it is not likely that the student will have occasion to use a spectroscope of this kind, it will not be considered further here.

The most common and most generally useful form of spectroscope for astronomical purposes is the compound spectroscope, consisting essentially of slit, collimating lens, prism, or other dispersive member, and observing telescope. It is seen in its simplest construction in the small spectroscopes used in chemical laboratories for the analysis of minerals.

The functions of the different parts of the compound spectroscope may be briefly explained as follows: The collimating lens serves to form a virtual, erect image of the slit at an infinite distance, and this image, the brightness of which determines the brightness of the spectrum, may be viewed directly with the observing telescope in the same way as a distant object. If the image is monochromatic (that is, if the slit is illuminated with monochromatic light), the action of a prism placed in the position of minimum deviation, so as to intercept the rays from the collimator, is simply to displace the image through a certain angle, without changing in any way its magnitude, shape, or (neglecting loss of light by reflection and absorption) its brightness. If the image emits light of different but determinate wave-lengths, each set of parallel rays is displaced through a different angle, forming a series of monochromatic images of the slit, or bright-line spectrum. As long as these images are separated in the field of the observing telescope, the brightness of the spectrum will depend solely on the brightness of the primary image, any change in the width of the slit making a corresponding change in the width of the lines without changing their brightness.[*] The case is different if the images overlap so as to form a continuous spectrum. The brightness is then proportional not only to the brightness of the primary image, but also to the width of the slit. The *purity* of the spectrum, or exactness with which the rays of slightly different wave-length are separated, also depends, down to a very small limit, upon the width of the slit, to which it is *inversely* proportional. To get a bright spectrum, the slit must be wide; to get a pure spectrum the slit must be narrow. In any practical case, experiment shows what compromise is most advantageous.

When different spectroscopes are compared, the width of the slit must be taken to be its width in angular measure, as seen from the optical centre of the collimating lens.

The laws which govern the brightness of the spectrum, as seen in the observing telescope under different magnifying powers, are the ordinary laws of the brightness of telescopic images. The highest power, P, which will give the maximum brightness, is obtained by dividing the aperture of the observing telescope by the aperture of the pupil of the eye. If the latter is taken to be $\frac{1}{5}$in., the value of P will be five times the aperture of the observing telescope in inches. In practice, a better result will be obtained with a power of 7 or 8 for each inch of aperture. For any magnifying power p greater than P, the brightness is proportional to $\frac{P^2}{p^2}$.

When the compound spectroscope, the principles of which have been briefly considered above, is used in connection with an equatorially mounted telescope, two different telescopes form parts of the apparatus—namely, the great telescope of the equatorial, and the telescope of the spectroscope. To avoid confusion they will be distinguished by the terms telescope and observing telescope respectively.

The spectroscope is mounted in such a way that the axis of the collimator is coincident with the axis of the telescope, and the slit is brought into the focal plane of the great objective. An image of any distant object to which the telescope is pointed is therefore formed upon the slit-plate. Certain limitations are then imposed upon the dimensions of parts of the spectroscope.

The first condition to be fulfilled is that the angular aperture to focal length shall have the same value for both telescope and collimator; otherwise there will be a marginal ring on one lens or the other which will never be used. If the great telescope is of 1ft. aperture and 15ft. focal length, the collimator, if of 1n. aperture, should have a focal length of 15in. For reasons which will appear further on, it will be advantageous to have the aperture of the collimator lens a little greater than that given by the rule, but in that case we must distinguish between actual aperture and effective aperture. The latter, which is determined by the rule, is the diameter of the emergent beam from the collimator when the telescope is directed to a star, and a marginal ring on the lens receives no light from the telescope objective. A cap may be provided to cover this ring, so that the actual and effective apertures can be made the same if desired. In the following discussion it will be assumed that they are the same.

If no light is to be lost, the prisms and observing telescope must be capable of transmitting the cylindrical beam from the collimator. Greater dimensions than those necessary for this purpose would be useless. The effective aperture of the collimator may then also be called the aperture of the spectroscope.

The lens which is placed in front of the spectroscope to form an image of the source of light on the slit-plate (i.e., in the case we are considering, the telescope objective) is ordinarily called the "condensing lens." This name is inappropriate, as it fails to define correctly the function of the lens, and Prof. Hastings[*] has proposed to substitute for it the term "image lens." As the intrinsic brightness of the image of a surface—the moon, for example—in the focal plane of an image lens of constant linear aperture is inversely proportional to the square of the focal length of the lens, it might seem at first sight as if the spectrum of the surface, when a short-focus lens is used, ought to be brighter than with a long-focus lens of the same aperture. Nevertheless, it is easy to show that the brightness of the spectrum is independent of the angular aperture of the image lens.

To do this, let A, F, S represent respectively the aperture, focal length, and area of the image lens, a, f, s the corresponding dimensions of the collimating lens. Then, as has already been shown, $\frac{A}{F} = \frac{a}{f}$.

Let the source of light be a small uniformly bright surface, and let the unit of light be that quantity which falls upon an area equal to that of the collimating lens. Then the quantity of light which falls upon the image lens is—

$$\frac{S}{s} = \frac{A^2}{a^2} = \frac{F^2}{f^2}.$$

All this light falls upon the collimating lens, and is, therefore, found in the virtual image formed by the latter at an infinite distance; but the angular magnitude of this image is $\frac{F}{f}$ times its angular surface $\frac{F^2}{f^2}$ times that of the object.[†] Hence we have $\frac{F^2}{f^2}$ times the light distributed over a surface $\frac{F^2}{f^2}$ times as great, and, therefore, the brightness of the image is the same as that of the object.

The brightness of the virtual image determines the brightness of the spectrum. We conclude, therefore, from this discussion that the brightness of the spectrum of the distant object is independent of the angular aperture of the image lens. A long-focus telescope is as advantageous for observations of the spectra of the sun, moon, and extended nebulæ as a short-focus telescope. The efficiency, so far as brightness is concerned, is determined solely by the effective aperture of the spectroscope.

To illustrate this result, let us suppose that we have a spectroscope of 1in. aperture, with a collimator 20in. long, used in connection with a telescope of 1ft. aperture and 20ft. focal length. The diameter of the solar image on the slit-plate, when the telescope is directed to the sun, will be about 2·2in. Let us suppose that the slit-width is adjusted until the spectrum is of satisfactory purity and brightness.

If the spectroscope is now removed and placed upon a telescope of the same aperture, but only half the focal length, the image of the sun on the slit-plate will be only 1·1in. in diameter, and it will consequently be four times as bright; but only one-fourth of the rays passing through the slit fall upon the collimator lens. The spectrum will therefore have the same brightness, and, as the slit-width has been unchanged, the same purity as before.

If the collimator is now shortened one-half, all other dimensions being as before, all the rays passing through the slit will fall upon the collimating lens, which must now have a focal length of 10in.; but the slit is now twice too wide, and if narrowed until the original purity is restored, the spectrum will be just as bright as before.

If, instead of shortening the collimator to make its angular aperture equal to that of the second telescope, we increase its aperture to 2in. (the dimensions of the other parts of the spectroscope being correspondingly increased), the brightness of the spectrum will be increased four times, with the same degree of purity as at first.

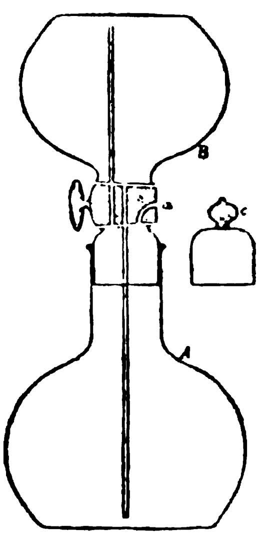
Another interesting conclusion, which is a well-known fact in optics, may be drawn from the preceding discussion. Since in determining the brightness of the virtual image F and f may have any values, and since the virtual image formed by one set of lenses may become the object for another set, it follows that by no combination of lenses can we obtain an image of an object which shall be brighter than the object itself.

If an image of the sun is formed by a convex lens, the conditions of temperature and brightness at any point within the image are (neglecting loss of light due to absorption and reflection) the same as if the point were brought to within such a distance of the sun that its disc would subtend the same angle as the lens. The same statement holds good for any other extended surface. We may base upon this a conventional way of regarding the distant source of light which is sometimes useful in determining the brightness of the image upon the slit-plate—namely, we may regard the object-glass as replaced by the luminous surface itself, stretched across the open end of the telescope tube; or we may consider the luminous surface to be just outside the objective, in which case the absorption of the glass is taken into account. This convention leads to the same conclusions as the discussion already given. It can be applied to a consideration of the brightness of the spectrum only when the image is sufficiently large to fill the slit of the spectroscope.

(*To be continued.*)

APPARATUS FOR THE ESTIMATION OF FAT IN MILK.

THE author, E. Molinari, after criticising the various methods for estimating fat in milk which have been proposed from time to time, agrees with Stokes (*Analyst*, 1885, p. 48), Eustace Hill (*Analyst*, 1891, p. 67), and Bondzynsky (*Landwirth Jahrb. der Schweiz*, 1889), that the method of Werner Schmid is the simplest, most rapid and convenient hitherto introduced. The conditions tending to accuracy are: The employment of ether containing alcohol; boiling the mixture of milk and acid too long, when a caramel-like body is formed, soluble in ether; the difficulty of reading off the volume of ether left in the tube, owing to the gradations of the instrument being obscured by the flocculent layer of casein; when only a portion of the ether is used, fat may be left behind in the acid mixture, as shown by Allen (*Chem. Zeit.*, 1891, p. 331). The author believes that by the invention of the simple apparatus represented in the accompanying figure, he has rendered the process both accurate and convenient. This consists of a flask, B, of about 76 c.c. capacity, which has a glass tap



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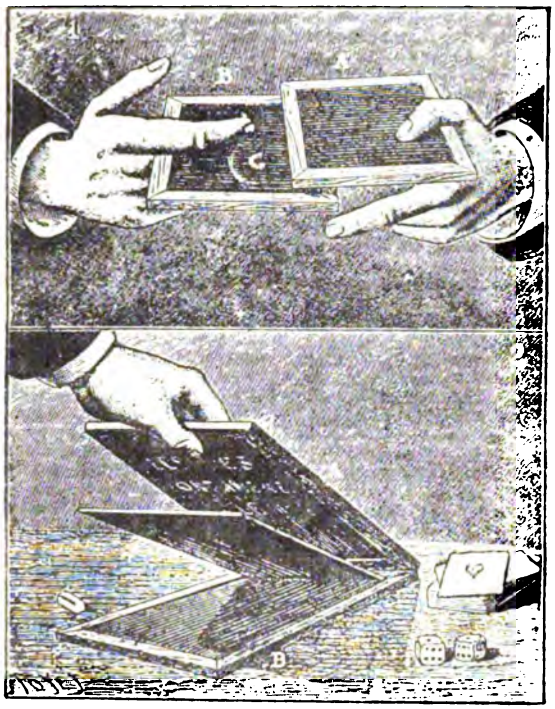
[*] Provided the angular width of the slit is greater than the angle subtended by one wave-length of light at a distance equal to the collimator aperture.

[*] Caroline Island Report, p. 108.

[†] It will easily be seen that this is true. The collimator lens may be regarded as the eyepiece of a telescope, the magnifying power of which is $\frac{F}{f}$.



fused on, with two capillary tubes attached, the one passing upward, the other downward. The neck of flask B is ground into the neck of Flask A, which holds about 90c.c. Either of the flasks can be placed in communication with the external air by the opening *a*. The ether must be previously washed with one or two tenths of its volume of water, to remove traces of alcohol. The operation is performed as follows: 10c.c. of well-mixed milk are weighed in (or measured into) flask A, 10c.c. of hydrochloric acid added, and the mixture heated to boiling on an asbestos sheet. The boiling must not exceed a minute and a half, the fluid being shaken from time to time and not allowed to become of a deeper colour than a dark brown [not black]. The flask is cooled and 25c.c. of ether added. The two flasks are connected as shown in the figure, the tap closed and the whole shaken for a few minutes, the flask being vented two or three times by the opening *a*. The apparatus is now inverted, allowed to stand five or six minutes, the tap turned, and the dark acid liquid drawn off into flask B. By a little shaking of the ether the whole of the acid liquid may be easily got into the lower flask. The apparatus is again inverted, then separated, 10c.c. of ether are introduced into the flask B, the tap closed, and the fluids well shaken. When the ether layer is distinct, the acid liquor is run off, and the ether solution transferred to A. The whole of the ether solution is washed in the apparatus two or three times with a little water, the flask A removed to the water bath, the ether driven of, the last traces of ether and water being removed by placing the flask in a drying oven heated from 107° to 110° C., where it must remain at least twenty minutes. The usual cooling in the exsiccator and weighing concludes the operation. Examples are given showing its concordance with the Adams and other recognised processes. Sour milk, which must be weighed in the flask, can be conveniently analysed; also cream, using 5 grammes cream and 10 c.c. hydrochloric acid. (*Berichte Deutsch. Chem. Gesell.*, 24, p. 2204).—*The Analyst.*.

THE "SPIRIT" SLATE TRICK.

THE following description of a method of working the "spirit" slate trick is given by *La Nature*:—Two ordinary wooden framed slates are presented to the spectators and examined in succession by them. A small piece of chalk is introduced between the two slates, which are then united by a rubber band held aloft in the prestidigitator's right hand. Then, in the general silence, is heard the scratching of the chalk, which is writing between the two slates the answer to a question asked by one of the spectators—the name of a card thought of or the number of spots obtained by throwing two dice. The rubber band having been removed and the slates separated, one of them is seen to be covered with writing. This prodigy, which at first sight seems to be so mysterious, is very easily realised. The writing was done in advance; but upon the written side of the slate A there had been placed a thin sheet of black cardboard which hid the characters written with chalk. The two sides of this slate thus appeared absolutely clean.

The slate B is first given out for examination, and, after it has been returned to him, the operator says: "Do you want to examine the other one also?" And then, without any haste, he makes a pass analogous to that employed in shuffling cards. The slate A being held by the thumb and forefinger of the left hand and the slate B between the fore and middle finger of the right hand (Fig. 1), the two hands are brought together. But at the moment at which the slates are superposed, the thumb and forefinger of the right hand grasp the slate A, while at the same time the fore and middle finger of the left hand take the slate B. Then the two hands separate anew, and the slate that has already been examined, instead of the second one, is put into the hands of the spectator. This shifting, done with deliberation, is entirely invisible.

During the second examination the slate A is laid flat upon a table, the written face turned upward and covered with black cardboard. The slate having been sufficiently examined, and been returned to the operator, the latter lays it upon the first, and both are then surrounded by the rubber band.

It is then that the operator holds up the slates with the left hand, of which one sees but the thumb, while upon the posterior face of the second slate the nail of the second finger makes a sound resembling that produced by chalk when written with. When the operator judges that this little comedy has lasted quite long enough, he lays the two slates horizontally upon his table, taking care, this time, that the non-prepared slate shall be beneath (Fig. 2). It is upon it that then rests the black cardboard, and the other slate, on being raised, shows the characters that it bears, and that are stated to have been written by an invisible spirit that slipped in between the two slates.

Our readers will not ask us how we manage to know in advance what should be written upon the slate. It is useless to say that deceit is allowable in prestidigitation; loaded dice always turn up the same number, and nothing is easier than to know the name of a card that a spectator will draw from a pack composed of thirty-two similar cards, if one is not skilful enough to cause him to take the forced card.

SHARPENING DRILLS.

IN sharpening drills for stone work, the first thing to be looked at is not to heat the steel too hot. All the books treating upon this subject say, "never heat above a cherry heat." This is certainly a safe rule to work to, but it does not apply to varieties of steel. Some kinds will bear heating to a bright red heat, and still others will bear a yellow colour without detriment to the metal. In all cases the steel should be worked as hot as it will bear, notwithstanding the old advice "to forge at as a low a heat as possible."

As stated, the forging should be done at as high a heat as the steel will bear, but the finishing should be done at a very low heat, and it is better to hammer the drill until the heat is out of sight and the metal becomes black. For such hammering the blows should be light, and very little drawing of the metal should take place. Heavy blows upon a cold or nearly cold piece of steel will cause the particles of the metal to move over each other, ending in disintegration of the metal. Cracks often develop after steel has been hammered too cold, or rather after it has been hammered too much while nearly cold.

Suppose that a common ⅞in. drill is to be made for use in making holes in plug wedges. Select a piece of ⅞in. octagon steel; cut off a piece 24in. long, which is just enough to make two good drills. Heat one of the pieces for about 6in. in length, drawing it down to five-eighths of an inch; then hammer it octagon and still further reduce to a little over one-half inch. A swage should next be placed upon the anvil, the drill placed therein and operated upon by a top swage and sledge hammer. Draw down to about one-sixteenth more than ½in. Take care to make a fine taper at the point where the octagon shape merges into the round part of the drill. This taper should be about two inches long. Take great care that the round part of the drill is exactly central with the large part; an overset at this point will result in making a poor tool. All instruments to be used by percussion must be perfectly straight from one to the other, otherwise they will spring when struck by a hammer, and a large portion of the force of the blow will be lost, to say nothing of jarring the fingers of the operator and badly damaging his temper.

The drills should now be about 18in. long, 6in. or 7in. of one end being octagon, 2½in. taper, and nine of 10in. ½in. in diameter and round. After finishing as many drills in this manner as it is desired to make, allow them to cool slowly; under no pretence whatever quench them in water or let them lie upon an iron surface while cooling. It is best to throw them upon the coal and dust on top of the forge, or if it is desired, stick them into dry dirt and ashes in any convenient place.

To sharpen the drill, hammer 1in. on one end of the drill to a square section; then flatten out to a flat point, so that the bevel will be about 1¼in. long. Hammer the edges frequently so that the drill will not spread in width. Upset the end of the drill occasionally, so that it assumes and retains a slight diamond shape when drawn down to $\frac{1}{16}$in. in thickness at the extreme point; the corners of the drill will be about $\frac{1}{12}$in. in thickness. Revolve the drill upon the anvil so that one side of the diamond-shaped end lies true with the outer surface of the anvil. With light, true blows thin this side of the diamond point down to $\frac{1}{16}$in., allowing the drill to spread sidewise at the same time. Treat the other side of the drill in the same manner, and after a little truing up of the edges of the drill, it has assumed a correct shape and is ready for hardening.

Heat about two inches of the drill to a dull red; for some steel the cherry red will be sufficient, but other varieties require a little more heat. Heat slowly, so that the heat is uniform and the colour alike all over the heated portion. Lower the drill slowly into a pail of cold water, the point first, and do not hold the drill still for an instant while it it is in the water. If 2in. of the end have been heated, lower the drill into the water about 1in. passing it down slowly and gradually as stated; the end of the drill will then be as hard as "fire and water can make it."

Remove from the water immediately after it has reached the desired depth and polish by rubbing upon a piece of board, on top of which a little sand or dirt has been sprinkled. The polishing process is merely to allow the colour to be seen as the temper runs down from the heated portion of the drill. During the drawing process skill and judgment are the only guides to obtaining a drill that is just hard enough to do the work, and not hard enough to break. The colour necessarily varies with different qualities of steel. The steel that will not bear heating harder than a cherry red must have a temper drawn to a purple or blue colour. Steel that stands a higher working temperature will stand a straw colour, for temper, and perhaps even lighter.

The instant that the red colour is noted the drill must be again plunged into the water. In watching the colour run down, it often happens that the corners of the drill become blue sooner than the middle. When this happens the corners of the drill must be dipped in water at the instant that the desired colour appears.—*North-Western Mechanic.*

LESSONS IN THE DIFFERENTIAL CALCULUS.—ERRATA.—Some errors have occurred in reprinting these lessons owing to figures dropping out, and we are indebted to a correspondent for pointing out others which appeared in the original edition. In p. 368, first column, line 30, for "would be x^{n-1}" read "would be $n x^{n-1}$"; in the 48th line, a figure 2 should be in front of the first parenthesis. In the fifth line from the bottom of column 2, the figure 5 should be *y*; and just below, a figure 4 is wanting in front of the square-root mark. In the third column, in the paragraph beginning "The captain," the line commencing "to the space" should read "to the cube of the space." It is probable there are other errors, which are almost unavoidable in printing such matter.

SCIENTIFIC SOCIETIES.

BRITISH ASTRONOMICAL ASSOCIATION.

THE second ordinary meeting of the second session was held at Barnard's Inn on Wednesday, the 30th ult., Captain Noble, the president, in the chair. Five new members were elected, and a list of seventeen candidates for membership was read.

Among the presents received during the month were the "Publications" of the Paris Observatory for 1887 and 1891, and the "Annals" of the Vienna Observatory for 1891, and a large-scale lunar map, presented by Mr. Gümpel.

The President, referring to a discussion at the previous meeting on the relative light-grasping power of reflectors and refractors, said he thought it would be of interest to the members if he reproduced the opinion of his lamented friend, the late Prebendary Webb, as to the general comparative merits of the two forms of instrument. In a letter to Mr. Finch, under date of Feb. 5, 1867, Mr. Webb remarked: "I was much of your opinion as to the superior style of vision in the refractor as compared with With's earlier attempts. Even when the definition was good, there was a something—one did not know what—about the focal picture which produced a little sensation of strain about the vision. It was due, I believe, partly to surface error, partly to bad flats." In another letter, under date of July 14, 1868, he says: "In reply to your inquiry about silvered mirrors, I am delighted with mine and the others I occasionally see at the makers. I do not, of course, mean to say that my 9⅓in. is *equal* to the Dorpat achr. of nearly the same aperture; but I do not believe there is much inferiority, except, of course, in light, and no comparison in price. My idea is, that for those who know how to use them (or know how to use any good instrument), they give by far the greatest amount of work in proportion to the price. As to a comparison of figure, which you mention, between these and the best metals, all I know is that Mr. De la Rue considered his own metal a *trifle* superior to the better of the two he had from With. . . . My notion is that the material signifies little. . . . On anything but big stars, I consider the reflector to be the best." The President remarked that, to some extent, these notes had only an historical interest, as the methods of testing mirrors had been so wonderfully improved and simplified since they were written.

Mr. Cottam read three papers on the recent "Total Lunar Eclipse," by L. A. Eddie, F.R.A.S., of Grahamstown, South Africa; Thomas Keig, of Douglas, Isle of Man; and J. Power, of the Cape Observatory.

With reference to a remark in Mr. Eddie's paper that he had been unable to detect any trace of the shadow of the Andes during the eclipse, Mr. Ranyard remarked that a ray of light striking the top of a mountain on the earth would be refracted, at least, one degree, and that, consequently, it would be thrown on the moon's centre. He maintained that a ray of light could not pass through the earth's atmosphere within seven miles of the sea-level. It appeared to him impossible that a range of mountains, or even clouds, could throw any shadow on the moon.

Capt. Noble remarked that the highest peaks of the Andes subtended an angle of 3".

Mr. Green said, speaking as an artist, that even if there were no terrestrial atmosphere, any shadow of mountains on the earth would be utterly lost and blurred before reaching the moon.

Mr. E. W. Maunder referred to a note in the *Journal*, in which Dr. Hartmann's determination of the diameter of the shadow of the earth was given, and which was greater by one-fiftieth than the geometrical shadow.

A paper by the Rev. A. Freeman, M.A., on "The Shadows of Titan and Rhea in Transit," was then read by the Secretary. The writer said the observation of these phenomena was still difficult by reason of the small elevation of the Sun, Titan, and Rhea above the plane of Saturn's rings. Notwithstanding the far from clear state of the air, he was, however, able to see the shadow of both these satellites with his new 6¼in. object-glass. Dec. 7, 3h. 50m. 40s. a.m (G.M.T. civil time), the shadow of Titan was seen in the central meridian. It was in view for about 15 minutes before, and 8 minutes after this time. Dec. 11, 7h. 28m. 45s. a.m., the shadow of Rhea was very close to the central meridian, if not quite up to it. Dec. 20, 7h. 37m. 40s. a.m., the shadow of Rhea was about central, and was seen as a darker spot in the dark rings.

Mr. Downing remarked on the good work done by Mr. Freeman with his 6¼in.; he thought it should be an encouragement to the possessors of small telescopes to undertake similar work.

Capt. Noble said that Titan did not require a large telescope for observation; 3in. would suffice, but he could not say if that would show a transit of Rhea.

Mr. Cottam wished to correct a mistake he had made at the last meeting. He had stated that he had observed a transit of Titan with a 2¾in. He found, upon referring to his notes, that it was a 3¼in.

A paper by Mr. Waugh on the "Dewing of Mirrors" was then read. Mr. Waugh said that he had adopted the plan recommended by Mr. Philips of Barton. He had a square box made with a nearly air-tight lid, containing a smaller uncovered box, to hold some lumps of quicklime and a perforated tray or shelf to hold the speculum. This plan he had found perfectly successful.

Mr. Seabroke said he had never been troubled with dewing. He kept his instrument always out of doors, and the tube extended 2ft. beyond the flat.

The President asked what the focal length of his telescope was.

Mr. Seabroke replied, 6ft., and the mirror was 12in. in diameter.

Mr. Ranyard had been very much troubled with dewing. His remedy had been to have holes cut in the support of the mirror, so that it might as quickly as possible reach the temperature of the air, and he had silvered the back of the mirror. This he had found effectual.

Mr. Holmes had always gone on the opposite plan and protected his mirror, and he never had any trouble with it. He believed that vegetation in the immediate neighbourhoood had a considerable influence.

Mr. Green had found that a covered observatory and a wooden tube had practically remedied the difficulty in his case. In reply to Mr. Cottam, he said that the gas in his observatory did not raise the temperature more than 1°.

Captain Noble had always considered it an absolute rule that the temperature of the observatory should be the same as the outside air, but he remembered, on one occasion, visiting Mr. Rand Capron's observatory at Guildford, which he found thoroughly warmed. To his very great surprise, he got a splendidly clear view of Jupiter.

Mr. Maw said that he has always used a stove in his observatory, and has never found it interfere with his observations.

Mr. Maunder showed a number of lantern slides relating to the great spot group of last September. The first slide showed the Dallmeyer photoheliograph of the Greenwich Observatory in its temporary home on the first floor of the new building in the south ground. The next slide showed the great sunspot of June, 1885, as taken by M. Janssen, at Meudon, the most perfect photograph of a sunspot extant. The spot of last September was the largest group which had been seen on the sun since this great group of June, 1885. The slides he had to show would, he feared, compare but poorly with this superb photograph; but two things should be remembered — one, that the Meudon photograph was quite an exceptional one, whilst the Greenwich photographs were just those taken in the ordinary course of the daily series; and, next, that the Greenwich sun pictures were purposely too thin as a rule to serve as good printing negatives, for their first object was that they might be measured, and to have them dense spoiled them for that purpose. The group formed on the east limb on Aug. 28th. It consisted in chief of two principal spots, separated from each other on Aug. 29th by about 6·0° of heliographical longitude. It was, in its behaviour, quite a typical spot, the first of the two principal spots moving forward at a rate of nearly 1°—say, roughly, between 7,000 and 8,000 miles a day. The following spot, which was the larger, remained fairly stationary on the whole. The group increased in size very rapidly from day to day, rising from an area of about 100 millions of square miles on Aug. 28 to more than 2,000 millions on Sept. 7. After this it declined in size, and passed out of sight at the west limb on Sept. 10, reappearing at the east limb on Sept. 25. During this second appearance only the preceding spot was seen; the following spot having closed up. This disappearance of the following spot was entirely in accordance with the usual behaviour of a great solar outburst; and so, too, was the drift of the preceding spot, which had ceased to move forward in longitude, and had returned on its path, so that its extinction on Oct. 4 took place nearly in the same longitude as its formation.

Mr. Ranyard: What was adopted as the prime meridian?

Mr. Maunder: The usual rotation period, 25·38 days, was adopted. Or, to put it another way, supposing the second spot to have remained stationary on the surface, then the first spot rushed forward with an average speed of nearly 1° per day during its first appearance, had drifted backward 5° during the fortnight that it was on the further side of the sun, and on the whole continued that backward drift till the time of its final disappearance, when it had nearly got back to the place from whence it started.

Mr. Maunder also said that one of the members of the Solar section had forwarded to the Director some notes on a small group, which was interesting from other points of view from that of the group which they had just been considering. Two noticeable features characterised the progress of the sun-spot cycle: one the alteration in the numbers and areas of the spots, the other the alteration in their latitudes. A little before the minimum we found the few spots then seen haunting the Equator; then just before the minimum a fresh series of spots began to appear in high latitudes—say 30° to 40°. This state of things was represented in the latter half of 1889, when the spots were arranged in three zones—a high northern one, an equatoreal one, and a high southern zone. The region 10° to 20° was absolutely bare of spots in both hemispheres. Then the equatoreal spots, which represented the last efforts of the old cycle, died out, and shortly after minimum we had only two zones, one north and the other south, both in fairly high latitudes. Finally, as we approached maximum, the spots appeared more frequently in lower latitudes, and the zones broadened out till they met, or nearly met, on the Equator. Now, what was remarkable about the spot to which Mr. Townsend had drawn attention was that it was almost on the Equator, although we were yet in the early part of the new cycle. In the preceding cycle a similar instance of a spot in lower latitude had been noticed in Sept., 1881; but that was nearly a year later in the progress of the cycle than was the case with the present one. So that the group, though so insignificant in area, was really a remarkable one as to its position.

Mr. Newbegin showed a slide, representing a fine prominence, which he had observed on Nov. 10. The height of the prominence was about 40,000 miles. The slide which he had had made for him from his drawing was a very faithful representation of the object. His children, who had seen the prominence in the spectroscope, recognised it at once on the slide.

Mr. Ranyard remarked on the curious spiral form of the prominence, and on the frequency with which that form, so hard to understand in the case of a column of gas, was noticed in solar prominences.

Mr. Maunder then gave some simple directions for the adjustment of an equatoreal. After showing several slides, illustrating the different forms of equatoreal mounting, Mr. Maunder showed one representing M. Loewy's equatoreal coudé.

Mr. Schooling then explained an idea he had formed for a simpler equatoreal coudé. His idea was to discard the mirror before the object-glass, and make the first part of the tube, that carrying the object-glass, inclinable at any angle to the polar axis, the mirror moving through just half the angle of the tube. He would like the opinions of those present as to the practicability of his ideas.

Mr. Maunder resumed his account of the necessary adjustments of an equatoreal.

The President announced that the Council had resolved to set on foot a Photographic Section, and that Mr. Schooling had consented to undertake the direction; subject, of course, to the confirmation of the Association at the next Annual General Meeting. He also announced that Mr. Maunder would give an elementary address on the spectoscope, illustrated by the lantern, at their meeting on Jan. 27th.

The meeting adjourned at 7.0 p.m.

Cyclone Weather.—The common type of cyclone weather is sometimes materially altered by orographical conditions. This is the case—e.g., at Turin, as recently shown by Signor Rizzo, in a paper to the Academy there. He cites thirty-three cases in the last twenty-five years, says *Nature*, which indicate the general course of the weather when a cyclone passes over Northern or Central Europe. After a fall of the barometer, with strong west wind, the sky clears, the temperature rises considerably, and the moisture of the air diminishes. This is explained by the influence of the Alps. The strong west wind is forced up the mountain range, so that its aqueous vapour is condensed, and falls as rain and snow on the western slopes and summit. After crossing the ridge, it descends, and, having parted with its moisture, appears as a warm, dry wind, thus forming an unusual feature in cyclones.

MR. S. W. HUFF states, as the results of experiments which he has carried out, that dynamos and motors will run silently when the brushes are off and there is no current passing; but so soon as a strong current was sent through the fields a musical hum was heard, the note increasing in volume with the increase in current through the fields, and increasing in height of pitch with the increase of speed of the armature. This was tried repeatedly with the same result. The armature was then replaced by a bare armature core, and this was put through a similar test, with the same result. The experiment seeming to indicate that the musical note takes its pitch from the speed of the armature, and that the note in vibrations per second corresponds to the number of times per second that the armature passes from one field pole to the next, would lead to the conclusion that in machines with armatures changing pole less than sixteen times per second there would not be given out any musical hum.

SCIENTIFIC NEWS.

TWO of the known periodical comets should return to perihelion early this year if the calculations are correct. Both have a period of about five and a half years, and were last observed during the summer of 1886. One is the comet first discovered by Mr. W. R. Brooks in 1886, and the other is that discovered by Pons in 1819, which was re-discovered and its period calculated by Prof. Winnecke in 1858. Its returns were observed in 1869, 1875, and 1886; but not in 1863 or 1880, when the positions were unfavourable. The comet is entered as Winnecke's, and was due last month, as in 1886 it passed perihelion 12 days earlier than the predicted time.

Prof. Pickering, in *Ast. Nach.* No. 3070, calls attention to three stars which show bright lines in their photographic spectra, and are of the same class as those noted by Wolf and Rayet. They are D.M. + 55·2721°, R.A. 22h. 15m., Dec. 55° 37'; another in R.A. 22h. 23·7m., Dec. 55° 46'; and D.M. + 56·2818°, R.A. 22h. 32·9m., Dec. 56° 23', all about the centre line of the Milky Way.

The Lalande prize of the Paris Academy of Sciences for 1891 has been awarded to M. G. Bigourdan, of the National Observatory, Paris, for the work he has already done in micrometrically measuring all the known nebulæ observable from Paris—about 6,000 in number—a first step towards obtaining a knowledge of their proper motions, and ultimately, perhaps, of their distances from the sun. The Janssen prize has been awarded to M. G. Rayet, director of the Bordeaux Observatory for his work towards the creation of astronomical spectroscopy. The Damoiseau prize failed to attract a memoir, and is raised to 4,000f. for 1892. The Valz prize has been awarded to Prof. H. C. Vogel, of Potsdam.

The *Journal* of the British Astronomical Association contains several interesting papers and notes, and the index number for Vol. I. has as a frontispiece an ink photo. of the interior of Barnard's Inn Hall, accompanied by a brief historical description of the meeting-place of the Association.

Comet Tempel-Swift is now very faint, and Wolf's Comet is also getting so faint that it can only be observed well in powerful instruments.

The death of a distinguished American is announced in the person of Major-General M. C. Meigs, at the age of 76 years. After graduating at West Point, he joined the corps of Engineers, and devoted himself for several years to the works of peace. He supplied the national capital with water from the Potomac, and designed the Washington aqueduct, including a bridge, the span of whose arch is the largest in the world. These works were constructed under his personal direction, simultaneously with which important service he conducted the construction of the extension of the national Capitol, and of its great dome. When the war broke out, Capt. Meigs took an active part on the Northern side, and was soon raised to the responsible position of Quartermaster-General of the United States Armies, a post he filled with consummate ability. He retired from the service in 1882, and then built the great structure in the City Park of Washington, known as the Pension Building. He was one of the Regents of the Smithsonian Institute, and was a member of council of the National Academy of Sciences.

Dr. Ferdinand Roemer, of Breslau, one of the most distinguished amongst the geologists of Germany, died recently. He was an indefatigable worker in the fields of geology and palæontology, especially amongst the older rocks. He was a foreign member of the Geological Society of London, and received the Murchison Medal of that Society in 1885.

Prof. John Wood, F.R.S., the distinguished surgeon, died last week in his 66th year. He was Emeritus Professor of Clinical Surgery at King's College Hospital.

Austrian papers record the death of Dr. Paul Hunfalvy, the most eminent Hungarian ethnologist and philologist.

Under the title of "A Naturalist in the Transvaal," Mr. Distant, the well-known entomologist, intends to publish the results of his journeys in the Transvaal, which extended over a period of twelve months. He traversed the country from north to south, but made a special study of the fauna of the district around Pretoria.

The Christmas Lectures at the Royal Institution have been delivered by Prof. J. G. M'Kendrick, F.R.S., on "Life in Motion," and very interesting he made them. These lectures, ostensibly for juveniles, have been made celebrated by Faraday, Tyndall, Dewar, and Ball, but have never before been intrusted to a physiologist. After introducing the subject in his preliminary lecture, Dr. M'Kendrick, with the view of illustrating the principle of the electrical apparatus (an induction coil) used by physiologists for stimulating nerves and muscles, showed the method followed by Faraday in making his famous discovery of producing electricity in wires by induction, experiments made by the great discoverer in a laboratory of the Royal Institution itself. Many of the arrangements now in use for recording minute periods of time were also shown. A lightning flash occupies only the millionth part of a second, and a gnat's wing, as it passes through the air on a summer day, may be quivering many hundred times a second. It was then demonstrated by refined appliances that a muscle does not contract the moment it receives the nervous stimulus, but that an interval, varying from one-hundredth to one four-hundredth of a second, elapses during which changes occur in the muscle antecedent to contraction. He also showed that a living being may be highly electrified without any sensation being felt, and that it was only when electricity passed suddenly into or out of nervous tissues that these were stimulated. An experimental demonstration was given of the nature of tetanus or cramp, and it was shown that it consisted of a fusion or summation of minute contractions. The curve produced by a single muscular twitch was analysed, the time occupied being about eight-hundredths of a second. The elasticity of muscles keep them "taut," not "slack," so they are always ready to work. But in contraction an elastic force is developed, and it is this that pulls on the movable parts of the skeleton.

The life of a fish (carp notably) is known to be very long compared to other animals; but it is stated that in the royal aquarium at St. Petersburg there are fish which were placed there more than 150 years ago.

Dr. Otto Zacharias has established a biological station at Plön in Slesvig-Holstein, which he expects to be able to open in the spring.

The general meeting of the Association for the Improvement of Geometrical Teaching is to be held at University College, Gower-street, W.C., on Saturday, Jan. 16th. At the morning sitting the reports of the Council and the committees will be read and the new officers will be elected. At the afternoon sitting the following papers will be read:—"On Laguerre's Dictum concerning Direction," by Prof. R. W. Genese; "On the Geometrical Interpretation of Fallacy in Elimination," by the same authority; and "On the Use of Horner's Method in Schools," by Mr. E. M. Langley.

Some interesting experiments in the analysis of milk have recently been carried out by Prof. A. R. Leeds and Dr. E. P. Davis, of the United States. These experiments have led them to confirm the opinion that sterilised milk, though a useful remedy in various stomach complaints, is insufficient to sustain life. If it is necessary to sterilise milk, the desired effect can be produced without detracting from its digestibility, by first making the milk very slightly alkaline with lime-water, and then heating to 155° F. for six minutes. By raising the temperature to the boiling point, and retaining it at that point for some time, a considerable portion of the soluble proteids are converted into insoluble. The result of their conclusions is that sterilised milk is less readily and less perfectly digestible than raw milk.

In a German technical periodical, Dr. Kooyker reports a case of gastric calculus, which, common enough in animals, is rarely found in man. His patient died from exhaustion, and at the post-mortem examination a concretion was found in the stomach, almost entirely filling its cavity, which weighed 885 grammes, and was 18 centimètres in length. The microscopic examination resulted in finding starch, vegetable cells, chlorophyll, and vascular tufts, while hair and other animal elements were entirely absent. The patient—a man—was fifty-two years of age.

Dr. C. Smith, of Casterton, Australia, treats diphtheria by the continuous inhalation of a vapour composed of a mixture of carbolic acid, eucalyptus oil, and turpentine, together with the administration of tincture of digitalis, tincture of belladonna, and aromatic spirit of ammonia.

The United States Patent Office proposes to exhibit, at the Chicago Exposition, a comprehensive array of models to illustrate the progress of mechanical civilisation. One group of models will show the progress of the printer's art from Gutenberg's invention to the latest rotary perfecting and folding printing press, capable of turning out newspapers at the rate of many thousands per hour. Other groups will show the development of the steam-engine, sewing-machine, agricultural machinery, applications of electricity, &c.

It is stated that Mr. Edison promises to erect at Chicago, the largest electric-light plant in the world, at a cost of about £400,000. Messrs. Siemens and Halske also intend to have a very large exhibit at the World's Fair of 1893.

It is stated that the Sims-Edison torpedo has been successfully tried in the Tyne from a moving ship, and is described as the most formidable weapon in the world. It will be remembered that the Admiralty recently gave £100,000—considerably more, it is rumoured—for the Brennan torpedo; but the Admiralty is always in difficulties, even with the boilers of the costly men-of-war. It would not pay the owners of the Atlantic liners to be continually putting new boilers into their vessels.

It is stated that the culture of the vine is rapidly extending in Ontario, and that the quality of the grapes is being gradually improved. The vines are so prolific that the price obtained for the grapes is only about 2 cents a pound, such quantities being placed on the market at once. We shall shortly hear of Canadian wine.

AMONG the forty odd species of snakes in the collection of Prof. G. R. O'Reilly at the Central Park Menagerie, one of the most interesting is the cribo, a yellow-tailed tropical snake, which has a taste for devouring other snakes, including those which are poisonous. It is said that he does not hesitate to attack bigger reptiles than himself, but crawls slyly up to his intended victim, pins the enemy's head down, and holds it firmly till he is dead. The cribo is not afraid of any other snake; but all others are mortally afraid of him, including the most venomous, as well they may be.

Corn Cures.—Dr. H. M. Whelpley, Ph.G., M.D., says probably the most popular corn cures depend on the action of salicylic acid. Among the many therapeutic properties of this comparatively new remedy is its power to disintegrate epithelial tissue. It is usually combined with Cannabis Indica. The form I have found useful is to mix nine parts of salicylic acid with one part of extract of Cannabis Indica and forty-eight parts of collodion. This is applied to the corn every night with a camel's-hair brush. The foot should be clean before it is applied, and the mixture permitted to thoroughly dry before it comes in contact with clothing. A salicylic-acid corn plaster is made by mixing six parts of resin and adding five parts of balsam of fir, and then stirring in ten parts of salicylic acid as it cools. This can be spread on any suitable medium for a plaster. When used, the corn must not be rubbed with the shoe. Lanolin forms the basis of another salicylic acid plaster, and cocaine is added with the idea of making it painless. To form the plaster, mix 6dr. of salicylic acid thoroughly with 10dr. of lanolin. Dissolve 5gr. of hydrochlorate of cocaine in a small quantity of warm alcohol, and mix the solution with 1fl.-oz. of creosote. Mix ½oz. of melted white wax with ½oz. of vaseline, and add the creosote solution. To this add the cocaine solution and mix. Some of the salicylic acid corn cures are simply a salicylic acid cerate, made by mixing one part of salicylic acid with eight parts of simple cerate. Among the corn plasters made without the use of salicylic acid is one composed of forty parts of resin cerate, forty parts of galbanum plaster, fifteen parts of verdigris, five parts of turpentine (the oleoresin), and three parts of creosote. There is also in the market a corn plaster which is ordinary adhesive plaster, with about 15 per cent. of salicylic acid and a small percentage of benzoin. Still another corn plaster is made of salicylic acid one part, Burgundy pitch one part, and yellow wax one part. A caustic corn salve is made by mixing a hot saturated solution of caustic soda or potassa with twice its bulk of glycerite of starch. A solution for the cure of corns has been made by dissolving 30gr. of tannic acid in 1oz. of a mixture of equal parts of tincture of iodine, acetic acid, and glycerine.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

THE DRAPER MEMORIAL—"OLD AND NEW ASTRONOMY"—THE MOON'S HEAT—THE SHADOW OF TERRESTRIAL MOUNTAINS ON THE MOON DURING A LUNAR ECLIPSE—OVERTAXED BRAIN—THE PRISMATIC COMPASS—FOCI TO SECONDS OF ARC!—EQUATION OF TIME—LOGARITHMS OF THE DISTANCES AND RADII VECTORES OF THE PLANETS—ASTRONOMICAL CAUSE OF GLACIAL EPOCHS—SUN'S DISTANCE AND PARALLAX.

[33047.]—YET another volume devoted to that glorious monument, alike of private munificence and of honest, able, and conscientious public scientific work, the Draper Memorial, has just been issued as part 1 of Vol. XXVI. of the *Annals* of the Harvard College Observatory. It treats of "The Preparations and Discussion of the Draper Catalogue," and when I say that it is by Prof. E. C. Pickering, I might almost be held to be absolved from the necessity of adding anything to that announcement. I may, however, just say here that the amount of work whose results are embodied in the portly volume before me is something amazing; but that such results are confined to those obtained during the years 1885 to 1889 only with the Bache telescope. This, as I probably need scarcely remind those likely to take an interest in the subject, is an instrument of a kind which may almost be regarded as unique, consisting of a Voightländer photographic portrait-lens of 8in. aperture and a focal length of 45in.; reground and equatorially mounted by Messrs. Alvan Clark and Sons. This furnishes a field of view of 10°. Where spectra were to be photographed, a square prism of dense flint glass 8in. long, with a refracting angle of about 13°, was placed over the objective with its refracting edge parallel to the equator. Occasionally a prism with a refracting angle of 5° was used. Thus the image of a star was spread out into a line, red at the northern end, and blue at the southern, and by giving a motion in right ascension to the telescope, slightly different from that of the earth, this line was spread out into a band in which the lines of the spectrum were distinctly seen. One advantage of a telescope the ratio of whose angular aperture to its focal length is so large, must be at once apparent to every one with the most rudimentary acquaintance with optics. Being double that of ordinary telescopes, it reduces the time needed for photographing a faint object like a nebula to about one quarter; moreover, the lens being a doublet, a much larger portion of the sky can be photographed on each plate. "With a single telescope lens," says Prof. Pickering, "a circle 2° in diameter, that is three square degrees, can be photographed. With the doublet regions 5° square, covering twenty-five square degrees, are not badly distorted even at the corners. The time required to cover the entire sky is therefore reduced several times." The telescope was ingeniously made of such a focal length that the scale of the photographs was the same as that of the charts of the Durchmusterung, so that if the negative was laid upon one of these charts, and the images of the brighter stars made to coincide, the rest could be identified by inspection. With this apparatus, and during the years specified, no less than 3,300 plates were taken, of which a catalogue is given. The work is further classified in a series of tables, and the methods of measurement and reduction explained. In the chapter following that which furnishes this explanation, is an account of the measurement of certain circumpolar stars as standards. Then we have an investigation of the distribution of spectra; a comparison of photographic with visual magnitudes, and a further comparison of the spectra in the negatives with visual spectra. This gives in the most condensed possible form the leading features of this admirable volume. Everyone interested in stellar spectroscopy and photography will of course procure it for himself.

"Everything," said Lord Beaconsfield (in "Tancred"), "comes to him who waits." As I write, Part XII. of "Old and New Astronomy" lies before me, and it is certainly a singularly interesting one; for the present editor of the work has furnished us with the results (beautifully illustrated by reproductions of photographs) of the latest researches into the physical structure of the stellar universe, and very remarkable results they are. The student of Prof. Nichol's books and other works of our youth will peruse these pages with something akin to amazement, at the misinterpretation by our immediate predecessors of the phenomena of our stellar surroundings. *Festina lente* is, seemingly, in the never-to-be-forgotten words of Mrs. Gamp, Mr. Ranyard's "mortar, which he sticks to"; but it will scarcely be denied that this last number of the continuation of the *magnum opus* of our great dead astronomer was worth waiting for.

In letter 33008, on p. 395, I spoke of a new antagonist who had risen up to combat Mr. Peal. Since writing that letter I have come across a *précis* of Mr. Frank H. Very's essay on the distribution of the moon's heat and of its variation with the phase, which gained the prize of the Utrecht Society of Arts and Sciences in 1890, and which has recently been published. Employing the bolometer, with a very sensitive galvanometer, an image of the moon some ·4in. in diameter was projected by a concave mirror and the heat measured of a limited part of it, say $\frac{1}{35}$th to $\frac{1}{80}$th of the area of the disc, the observations being repeated at different points and at different phases of the moon. Six hours after Full Moon it was found that the east limb was hotter than the west one in the proportion of 92·2 to 88·9. Once this excess was found to be much greater. There is a regular decrement of heat in passing from higher to lower latitudes, and observations seem to show that heat is accumulated after many days of continuous sunshine. The heat in the circumferential zone of the Full Moon differs 20 per cent. from that at her centre, so that the thermal and visual images are alike in this respect. The diminution of the heat from the Full to the Last Quarter is slower than its increase from the First Quarter to the Full. This result agrees with that obtained at Lord Rosse's observatory, and is direct evidence of the storage of heat by lunar rocks. I venture to express my opinion that these elaborate and beautiful observations of Mr. Very's are well worth Mr. Peal's serious consideration.

Writing of the moon suggests to me to remark that I have just heard that M. Folie, the Director of the Belgian Royal Observatory at Uccle, has been demonstrating that by no possibility could such a chain of mountains as the Andes, when on the earth's limb, cast a visible shadow on the moon during a Lunar Eclipse. Well, I venture to think that this depends materially upon atmospheric conditions. The penumbra on Nov. 15 last was quite abnormal, as far as my experience is concerned, and blurred the edge of the true shadow in a manner which I never remember to have previously seen. The shadow of the general chain of the Andes on that night subtended an angle of 2·65″; that of the loftiest peaks, like Aconcagua, 3·01″. Surely this ought to be visible if it fell on a smooth part of the moon's surface?—unless, of course, we are to assume that our atmosphere is opaque to the sun's rays, to a height of many miles.

If Mr. Fridy (letter 32963, p. 350) really has overtaxed his brain, let me assure him that the one sovereign remedy is *rest*. It is useless his quacking himself with homœopathic rubbish, which will do him neither harm nor good. I have told before in these columns, but will here repeat, for his information, how, some years ago, in computing a set of tables to facilitate transit reductions, I had to take out many hundreds of logarithms, and how, at the end of my labour, I found myself in this very peculiar intellectual condition: that in writing down a set of figures I always misplaced the two last. For example, for £44 6s. 8d. I would write £44 8s. 6d; for 1892, 1829, and so on. I spoke to a physician about this, and his reply was: "You have overdone it a little. Don't look at a figure for a fortnight." I followed his advice, and have never had the smallest symptom of a return of this odd result of an overtaxed brain since.

I quite endorse what "O. H. T." says (in letter 33014) on p. 396, as to the ease and considerable accuracy of surveying with a prismatic compass. General Drayson's "Practical Military Surveying and Sketching," published by Chapman and Hall, contains an excellent chapter on the use of this very handy instrument. I find it very useful, too, in taking bearings in connection with the Ordnance maps.

I do not quite understand Mr. Gadd's formulæ in letter 33015, p. 396. At what distance do his *r*, *s*, and D subtend angles of 10″, 12″, and 23″ respectively? And what is, say, the sine of − 20·75″?

If "Mac" (query 75159, p. 404) will reflect how Leap Years shift the days, he will find that the equation of time for, say, 1891, will be shifted to another day in 1892 after February 28th; but otherwise, although it does vary to the amount of some seconds, it is scarcely to an extent perceptible on any sundial. For example, the equation of time on December 1st, 1891, was + 10m. 52·14s.; on December 1st, 1892, it will be + 10m. 33·81s. The equation on November 30th, 1892 (corresponding to December 1st of the previous year) will be 10m. 56·45s.; but no one, as I have intimated, can read to 4 seconds on a sundial.

"Alcyone" (query 76176, p. 404) will find that the logarithms of the true distances of the planets from the earth, and of their radii vectores, are those of the number of times the earth's mean distance from the sun, considered as unity, is contained in the quantities they represent. For, take his own selected example (*Nautical Almanac* for 1892, p. 250), 0·7267060 is the log. of 5·32974; so that Jupiter is at the instant specified 5·32974 times the distance from the earth that the earth is from the sun when at her mean distance. So we say:

0·7267060
7·9656365

8·6923425 the log. of 492,427,800 miles.

Similarly, at the same instant, the log. of Jupiter's radius vector is— 0·6955517
to which we add the log. of the earth's mean distance........ 7·9656365

and we obtain .... 8·6611832, which is the log. of 458,340,400 miles, the length of Jupiter's radius vector.

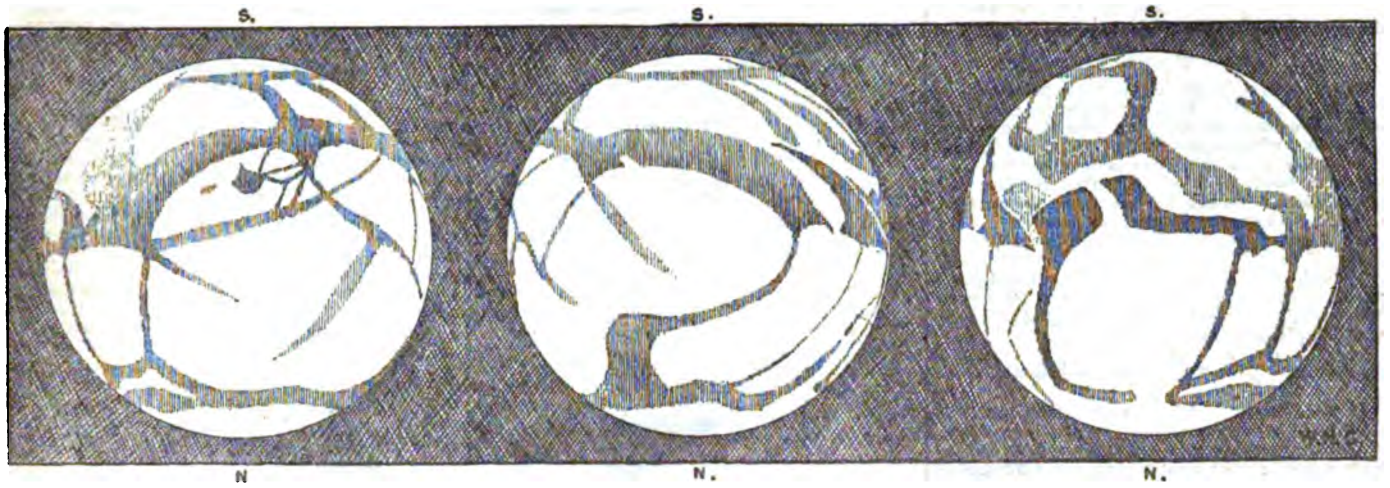
"Alcyone" will note that the logs. of the radii vectores of the interior planets have the negative characteristic 9· (for $\bar{1}$·), the numbers they represent being only fractions of the earth's mean distance from the sun. Thus, take the radius vector of Venus on Jan. 1 (*N. A.* p. 234) 9·8618129; this is the log. of 0·727466. Then as before, we say:

9·8618129
7·9656365

and we get 7·8274494, the log. of 67,212,400 miles. What does "Alcyone" need to trouble his head about Kepler's Laws in connection with this for?

All who have read the "Climate and Time" of the late Dr. Croll, or the embodiment of its results, contained in Geikie's "Great Ice Age," will have been struck with the singularly cogent evidence adduced in proof of the connection between successive Glacial Epochs which have left such striking traces of their existence on our globe, and the variation in the eccentricity of the earth's orbit, and the change in the position of her axis in space, owing to the familiar phenomenon of precession. But, strong as the case was, Dr. Croll considerably weakened it by reliance upon a most remarkable passage in Sir John Herschel's classical "Outlines of Astronomy" (pp. 231 *et seq.* of the last edition, 1875), to the effect that if we represent the total heat received from the sun during a year on one hemisphere to be represented by 100, then would this heat be equally distributed, so that we should receive 50 parts in summer and 50 in winter. Coming as this statement did from one of the most illustrious astronomers and mathematicians of the age, it was, not unnaturally, received without doubt or cavil, and a mass of figures and arguments were founded upon it. But *Nemo mortalium omnibus horis sapit*, and in the part of your contemporary, *Knowledge*, for January, the Astronomer Royal for Ireland, Sir R. S. Ball, enters into the subject from a mathematical point of view, and shows that Sir John Herschel, in some occult fashion, made a most remarkable mistake; for that, in reality, out of every hundred parts of Solar heat that fall on the earth during twelve months, 63 parts are received on each hemisphere during its summer, and, of course, only 37 during its winter. This proportion, be it noted, persisting, whatever be the eccentricity of the earth's orbit. The orbit is at present nearly circular; but (largely owing to perturbations induced by Jupiter and Venus) this circle has a tendency to pass into a pretty pronounced ellipse, and so back in the course of hundreds of thousands of years to a circle again. How this operates in producing Glacial Epochs I must refer the reader to Sir R. Ball's paper to learn. I will not weaken the force of his argument by attempting a *précis* of it here. I gather from the text of his article, which I strongly advise every one to read, that he has just published a little book entitled "The Cause of the Ice Age," in which the whole question is treated in detail; but this I have not seen.

In reply to "F. G." (query 76207, p. 427), the final results obtained by Prof. Auwers are, from the 1874 Transit of Venus 8·877″ ± 0·043, and from the Transit of 1882 8·879″ ± 0·037″. Prof. Harkness's most elaborate discussion of all the available determinations of the Solar Parallax resulted in his adoption of one of 8·80905″. In the existing state of our knowledge, I can only regard 8·8″ as the most probable value. At all events, no



results obtainable from the Transits of Venus will ever improve it: for there can be no doubt that the accuracy of that method was much overrated by the astronomers of a past generation.

A Fellow of the Royal Astronomical Society.

MARS.

[33048.]—HEREWITH I inclose three sketches of Mars. Fig. 1 is on the meridian of 90°, extending from 0° to 180°. Fig. 2 is on meridian of 210°, from 120° to 300°. Fig. 3 is on meridian of 330°, extending from 240° to 90°. The sketches are based upon the chart by Burton and Dreyer, published in the latest edition of "Webb." **Wm. H. Gates.**

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AN ISLAND WITH A FUTURE—52 ORIONIS—MERCURY AND VENUS.

[33049.]—IN these days of superabundant capital and lack of remunerative investments, it appears to me that a noble future is open to the enterprising individuals who will form a "St. Lucia Fruit Company." Would that I could appear in the desirable light of a "promoter" of such an association; but, alas! the British officer is not a business man, nor is he one of those fortunate individuals to whom the disposal of surplus cash offers any difficulty. So I put forward the idea in the hope that it may be useful to someone else, and may help in the development of a much-neglected island, which has a fine future before it.

Somewhere about 100,000 acres of virgin soil, well watered, and in a climate where there are no important alternations of heat and cold, can be purchased from the Crown in St. Lucia at the rate of £1 per acre, payable, if desired, in annual instalments of 5s. Let us suppose that an English company is raised, with a capital of £200,000, and examine into its prospects.

So far as an outsider can judge, they would be most excellent. Cultivation of oranges, pineapples, and bananas might be commenced at once, and at the same time a proportion of the land planted with such trees as the nutmeg, which would form a sort of steadily increasing reserve fund. Cocoa, pepper, bread fruit, and spices of all kinds could also be grown; but the first object of the company should be the fruit trade. From the very earliest this would be a large one. St. Lucia has the best harbour in the Windward and Leeward Islands, with wharves alongside in which steamers drawing up to 27ft. of water can lie. It is rapidly being fortified, and will in a year or two become the head-quarters of the troops, and the great coaling station of the Navy in these parts. This is a matter of the highest importance, as it will give absolute security to capital invested in the island, which Great Britain will always be obliged to hold as a coaling station, even were she to part with her other possessions.

Without exporting a pound of fruit, the company can then commence its operations by supplying the large garrison, the cruisers of the navy, and the vessels calling at the port. These latter amount already to some 400 steamers and 250 sailing vessels. Till the fruit-trees were throughly grown this trade would be sufficient to pay a fair dividend.

When once either the Panama or the Nicaraguan Canal is opened, the importance of St. Lucia will increase tenfold. It is scarcely too much to say that thousands of vessels will call at the island every year, and the trade done will be enormous. The property of the company will increase vastly in value, and a most ready sale for its fruit be obtained. If any considerable surplus of the latter exist, a fast steamer or two could place it on the London market in 12 days. Surely here is a noble prospect for the future!

The disadvantages against which the company would have to contend would probably be the following:—

1. The possible action of the Colonial Government, which, in 1840, extinguished a thriving trade in the sulphur of the Souffrière crater by imposing an export duty of 16s. per ton! This extraordinary policy was resorted to in order to prevent the coloured labourers being withdrawn from the sugar plantations. But we have advanced a long way since 1840, and in 1891 the Colonial Office would scarcely allow such an act to be repeated. It would probably be easy to obtain a guarantee to that effect.

2. *Labour.*—So long as the negro can live without working, it is difficult to obtain labour. But the Indian coolie has taken a firm root in St. Lucia, and the negro population of the West Indies increases so rapidly that soon labour will be necessary to them. The last Census shows a population of over 182,000 in the island of Barbados, only 166 square miles in extent! Of course they are being driven to emigrate, and as St. Lucia is only 90 miles away, an offer of employment would doubtless attract numbers.

3. *Hurricanes.*—This would undoubtedly be a real danger. It is many years since a violent hurricane visited St. Lucia, and may be many more, as their course seems to have altered towards the northward during the present century. Against this danger we must set the advantages of a climate where no frost or cold wind is ever to be feared.

Beyond the fact that I desire to see the lovely islands of the Caribbean Sea raised from their present state of stagnation and decay, I have no interest whatever in writing this letter. Therefore, Mr. Editor, as it is rare in this day to be able to offer a wholly unprejudiced opinion upon any subject, I hope you will not decline to insert it. The development of British commerce is worthy of the pages of the ENGLISH MECHANIC.

Obstinate adherence to the growing of sugar seems to me the curse of these islands. Sugar is a valuable product; but in these days there are many good substitutes, and the trade can only be made profitable by artificial protection duties, &c. I should be sorry to see St. Lucia turned into a second Barbados—a vast sugar farm, with a population of three to an acre, obliged to import absolutely every article they require, even refined sugar. What would happen in such a place in the event of an interruption in naval commerce? Of course, if the one object to be aimed at is to support the largest possible number of human beings on each acre of land, there is nothing more to be said; but to my mind such a proposition is a very startling one. Applied generally, it could scarcely lead to any other result than a Chinese civilisation, and universal monotony of life, varied by enormous disasters and plagues, relieving from time to time the swarming human ant hill. The West Indies have a great future before them, if they know how to use their opportunities aright. But it will never be reached by sugar growing. At all events that is my personal opinion as an outsider. Sugar has had its day and flourished therein, but that was before 1838.

I am having some excellent views of Orion at present. Zeta Orionis I find very easy with 250 even when pretty low down to the horizon. But 52 Orionis is about the limit of my telescope. On clear nights, with 250 eyepiece, I can see it as two minute circular dots with the thinnest possible dark division between them. I am confident that I could divide no closer double with the telescope. I have tried the eye-lens only of the 250 e.p. which divides ζ Orionis very widely but has no visible effect in increasing the dark division of 52 Orionis. Therefore, I assume that the object-glass can do no more. According to theory, a 3in. should be able to divide 52. I wish some owner of a large instrument would stop his aperture down to 3in., or 3½in., and report results on this star. It is a very pretty test.

Mercury and Venus are glorious in the evening skies just now, and it is a pleasure to watch their movements with respect to each other. It is not often that one has the chance to see both these planets so long in practically the same Right Ascension, as in this month.

I look forward to some fine views of Mars next summer.

T. Preston Battersby, Capt. R.A., F.R.A.S.

Barbados, 14th Dec.

CALCULATIONS CONCERNING THE LENS.

[33050.]—I AM sorry to disappoint Mr. Kircher (33016, p. 396), but I cannot conscientiously undertake what he suggests, because, in the first place, I am not sufficiently familiar with the details of modern optical lanterns; and, secondly, the calculations necessary to be made in cases of the kind named, if anything like correctness is to be attained, are too complex and laborious for me to enter into at present, even assuming the necessary knowledge on my part to exist, which is very doubtful indeed. Perhaps some other correspondent will supply that which is required.

It may be said that the two great obstacles to be overcome are (1) dispersion of the coloured rays, and (2) spherical aberration due to the curves of the lenses. The first of these depends chiefly on relative focal lengths of the lenses, and the latter on the *forms* of lenses used. **A. Gadd.**

[33051.]—IN the simple astronomical telescope, we have merely two lenses, consisting of an object-glass, which forms a small, bright image at about its principal focus, and an eye-glass to magnify such image; and the distance between the lenses is, for normal sight, equal to the sum of their focal lengths. But for the purpose of overcoming the disadvantages of a single eye-lens, i.e., spherical and chromatic aberration, this is generally substituted by an eye-piece composed of lenses in combination, as already referred to. However, we may generally assume the case of a single eye-glass, by understanding such to mean the one which is equivalent in focal length to the combination.

If, in the refracting telescope, we find F and f = focal length of object and eye-glass respectively, lenses convex, and M = magnifying power of telescope, then—

$$M = \frac{M}{f}.$$

It is to be noted that M = magnification of image formed by the o.g.

The above assumes normal sight on the part of the observer, and will not be the same for all eyes. Suppose x = a new distance of eye-glass from the image, due to different sight, and d = distance of distinct vision, then we have—

$$M = \frac{F}{f} \times \frac{f + d}{d},$$

and distance between eye-glass and o.g. $= F + x$ $= F + \frac{f d}{f + d}$.

It is not difficult to see from the above that short-sighted persons have an advantage over those with long sight in the use of telescopes.

When a Ramsden e.p. is used, distance between field-lens and image = ¼ focal length of such lens; and in the case of the Huygen's e.p. the piece has to be so placed that if the field-lens had no effect the image would be at a distance *behind* it equal to half its focal length; or the image should be in that position between the two lenses forming the e.p.

In the Galilean telescope, where the eye-glass is concave, $M = \frac{F}{f}$, as before; but distance between O.G. and eye-glass $= F - f$ for normal sight.

Speaking also briefly about the reflecting telescopes, we have the Gregorian telescope, composed of the large concave speculum with an aperture in the centre, which aperture may equal in diameter that of the other or smaller concave mirror, concavities facing each other. Theoretically, the larger mirror should have a parabolic surface, and the small one an elliptical surface.

Distance between mirrors is a trifle more than the sum of their focal lengths.

If F, f_1 and f = focal lengths of large and small mirror and eye-glass respectively, and the second image supposed to be formed at the aperture of the speculum, then we may say—

$$M = \frac{F + f_1}{f_1} \times \frac{F}{f} \text{ (for normal sight).}$$

In the Cassegrain telescope the small mirror is substituted by a (theoretically) hyperbolic surface, convex to the speculum, and distance between the mirrors is somewhat greater than the difference of their focal lengths, and—

$$M = \frac{F - f_1}{f_1} \times \frac{F}{f}:$$

In the Newtonian telescope the plane mirror (or may be prism), substituted for the small curved one, has no effect on the magnifying power, and—

$$M = \frac{F}{f}.$$

If a and b represent the distance of speculum and eye-glass from centre of plane mirror, then $a + b = F + f$.

A. Gadd.

(*To be continued.*)

DIALLING.

[33052.]—I HAVE seen several letters in your valuable paper asking how to make sundials. I have not had time to answer before, and I hope you will be kind enough to insert the following in your next week's issue, with the diagram.

Dial, or sundial, is a plane upon which lines are described, so that the shadow of a wire, or of the upper edge of a plate stile, erected perpendicularly on the plane may show the true time of day. The edge of the plate by which this is found is called the stile, which must be parallel to the earth's axis, and the line on which this plate is erected is called the substile. The angle included between the substile and stile is called the elevation, or height of the stile.

Those dials whose planes are parallel to the plane of the horizon are called horizontal dials; and those dials whose planes are perpendicular to the plane of the horizon, vertical or erect dials. Erect dials, whose planes front the north or south, are called erect north or south dials; and all other erect dials are called decliners, because their planes are turned from the north or south.

Those dials whose planes are neither parallel nor perpendicular to the plane of the horizon are called inclining or reclining dials, as their planes make acute or obtuse angles with the horizon; and if their planes are also turned aside from facing the south or north, they are called declining-inclining or declining-reclining dials.

The intersection of the plane of the dial with that of the meridian passing through the stile is called the meridian of the dial, or the hour-line of XII.

Those meridians whose planes pass through the stile and make angles of 15°, 30°, 45°, 60°, 75°, and 90° with the meridian of the plane (which marks the hour-line of 12) are called hour circles, and their intersections with the plane of the dial are called the hour-lines.

In all declining dials the substile makes an angle with the hour-line of XII.; and this angle is called the distance of the substile from the meridian.

The declining-plane's difference of longitude is the angle formed at the intersection of the stile and the plane of the dial by two meridians, one of which passes through the hour-line of XII., and the other through the substile.

We shall now proceed to explain the different principles of their construction.

If the whole earth, *a* P *c p* (Plate Fig. 1), were transparent and hollow, like a glass sphere, and had its equator divided into twenty-four equal parts by so many meridian semicircles, *a*, *b*, *c*, *d*, *e*, *f*, *g*, &c., one of which is the geographical meridian of any given place, as London (which is supposed to be at the point *a*), and if the hour of XII. were marked at the equator, upon that meridian and the opposite one, and all the rest of the hours in order on the rest of the meridians, those meridians would be the hour-circles of London; then, if the sphere had an opaque axis, as P E *p*, terminating in the poles P and *p*, the shadow of the axis would fall upon every particular meridian and hour, when the sun came on the plane of the opposite meridian, and would, consequently, show the time at London and at all other places on that meridian.

Horizontal Dial.

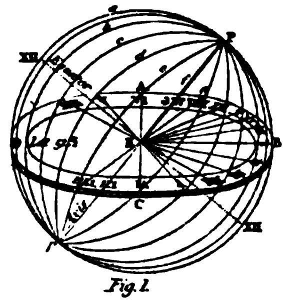


Fig. 1.

Vertical Dial.

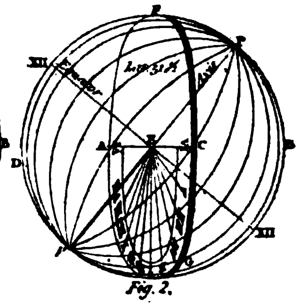


Fig. 2.

Horizontal Dial.

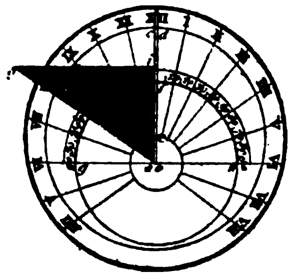


Fig. 3.

Erect South Dial.

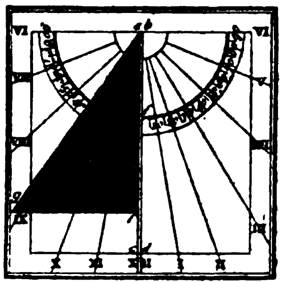


Fig. 4.

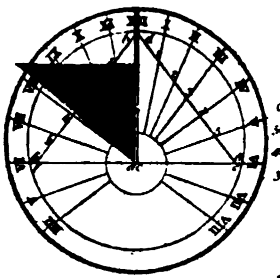
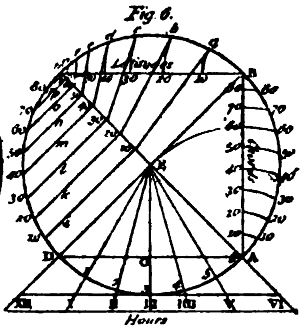


Fig. 5.

Fig. 6.



Dialling Lines.

Horizontal Dial.—If this sphere was cut through the middle by a solid plane, A B, C D, in the rational horizon of London, one-half of the axis E P would be above the plane, and the other half below it; and if the straight lines were drawn from the centre to those points where its circumferences is cut by the hour-circles of the sphere, those lines would be the hour-lines of a horizontal dial for London, for the shadow of the axis would fall upon each particular hour-line of the dial when it fell upon the like hour-circle of the sphere.

Vertical Dials.—If the plane which cuts the sphere be upright, as A F C G (Fig. 2), touching the given place at F, and directly facing the meridian of London, it will then become the plane of an erect direct south dial; and if right lines be drawn from its centre, E, to those points of its circumferences cut by the hour-circles of the sphere, these will be the hour-lines of a vertical or direct south dial for London, to which the hours are to be set as in the figure; and the lower half E *p* of the axis will cast a shadow on the hour of the day in this dial at the same time that it would fall upon the like hour-circle of the sphere if the dial-plane was not in the way.

Inclining and Reclining Dials.—If the plane be made to inclide, or recline, by a given number of degrees, the hour-circle of the sphere will still cut the edge of the plane in those points to which the hour-lines must be drawn straight from the centre; and the axis of the sphere will cast a shadow on these lines at the respective hours. And it will be the same if the plane be made to decline by any given number of degrees from the meridian towards the east or west; provided the declination be less than 90°, or the reclination be less than the co-latitude of the place; and the axis of the sphere will be a gnomon, or stile of the dial. But it cannot be a gnomon when the declination is 90°, nor when the reclination is equal to the co-latitude; because then the axis has no elevation above the plane. And thus it appears that the plane of every dial represents the plane of some great circle upon the earth, and the gnomon and the earth's axis.

Dialling by the Terrestrial Globe.—If a globe, of 12in. diameter, with 24 meridian semicircles drawn upon it, be elevated to the latitude of a place, and turned about till one of the meridians cuts the horizon in the north point, where the hour of XII. is supposed to be marked, the rest of the meridians will cut the horizon at the respective distances of all the other hours from XII. Then, if these points of distance be marked on the horizon, and the globe be taken out of it, and a flat board put into its place, even with the surface of the horizon, and if straight lines be drawn from the centre of the board to those points of distance on the horizon which were cut by the 24 meridian semicircles, these lines will be the hour-lines of a horizontal dial for that latitude, the edge of whose gnomon must be in the same situation that the axis of the globe was before it was taken out of the horizon—that is, the gnomon must make an angle with the plane of the dial equal to the latitude of the place for which the dial is made.

If the pole of the globe be elevated to the co-latitude of the place, and any meridian be brought to the north point of the horizon, the rest of the meridians will cut the horizon in the respective distances of all the hours from XII. for a direct south dial, whose gnomon must make an angle with the plane of the dial equal to the co-latitude of the place; and the hours must be set the contrary way on this dial to what they are on the horizontal. But if your globe have more than 24 meridian semicircles upon it, you must take the following method.

To construct a horizontal dial, elevate the pole to the latitude, and turn the globe till any particular meridian (suppose the first) comes to the north point of the horizon, and the opposite meridian will cut the horizon in the south. Then set the hour-index to the uppermost XII. on its circle, turn the globe westward till 15° of the equator pass under the brazen meridian, and then the hour angle will be at I., and the first meridian will cut the horizon in the number of degrees from the north point, that I. is distant from XII. Turn on till 15° more of the equator pass under the meridian, and the hour-index will be at II., and the first meridian will cut the horizon in the number of degrees that II. is distant from XII.; and so by making 15° of the equator pass under the brazen meridian for every hour, the first meridian of the globe will cut the horizon in the distance of all the hours from XII. to VI., or 90°; and then you need go on further, for the distances of XI., X., IX., VIII. VII., and VI. in the forenoon are the same from XII. as the distances from I., II., III., IV., V., and VI. in the afternoon.

Thus to make a horizontal dial for this latitude of London, which is about 51° 30′ north, elevate the north pole of the globe 51½° above the north point of the horizon, and then turn the globe until the first meridian (which is that of London on the English terrestrial globe) cuts the north point of the horizon, and set the hour-index to XII. at noon.

Then, turning the globe westward till the index points successively to I., II., III., IV., V., and VI. in the afternoon, or until 15°, 30°, 45°, 60°, 75°, and 90° of the equator pass under the brazen meridian, you will find that the first meridian of the globe cuts the horizon in the following number of degrees from the north towards the east—viz., 11⅗, 24¼, 38$\frac{1}{20}$, 53⅗, 71$\frac{1}{10}$, and 90, the distances of the above hours from XII. on the plane of the horizon.

To transfer these, and the rest of the hours, to a horizontal plane, draw the parallel right lines *a c* and *b d* (Fig. 3) upon the plane, as far from each other as is equal to the thickness of the gnomon, and the space included between them will be the meridian or twelve o'clock line on the dial-cross, this meridian at right angles with the six o'clock line, *g h*, and setting one foot of your compasses in the intersection *a*, as a centre, describe the quadrant *g e* with any convenient radius or opening of the compasses; then, setting one foot on the intersection *b* as a centre with the same radius, describe the quadrant *f h*, and divide each quadrant into ninety equal parts or degrees. Because the hour-lines are less distant from each other about noon than in any other part of the dial, it is best to have the centres of these quadrants at a little distance from the centre of the dial-plane, on the side opposite to XII., in order to enlarge the hour-distances there about under the same angles on the plane. Thus the centre of the plane is at *c*, but the centres of the quadrant at *a* and *b*. Lay a ruler over the point *b*, and keeping it there for the centre of all the afternoon hours in the quadrant *f h*, draw the hour-lines of I. through 11⅗° in the quadrant; the hour-lines of II. through 24¼°, &c., and because the sun rises about four in the morning on the longest days at London, continue the hour-lines of IV. and V. in the afternoon through the centre *b* to the opposite side of the dial. This done, lay the ruler to the centre *a* of the quadrant *eg*, and through the like divisions or degrees of that quadrant draw the forenoon hour-lines of XI., X., IX., VIII., and VII.; and because the sun sets not before eight in the evening on the longest days, continue the hour-lines of VII. and VIII. in the forenoon through the centre *a* to VII. and VIII. in the afternoon, and all the hour-lines will be finished on this dial.

Lastly, through 51½° of either quadrant, and from its centre, draw the right lines *a g* for the axis of the gnomon *a g i*; and from *g* let fall the perpendicular *g i* upon the meridian line *a i*, and there will be a triangle, whose sides are *a g*, *g i*, and *i a*. If a plate similar to this be made as thick as the distance between the lines *a c* and *b d*, and set upright between them, touching at *a b*, its hypothenuse *a g* will be parallel to the axis of the world, when the dial is truly set, and will cast a shadow on the hour of the day.

The trouble of dividing the two quadrants may be saved by means of a scale with a line of chords upon it. For it we extend the compasses from 0° to 60° of the line of chords, and with that extent as a radius describe the two quadrants upon their respective centres, the above distances may be taken with the compasses upon the line and set off upon the quadrants.

To make an Erect Direct South Dial.—Elevate the pole to the co-latitude, and proceed as above from VI. in the morning to VI. in the afternoon, only the hours must be reversed, as in Fig. 4, and the hypothenuse *a g* of the gnomon *a g f* must make an angle with the dial-plane equal to the co-latitude of the place. As the sun can shine no longer on this dial than from six in the morning till six in the evening, there is no occasion for having any more than 12 hours upon it.

To make an Erect Dial Declining from the South towards the East or West.—Elevate the pole to the latitude, and screw the quadrant of altitude to the zenith. Then, if the dial declines to the east (which we will suppose it to do), count in the horizon the degrees of declination from the east point towards the north, and bring the lower part of the quadrant to that degree of declination at which the reckoning ends. Then bring any meridian of your globe under the graduated edge of the upper part of the brazen meridian, and set the hour-index to XII. at noon, keeping the quadrant of altitude at the degree of declination in the horizon; turn the globe eastwards, and observe the degrees cut by the first meridian in the quadrant of altitude (counted from the zenith) as the hour-index comes to XI., X., IX., &c., in the forenoon, or as 15°, 30°, 45°, &c., [illegible] the equator pass under the brazen meridian at [illegible] hours; and the degrees then cut in the [illegible]nt by the first meridian are the distances [illegible]renoon hours from XII. on the plane of [illegible]. For the afternoon hours turn the [illegible] altitude round the zenith till it comes [illegible] in the horizon opposite to that where [illegible] before, and turn the globe westward [illegible] meridian comes to the brazen [illegible] the hour index to XII. Then [illegible] globe westward, and as the index points to the afternoon hours I., II., III., &c., or as 15°, 30°, 45°, &c., of the equator pass under the brazen meridian, the first meridian will cut the quadrant of altitude in the number of degrees from the zenith that each of these hours is from XII. on the dial. And note that when the first meridian goes off the quadrant at the horizon in the forenoon, the hour-index shows the time when the sun will come upon this dial; and when it goes off the quadrant in the afternoon, the index will point to the time when the sun goes off the dial.

Having thus found all the hour-distances from XII., lay them down on your dial-plate, either by dividing a semicircle into two quadrants of 90° each, beginning at the hour-line of XII., or by the line of chords. In all declining dials, the line on which the stile or gnomon stands, commonly called the substile line, makes an angle with the twelve o'clock line, and falls among the forenoon hour-lines, if the dial declines to the east, and among the afternoon hour-line when it declines to the west—that is, to the left-hand from the twelve o'clock line in the former case, and to the right-hand from it in the latter.

To find the distance of the substile from the twelve o'clock line, if your dial declines from the south to the east, count the degrees of that declination in the horizon from the east towards the north, and bring the lower end of the quadrant of altitude to that degree of declination where the reckoning ends. Then turn the globe till the first meridian cuts the horizon in the like number of degrees, counted from the south point to the east, and the quadrant and first meridian will cross one another at right-angles, and the number of the degrees of the quadrant intercepted between the first meridian and the zenith is equal to the distance of the substile line from the twelve o'clock line, and the number of degrees of the first meridian intercepted between the quadrant and the north pole is equal to the elevation of the stile above the plane of the dial.

If the dial declines westward from the south, count that declination from the east point of the horizon to the south, and bring the quadrant of altitude to the degree in the horizon at which the reckoning ends, both for finding the forenoon hours and the distance of the substile from the meridian; and for the afternoon hours bring the quadrant to the opposite degree in the horizon, namely, as far from the west to the north, and then proceed in all respects as above.

Thus we have finished our declining dial, and in so doing we made four dials, viz.: 1, A north dial, declining eastwards by the same number of degrees; 2, a north dial declining the same number west; 3, a south dial declining east; and, 4, a south dial declining west; only placing the proper number of hours and the stile or gnomon respectively upon each plane. For in the south-west plane the substilar line falls among the afternoon hours, and in the south-east, at the same declination among the forenoon hours, at equal distances from XII. And so all the morning hours on the west decliner will be like the afternoon hours on the east decliner; the south-east decliner will produce the north-west decliner, and south-west decliner the north-east decliner, by only extending the hour-lines, stile, and substile quite through the centre, the axis of the stile, or edge that casts the shadow on the hour of the day, being in all dials whatever parallel to the axis of the world, and consequently pointing towards the North Pole of the heavens in north latitudes, and towards the South Pole in south latitudes.

An easy method of constructing dials. But because every one may not be provided with a globe, and may probably not understand the method of doing it by logarithmic calculation, we shall show how to perform it by the plain dialling-lines, or scales of latitudes and hours, which are sold by all mathematical instrument makers.

This is the easiest and best of all mechanical methods when the lines are truly divided, as not only the half-hours and quarters may be laid down, but every fifth minute and every single minute by those where the line of hours is a foot long.

Having drawn a double meridian line, *a*, *b*, *c*, *d* (Fig. 5), on the plane intended for a horizontal dial, and crossed it at right angles by the six o'clock line *f e*, take the latitude of your place with the compasses in the scale of latitudes and set that extent from *c* to *e* and from *a* to *f* on the six o'clock line. Then, taking the six hours between the points of the compasses in the scale of hours, with that extent set 1ft. in the point *e*, and let the other foot fall where it will upon the meridian line *c d*, as at *d*. Do the same from *f* to *b*, and draw the right lines *e d* and *f b*, each of which will be equal in length to the whole scale of hours. This done, setting one foot of the compasses in the beginning of the scale of XII., and extending the other to each hour on the scale, lay off these extents from *b* to *f* for those of the forenoon. This will divide the lines *d e* and *b f* in the same manner as the hour-scale is divided at 1, 2, 3, 4, 5, and 6, on which the quarters may also be laid down if required. Then, laying a ruler on the point *c*, draw the first five hours in the afternoon from that point through the dots at the numeral figures 1, 2, 3, 4, 5 on the line *d e*, and continue the lines of IV. and V. through the centre *c* to the other side of the dial for the like hours of the morning; which done, lay the ruler on the point *a* and draw the last five hours in the forenoon through the dots 5, 4, 3, 2, 1 on the line *f b*, continuing the hour-lines of VII. and VIII. through the centre *a* to the other side of the dial for the like hours of the evening, and set the hours their respective lines as in the figure. Lastly, make the gnomon the same way as taught above for the horizontal dial and the whole will be finished.

To make an erect south dial: Take the co-latitude of the place from the scale of latitudes, and then proceed in all respects for the hour-lines as in the horizontal dial, only reversing the hours, and making the angle of the stile's height equal to the co-latitude. See Leadbetter's "Mechanical Dialling," 8vo., and Leybourn's "Dialling," improved by Wilson, 1 vol. 12mo. **Jas. A. Robinson.**

OVERTAXED BRAIN.

[33053.]—How is it that your frequent correspondent, "The Lydney Dispenser," can never answer a simple medical question without making the question into a text upon which he can deliver an exhortation on the superlative merits and excellences of homœopathy? Surely, homœopathy has existed long enough to stand or fall by its own accomplished results, and should not need bolstering up by this "damnable iteration," which may attract and mislead the uninitiated, but is regarded by the *cognoscenti* as exemplifying the narrowness, the bigotry, and the wholesale appropriativeness of the egotist and the eclectic. "The Lydney Dispenser" has not moved with the times. He represents the medical attitude of fifty years ago, or he would have discovered that eclecticism in science is completely discredited, and has long been regarded as the bane of all true progress, and as only existing now in connection with quackery, self-seeking, and money-grubbing; or as the last refuge of minds the receptivity of which is so limited that something finite must be accepted, even if it be false or undemonstrable.

C. H. Fridy has my warmest sympathy. Eight years ago I was driven from a very large and profitable medical practice by the advent of the condition he ascribes to his symptoms, and since then this subject has had to me a lasting interest. It would have been better if "C. H. F." had been fuller in his statement of symptoms, as exhaustion of the brain is predisposed to by other antecedent morbid conditions in physiological habits or modes of life, and inherited diathetic peculiarities. For instance, gouty and rheumatic people are far more prone to it than those who are not similarly constitutionally handicapped; also people of nervous temperament, and those who have a liability to insomnia, though, again, these last are often connected with gouty and rheumatic tendencies. Physical strength has no influence in regard to liability to cerebral exhaustion; nay, many weak, delicate, and tuberculous-tending people have almost unlimited capacity for brain work, whereas many full-blooded, strong people are soon affected by symptoms of overtaxed brain.

These people often stand an indoor sedentary life badly. They eat much of strong, rich food; make blood—rich, but not pure—*fast*; accumulate fat, and become nervous, irritable, anxious, and sleepless, often with slight rheumatic manifestations as well. If the work is headwork and at all severe, and if, above all, it is work entailing heavy responsibility, and such as one can make himself anxious about, then insomnia and cerebral exhaustion are liable to present themselves. I have gone into the question of predisposition somewhat fully, as it has an important bearing upon treatment. The symptoms deserve very full description, as they are often misunderstood; but into these I will not go fully, as "C. H. F." has given us a diagnosis of his case, and only invites suggestions as to treatment.

Medicines are usually quite useless unless there are the unmistakable signs of a concurrent morbid state. This must be treated according to its nature, which can only be discovered by careful medical examination, which should include an analysis of the urine, an examination of the heart, the state of the blood, bowels, &c. Nothing in the general health having been found to be seriously defective, and to have preceded the exhaustion, the exhaustion may be regarded as uncomplicated, and alone requiring treatment. Medicines are quite useless usually. Alcohol is useless and dangerous. Narcotics often give temporary relief, but effect no cure, nor palliate long, and a habit may be formed which may prove utterly destructive. Phosphorus, much vaunted, is valueless; the same applies to arsenic and lime, and, I am convinced, to the whole list of drugs mentioned by the "L. D." If there is gout, rheumatism, anæmia, dyspepsia, or constipation present, treat it or them; but the real cure consists in the reversal of the mode of life which has led up to the condition. Limit the hours of work, or, better still, give up the headwork altogether, increase the outdoor exercise as much as possible.

The exercise must consist partly of sweating, but not winding, exercise. Nothing equals a bicycle or tricycle. This will produce copious action of the skin, without any distress of circulation or respiration.

Spend as much time as possible in the open air and sun. Rowing is good, and shooting, riding, and fly-fishing; but a good daily two hours' spin on a tricycle will do wonders. A warm bath once a week with plenty of soap and scrubbing of skin at bed time. Go to bed early, eight or nine o'clock. Insomnia is at the bottom of cerebral exhaustion always, and the exhaustion will not disappear until the insomnia has been overcome. The treatment of pure exhaustion of brain is always a question of the treatment of insomnia. Avoid hard headwork and excitement in the evening; also heavy suppers.

If patient is a good eater, full blooded, and of gouty, rheumatic, or bronchitic tendency, a bleeding from the arm to the extent of a pint often diminishes irritability, removes insomnia, and promotes a return to the normal. If necessary, it may be repeated in a month or so. This is a very unfashionable remedy at present; but is very probably destined to be used more frequently than it has been of late, though not in the wholesale and eclectic fashion once prevailing.

"C. H. F." must see that his apartments, particularly his sleeping place, are well ventilated, and should ascertain that his health is not being impaired and undermined by escape of sewer gas or other insanitary condition. Acidity or flatulence, or constipation, must be treated, as also any other so-called functional disturbance, or departure from the physiological normal. I could write a good deal more upon this cerebral exhaustion with irritability; but it might be unsuited to your paper, and beyond the requirements of your correspondent. I have given a few hints, the value of which I have proved, and I shall be glad if "C. H. F." derives any benefit from them. Without further particulars, I consider it undesirable and unjustifiable to venture upon more precise and dogmatic directions.

Lancastrian.

SILVERING MIRRORS.

[33054.]—I have read Mr. Calver's letter (33020) hereon with much interest, having for some years used "Martin's"—a somewhat similar process—and this year having silvered my 15in. mirror by it with perfect success. My experience, which may be useful to other amateurs, proves to me that the greatest care must be taken in cleaning the mirror, and, notwithstanding some of the book directions, using nothing else than nitric acid to remove the old silvering, and water with pure clean cotton-wool to wash the surface clean, distilled water to finish with, and it is not clean until the thin film of water clings evenly to the whole surface for some minutes; if it dries off quickly at the edges or in spots, it is not absolutely clean, and must be washed again and again.

With regard to the solutions, I am certain that many failures occur through using sugar-candy or impure sugar, as the least trace of treacle or colour will insure a failure. There are some novelties to me in Mr. Calver's process. I think his manner of mixing the solutions excellent for avoiding any excess of ammonia. I see Mr. Calver uses nitric acid in the reducing solution, while in Martin's tartaric acid is used. Mr. Calver says "do not disturb until the silver is covering the top of the fluid." Does this mean that the bath is not to be gently rocked and agitated as usual, or only not to be *removed* from the bath till then? Another novelty is the drying the silvered surface with blotting-paper; this seems a risk, and must require very great care. It is, however, no doubt very important to dry the silver surface quickly, to prevent its tarnishing; and it is well to polish as soon as possible, to remove every trace of the solutions other than the silver, and the polishing pad should be (as suggested by a former correspondent in the "E. M.") as large as the mirror, to insure keeping its perfect figure.

Southampton. T. A. Skelton.

PROJECTILES AND THE ROTATION OF THE EARTH.

[33055.]—In assuming the length of the range constant, I also assumed the time of flight constant. The case of the same range being obtained with different elevations and corresponding charges did not suggest itself to me. In all cases, however, the deflection due to the earth's rotation is equal to time of flight multiplied by *difference* in tangential velocity of the two ends of the range. How Mr. Wake can make out that a projectile fired vertically, on a still day, would fall *west* of the gun or mortar may puzzle many readers of the "E. M." The truth is that, on leaving the muzzle, the shot has two velocities—one vertical, due to the charge; the other horizontal, due to the rotation of the earth. Its whole initial velocity in magnitude and direction is, therefore, the resultant of these velocities; and in order that this resultant may be vertical we must point the axis of the mortar a little west of vertical, in a plane perpendicular to the earth's axis. If the mortar be vertical, the initial direction of the shot is never at right angles to the horizontal line.

Charing. J. R. C.

ORGAN TEMPERAMENT.

[33056.]—Some time since I had the pleasure of suggesting through your columns a system of organ temperament as a practical compromise in that vexed musical question, and this I have put to actual test with encouraging results.

The method consists in having two rows of pipes, C D E, c d e, *each* tuned in *equal* temperament, but each note (such as e) in the latter so much flatter than the corresponding note E in the former as will make it a *true* third to the C (and not *sharp*, as in equal temperament). Thus—

$\overset{*}{C}$ D E F G A B C^1 in equal temp.
c d $\underset{*}{e}$ f g a b c^1 in equal temp.

giving— C to e a *true* third
F to a " "
G to b " "

and so on.

If C be then taken as a keynote, the following will be found to be an almost perfect scale:—

C D e F G a b C^1

And it will be found best to make all the accidental (black) notes, except B flat, act on the flatter set of pipes, giving as the chromatic scale—

C D F G B flat C^1
c sharp d sharp e f sharp g sharp a b

the flatter pipes giving the scale of e.

Thus it will be seen that if, taking *any* given note as a keynote, we cause, by suitable mechanism, the six notes forming the major scale on its mediant, or third, to act on the flatter set of pipes, and the remainder to act on the sharper set, we shall obtain a practically true scale. The tonic, dominant, and subdominant chords are very nearly perfect, and the chief relative chords are in very good tune. Messrs. Moore and Moore have tuned a harmonium for me on this principle, and the smoothness of the main chords is very noticeable. We may at any moment, by a touch on a lever, throw *all* the notes on to one set of pipes, and so play in equal temperament during a temporary change to an unrelated key; or, if the change is for long, we may, by altering the combinations of the two sets of pipes, cause the new key to be in accurate tune. A row of twelve stops just above the keyboard would probably be the most convenient way of making the proper combinations for the twelve different notes of the octave. These, and the lever for the reduction to equal temperament, would form the only visible addition to the instrument, the keyboard remaining precisely as it is now. I may add that this application of the ordinary keyboard to a more harmonious scale than that of the equal temperament is free to anyone who cares to make a trial of it. Criticism is cordially invited.

Harmonicus.

VIOLIN MATTERS.

[33057.]—"Orderic Vital" (letter 32999) asks if Mr. Pickering or the omniscient "Scio" will tell him how to clamp and vibrate the plates so as to determine their fundamental note. I had purposely left this unanswered, in order to give Mr. Pickering an opportunity of supplying the information.

Clamp at the nodes, or points where the vibrations meet or cross. The best nodes to clamp will be found at points about 2in. from either end of the plates, and on a line coinciding with the central join of the belly. Clamp the plates between two nicely-fitted pieces of cork, and use the bow as if playing harmonic notes on the string of the violin, and the harmonic desired will be produced. An octave higher may be obtained by clamping the tables in the centre where the nodal lines cross.

"Orderic Vital's" other query about curvature, thickness, &c., cannot be answered satisfacterily in a few words. I shall supply details concerning this in my articles later.

I may mention here that I would have sent in the articles before, but thought it better to allow Mr. Pickering to have his say out first.

Glasgow. Scio.

[33058.]—Mr. Wenham thinks that the *f* holes of a violin are of little importance. If this is so, why are they made at all? It is quite true that they are made in a conventional form; but they are really the mouths of an air resonator, of which the surface that inclosed the air varies from about 1½in. to 8in. distance from the mouth, and these distances correspond to the lengths of closed tube resonators which give the musical tones that are played on the violin. The action of the back and front is separate from the action of the air inclosed in the instrument; but I have no doubt that the back of a violin vibrates in unison with the lower tones and the front with the higher ones, in order to give the best effect.

The nature of wood is so uncertain that it is only by trial when strung that a good violin can be known, as a very small difference will give an alteration in the quality of tone for a wooden resonator.

J. Sutcliffe.

"THE HOUSEKEEPER'S TREASURE."

[33059.]—Just now, when the fogs are killing us off, I venture to draw readers' attention to a domestic contrivance which would benefit thousands and save millions. This new invention consists of an apparatus provided with folding doors, at the top of which is a perforated iron plate used as a radiator. At the bottom is placed an ashpan, in which is received the contents of the grate. The grate is double, and swings to facilitate the emptying at once of the ashes and cinders, during which operation the folding doors are kept shut to avoid the flying about of the dust. The under grate, provided with spikes that slide backwards and forwards, is to facilitate the clearing of the upper one when choked by the ashes. The front of the upper grate is provided with perpendicular bars instead of horizontal ones. For a full and accurate description, see the complete specification, No. 7234 (1891). The advantages of the invention are the following:—No poker required; no raking necessary; no dust raised in the room; no blower wanted; no screen required; no coal vase required; no danger from falling soot; immense saving of labour; great economy in the use of coal; high winds rendered perfectly harmless; in the brickwork of each side of the stove there is left a cavity for warming plates, dishes, &c.

G. Rieunier, Inventor.

Gobowen, Shropshire.

THE TRANSMISSION OF POWER BY ELECTRICITY.

[33060.]—We have heard so many times during the last ten or fifteen years about the transmission of power by electricity, that it would be interesting to hear from some of our electricians as to its feasibility; for instance, what would be the cost of transmitting the power from the dynamo station to a distant part of the works—say a mile—for the purpose of driving a small lathe? I understand that at last some really practical steps are being taken to utilise the power at Niagara, now that the Germans have shown at their recent exhibition how it may be done. The distance between the Falls and Chicago is about 175 miles, or more than four times the distance between Lauffen and Frankfort. In order to avoid excessive loss of power in the conductor, an American paper says that Mr. Leonard proposes the use of a potential of 80,000 volts at the generating end of the line. Assuming that difference of potential to be the working pressure adopted, and allowing 40 per cent. loss of power in the conductor, the cost of the generating and transformer plant at the Falls would be 55dol. per horse-power delivered in Chicago, the cost of the conductor would be 110dol. per horse-power delivered in Chicago, and the cost of the motors and converters at the receiving end would be 33dol. per horse-power delivered in Chicago. Thus we have for the total cost of the plant 198dol. for each unit of power delivered in Chicago.

There is little doubt that it would be practicable to work with a pressure of 80,000 volts. The experiments in Germany with pressure as high as 30,000 volts have been so successful that there is no question that the higher voltage could be easily managed when the necessity for using it arises. Even assuming that a pressure of 30,000 volts could be used, the transmission of power over the greater distance would still be quite possible; but to maintain the loss at 40 per cent. a considerable increase in the size of the conductors would be necessary, making the cost for conductors 782dol. per horse-power instead of only 110dol. with 80,000 volts. That seems to give some idea; but how does it work out on a small scale?

Smallman.

The length of the structure over the Mississippi at Memphis is to be 8,000ft.; bridge, 2,600ft; iron viaduct, 2,300ft.; timber trestle, 3,100ft. Its eight piers are to be 117ft. to 197ft. in height. The deepest foundation is 131ft. below low-water mark. The central span is to be 621ft. in length, with cantilever arms 169ft. in length.

Cellulose—made of the ground fibre of cocoanut—is said to be coming into favour as buoyant inside armour for war ships. When penetrated by a shot, the hole soon closes, so as to practically exclude the water. The United States cruiser, No. 9, will have this improvement.

Some samples of fibres from plants indigenous to some parts of the Windward Islands have recently been submitted to experts in this country. They report that some of the fibres are superior in some ways to Mauritius hemp, and are worth in London about £25 a ton, or nearly the price of isal hemp.

REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75475.]—**Diffraction Spectroscope.**—This is an arrangement in which sunlight is passed through a narrow slit, behind which is a telescope adjusted to distinct vision of the slit. A very fine grating is then placed over the object-glass, the bars being parallel with the slit, which changes the appearance of the slit altogether. In the centre a luminous line is seen, while on each side there is a broad black band, and beyond these a series of spectra. Those nearest the centre are the most perfect, and show the Fraunhofer lines to greatest perfection. The advantage of this form of spectroscope is that it, unlike the prism spectroscope, gives a normal spectrum in which the Fraunhofer lines have their true relative distances from each other, all the refrangibilities being subjected to equal dispersion, such not being the case in the refractive spectroscope, since the violet rays strike the second surface of the prism at a different angle to that of the red. I should imagine a great advantage of this form of spectroscope is that it is pointed straight at the object, and not at various angles away from it. A. E. B.

[75494.]—**Glass-Blowing with Oil Lamp.**—I have already answered this, and my answer was published. A. E. B.

[75871.]—**Division-Plate.**—I am much obliged to "T. L." for noticing my query; but would not that of buying a new plate from the makers be rather an expensive method of finding out the best numbers to divide my circles into. I have no difficulty in drilling or dividing my plate with a fair degree of accuracy, and have already drilled circles of 360, 300, 240, 192, 112, 108, 92, 88, 78, 42. I rather expect that those people who advise drilling a plate by a strip of metal divided by a double pointed punch have never tried it, for it won't work.

Watlington, Oxon. Dell.

[75890.]—**Siphon, Defective.**—Many thanks to "N. B." for his suggestion; but would he kindly tell me how to alter the proportions of the tubes to get the desired result? The two U tubes at present are four inches from top to bottom of bend, and the long tube ך is 8in., all having a uniform bore of $\frac{1}{16}$in. Shall be grateful for any help.

Subscriber since 1866.

[75903.]—**Incandescent Gas-Lights.**—I did not notice the original inquiry; but by this week's issue I see that someone is asking for personal experience. Some time ago I tried one of these burners in a sitting-room. The illumination was all that could be desired, and it was evident that one such light would equal three, or perhaps four, ordinary gas-lights; but, alas! the smell was so very bad that after a number of efforts to rectify whatever was wrong, and after changing the burner several times, I had reluctantly to return to the ordinary burner. So far as I could judge, the difficulty lay in regulating the supply of air and gas in the Bunsen burner so as to insure perfect combustion. I wish some of your readers would kindly say if the product of a Bunsen burner is more injurious than that of an ordinary burner?

S. G. R.

[75903.]—**Incandescent Gaslights.**—I am greatly obliged to "M..H.," p. 423, and to you, Mr. Editor, for inserting my question and "M. H.'s" reply. I have come to the conclusion that incandescent gaslight will fill a void in many a country house where gas cannot be obtained, for I know enough of air or petroleum gas-making to know that it answers well for heating purposes, and it is heat, and not light (it seems paradoxical to say so), which alone is required to work lamps made after the plan of the Welsbach mantle. I see that in the extract given by Mr. Moeller, he speaks of "our light" as if he were connected with the Incandescent Gaslight Company. Now what I want is independent testimony. I am going to test the matter myself, but I want to know the experience of others before I invest in a gas-making machine. I want to know particularly as to (1) durability; (2) whether you can trust the lamps to anyone, or must always, for fear of breakages, light them and clean the glasses yourself. At present I am not disposed to make water-gas.

Z. Y. X.

[75922.]—**Electro-motor.**—This query is rather mixed, and it is impossible to conceive what it is the querist is aiming at. I think he will find all he requires in back volumes, or even in recent numbers. He speaks of the motor for Edison's phonograph, and refers to some sketch; but any motor, provided it will run steadily, will do for the phonograph. O. M.

[75929.]—**Dynamo.**—It seems to me that "Sub from No. 1" should refer to his back numbers. The information he requires has been given many times since No. 1. Video.

[75936.]—**Paraffin Spray for Boiler.**—I remember seeing some years ago at Messrs. Churchill's, Cross-street, Finsbury, a steam-engine and boiler worked by paraffin oil. I think it was called the "Shipman," and was illustrated in a back volume. Steam has to be got up first of all by means of either gas-jets or paraffin burners; but as soon as there is sufficient to force a spray into the furnace-tube, the burning vapour goes roaring all round the boiler, and the steam is kept up readily. I suppose the engine is still in existence. Perhaps some other readers may remember the description. I am almost certain the engine was illustrated in a back volume.

Nun. Dor.

[75937.]—**Telephone.**—These appear to be Gower-Bell transmitters, with Bell receivers; but the querist's description is not sufficient to enable anyone to answer his question. He should read up Mr. Allsop's articles and look at the illustrations, and if he fails to understand them, get some expert to show him. What have "pressels" to do with it, except, perhaps, in connection with a call-bell? If the querist reads up, he will be able to put a more intelligible query. Carbzin.

[75938.]—**Gilding China.**—This operation is performed by firing real gold on the ware, not by means of gold bronze, which is simply minus gold altogether. The querist should use gold leaf, and lay it on as usual with gold size; but if he has put on what is termed "enamel," he may as well paint on the gold bronze, as real gold leaf is rather expensive. The querist should look up his back numbers for information. Video.

[75940.]—**Medical Coil.**—This querist will find what he requires in many back numbers if he will consult the indices. There are also some useful manuals on the subject. M. M.

[75953.]—**Turning Commutator.**—Why does "Apprentice" want to "turn" the commutator? Does he really want to take a cut off, or merely true it up? If the latter, surely running it round under a good file would do. Nor.

[75955.]—"**Greater Britain.**"—"Nun. Dor." saw a Midland express with only a light train, yet drawn by two locos, a single and a four-coupled. I should say the extra loco. was not put on expressly for assisting the other one to draw the train. Supposing this express to be travelling between London and Nottingham, the "single" would be the train engine, and the "coupled" attached in front would be an engine returning home to Nottingham—one, perhaps, that had been running a special of some kind, meat, fish, &c., up to London. This is done to save working an extra train through from London to Nottingham. The engine returning coupled to the express goes through in one "block," as one train. If not coupled to the express, it means just one more train throughout; coupled, it assists, and does not cause an extra train. When shunting and branch engines leave shed at 6 a.m., four or five go coupled together as one train. This saves considerable delay to other trains. The Midland singles burn about 1lb. of coal per mile less than the outside cylinder singles on the G.N., and 2lb. less per mile than some of the modern engines on the L.N.W. One of the mail trains (these are usually very heavy trains, with P.O. tenders) on the Midland is booked to run three miles in 2½ minutes, and there are several instances where two miles in two minutes are run; but the 60 miles per hour running cannot be kept up for great distances, owing to the constant rise and fall of gradient; but a good average run is obtained. I saw the Edinburgh or the Glasgow portion of the Midland Scotchman leave Trent the other morning, with five vans, five carriages (bogies and six-wheel), and one Pullman—vans each end of train, then carriages next—each end—then Pullman in centre. This did not appear a very long train, and the loco. had no difficulty in quickly leaving Trent. Only one loco. Ex-Midland.

[75956.]—**Electro-Magnet.**—See many hints in back numbers. For ½in. cores use No. 22 wire; wind until the thickness through all is 1½in., then try how much it will attract with varying battery powers. X.

[76028.]—**Ellipse.**—Mr. J. H. Truscott has done good service in giving the only true method of calculating the length of the periphery of the ellipse after all the attempts that have appeared in these columns; but he might have given the series in the usual form, instead of in decimal fractions. This series is so curious that I will write down a few terms. For the whole of the ellipse it will be—

$$2a\pi\left\{1 - \frac{1}{2^2}e^2 - \left(\frac{1}{2.4}\right)^2 3e^4 - \left(\frac{1.3}{2.4.6}\right)^2 5e^6 - \left(\frac{1\,.\,3\,.\,5}{2\,.\,4\,.\,6\,.\,8}\right)^2 7e^8 - \&c.\right\}$$

the general term being—

$$-\left\{\frac{1\,.\,3\,.\,5 \ldots\ldots\ldots 2n-3}{2\,.\,4\,.\,6 \ldots\ldots\ldots\ldots 2n}\right\}^2 .\,(2n-1)\,e^{2n}$$

The first term is the one with e^2, the others being given by substituting 2, 3, 4, &c., successively. Of course the dots between the figures are signs of multiplication. a is the semi-axis major = 6 in the example given, and e = ·909059. As the eccentricity is so great in this case, a good many terms would have to be used to obtain a correct result. The work of calculation, however, where n is large, that is, when the number of terms is great, may be shortened if we refer to Boole's "Finite Differences," Chapter V., Article 4, from which we may deduce from Wallis's theorem that the general term given above is (when n is large) equal to $\frac{e^{2n}}{\pi\,.\,n(2n-1)}$. I find that if n = 10, this will give a correct result to 4 places, and of course a more correct result if n is greater than 10. In practice, however, tables for the length of the ellipse are used; for instance Molesworth's "Engineering Pocket-Book"—they are probably taken from Legendre's "Treatise on Elliptic Functions."

Bath. M.I.C.E.

[75970.]—**Repairing Engine.**—This puzzle needs more explanation. If the querist has the old engine, cannot he get an idea of the sizes required from the parts as they exist? I do not see how anyone can tell him "how this scale is worked" without knowing what is meant by "this scale." L. T.

[76141.]—**Deafness.**—In chronic cases electricity, in the French hospitals, has performed wonderful and lasting cures; and Dr. Garratt, of Philadelphia, in his well-known book, describes the instruments, and mode of application. I need hardly add that none but a trained electro-therapeutic practitioner should attempt the application, ear and brain being two near neighbours.

Eos.

[76141.]—**Deafness.**—As unthinking readers, more or less deaf, may, through their utter anatomical (as to the ear) ignorance, be led to act upon "A. E. B.'s" reply *in re* the use of the ear-syringe, &c., it is as well to say that that procedure would probably rupture their sound tympanums, whereby permanent deafness to their ears (one or both) may result. As to "discharges," this has generally in such cases become more or less constitutional, the remedy for which promptly follows (as a rule) a judicious selection of the medicines of homœopathy, such as sulphur, calcarea, mercury, pulsatilla, auric salts, some of the chromic salts, potassic salts, some of the iodides, &c.

The Lydney Dispenser.

[76141.]—**Deafness.**—The writer was for about twelve years entirely deaf in his right ear, and doctors could not help him; they said if the wax was removed it would soon close again, as year by year creeps on, and the circulation of the blood gets less and less, and the organs die off by degrees. At any rate it is a sad case when one cannot understand when spoken to. Still, hope is a great comfort, and the mind will try to find the cause of the evil, but this would be too long to explain here. In former years, having cured rheumatism by very strong friction of the skin to open the pores and produce circulation of the blood, and so absorb the acid in those parts, which was quite successful, therefore, why should I not try and do the same for my ear? I did so, and was successful again, being able to hear with both ears as well as I did twenty years ago. I shall be most happy to explain the process to anyone, for humanity's sake, by appointment at this address. A. C. Engert.

Three Mills-lane, Bromley-by-bow, E.

[76141.]—**Deafness.**—I have been, and I am now, suffering from deafness, and, like "A. E. B.," went to the University College Hospital last August. The specialist there ordered me to clean my ears out (which are discharging) with cotton-wool wound tight on a knitting-needle, leaving a small tuft loose beyond the point or end of needle; also syringing my ears with a saturated solution of boracic acid, so that the liquid comes out through the nostrils. The saturated solution is made by placing an ounce of boracic acid in a pint bottle, and filling it with water; it will not dissolve all the powder, but replace the water used until powder is completely dissolved, when you will have to put more boracic acid in. To the solution you pour out of the bottle to be used add a little hot water, to make it comfortably warm; don't use it too hot. I do not believe there is any harm at all in it. When syringing your ears, you had better sit down to do it, as you will almost certainly feel giddy. Syringe them gently, and not in a violent manner. Procure an injection bottle, with a stout point or end, to fill the outer canal of your ear. After syringing, use cotton-wool plugs in your ears, to protect them from cold. Alltfab.

[76141.]—**Deafness.**—The pilo-carpine treatment would suit a case of catarrhal deafness; but it is nothing you can do for yourself. Syringing, as recommended on p. 425, will do you no good; nor do I think you have had any discharge from the ear. You might buy a catheter with double bellows, and get a surgeon to show you how to use it. This, with inhalation of iodine, of which I would send you a prescription, would do good. This is treatment won't do any marked good. It will relieve the malady, and perhaps prevent it getting worse as time goes on. Again, it might never get worse if no treatment were adopted. The nerve-weakness should be fought by outdoor exercise, and, above everything, by never allowing anything to worry you. If you begin to despair, you will do no good. If you cannot improve it, remember that you have done what you can, and rest content. Worrying about it will never do any good—listening here and there at every chance to see if you are hearing better will do no good. Further, whatever improvement be made, the people with whom you daily associate will scarcely notice it, nor will you yourself. But let the same progress be made away from home, and when you return everyone will congratulate you on hearing so much better, and you will beg them not to shout at you. Finally, if you have one ear serviceable, why trouble? Thousands of people are deaf in one ear, and get along perfectly well. ARCANUM.

[76153.]—**Distilled Water.**—It is certainly possible for a good mechanic to fit the necessary apparatus for this in his house; but it is somewhat strange for him to require distilled water for domestic purposes, and I think he will find some difficulty in producing it in any great quantity. I use it for photographic purposes, and produce it as follows:—Fit a tin can, such as is used to hold paraffin oil, with a well-fitting cork, or, better still, a perforated rubber stopper; into this fit a sufficient length of brass tubing to extend from the fireplace to a convenient spot for condensing and collecting; lead this tubing, which should slope downwards, through the sides of another tin vessel, into which it is properly soldered, which may be stood on a chair, and must be filled with cold water and renewed at intervals as it grows hot, and finally collect the water as it escapes from the tube. With such an apparatus as I have described you may get with a moderate fire (for the process must not be hurried) about a pint of water in half an hour. A. E. B.

[76157.]—**Barley Bread.**—Although wheat is the most nutritious corn, yet its difference from other kinds is only one of degree. The heaviness of most breadstuffs arises from the deficiency of gluten, which prevents the gases generated by fermentation from escaping, and thus causes the dough to rise. This deficiency is, on the Continent, compensated by the addition of animal gluten or gelatine, and with this addition, it seems, very palatable forms of bread can be produced.

A. E. B.

[76166.]—**Meteorology and High Winds.**—The man who could answer "Glatton's" query satisfactorily would need to have talents of no mean order. The reports in the daily papers issued by the Meteorological authorities, I suppose, are the best answer obtainable to his query, and their explanation of high S.W. winds over England is generally the passing of cyclonic centres over the North of Scotland or the Shetlands. A. E. B.

[76169.]—**Bleaching.**—There is no means of bleaching out lampblack or blacklead stains, for what would destroy them would also destroy the fabric. If the marks cannot be blown or lightly brushed off, there is no other remedy than washing.

A. E. B.

[76179.]—**Differential Calculus.**—As "H. G. M." points out, the $3\,m\,x^3$ in the working out of the last example (page 368) should be $3\,m\,x^2$, giving $x = \frac{3}{4}$ instead of $\frac{2}{3}$; but surely the 9st. 5½lb., the result given by "H.G.M.," is wrong, for $2\,x = \frac{3}{2}$, and $6 \times (\frac{3}{2})^3 = 6 \times \frac{27}{8} = \frac{81}{4}$ = 20st. 3½lb., which is a very unlikely result for practical application. J. S. C.

[76179.]—**Differential Calculus.**—"H. G. M." is right. Mr. Proctor must obviously have written $3\,m\,x^3$, by a slip of his pen, for $3\,m\,x^2$, and have finished the equation without perceiving the mistake. For, if

$$y = m\,x^3\,(1 - x)$$
$$\therefore y = m\,x^3 - m\,x^4.$$

Differentiating with respect to x, we get, for the differential coefficient:

$$3\,m\,x^2 - 4\,m\,x^3.$$

And equating to zero, we have:

$$4\,m\,x^3 = 3\,m\,x^2.$$

Hence, dividing both sides by $4\,m\,x^2$,

$$x = \frac{3\,m\,x^2}{4\,m\,x^2} = \frac{3}{4},$$

as correctly made by "H. G. M."—and not $\frac{2}{3}$. But "H. G. M." is wrong in thinking that the rectification of this error would bring out a more satisfactory answer. If he will look at the example again (the last on p. 368), he will see that the requisite weight of the oarsman is $6 \times (2\,x)^3$ stone; consequently, since $x = \frac{3}{4}$, the required weight comes out 20st. 3½lb. How "H. G. M." makes it only 9st. 5½lb. I cannot imagine. T. S. B.

[76180.]—**Accumulators.**—Coat with good copal varnish, or have them well lacquered; but as both varnish and lacquer are good insulators, be careful not to put any on actual contact surfaces.

Brighton. T. C. SMITH.

[76180.]—**Accumulators.**—Nothing can be put on the brass which shall prevent them corroding, and which will not, at the same time, interfere with the conducting properties. Why not use the proper "white metal" fittings, which, being composed of a kind of pewter, are much less affected by dilute sulphuric acid? S. BOTTONE.

[76181.]—**Electric Lighting.**—To MR. BOTTONE.—The fumes given off by accumulators when charging consist of hydrogen, and are not injurious. If in a fairly well ventilated cellar, no harm could accrue. The solution would not freeze in an out-house, but the cells do not work so well when very cold. The dynamo you describe should give 1 or 2 ampères at 30 volts pressure. S. BOTTONE.

[76184.]—**Boring and Turning Engine Cylinders.**—Being very much interested in the working of a small shop, I shall be very pleased to see what our experienced readers have to say about boring and turning cylinders at the same time, and would suggest that a boring-bar be used, with a screw along the side of it, let into the bar clear of the tool-holder, and run in between centres, or in journals. An old lathe-head and tail-stock would be the very thing for this job, if you could get them (I think you could make some cheap enough for a job like this), and bolt them down on to a flat plate of metal, similar to a planer table; or, if planer be not in use for a bit, bolt down on it. I think this arrangement would make a capital cylinder borer for small shop. In the first place, it is close to floor, and very steady; secondly, it does not take up the valuable time of a 16in. or 18in. centre-lathe, which, in a small shop, is of some account. For facing and turning flanges of cylinder, it is easy to have a loose rest to bolt on to the bar, and be self-acting as well. A bar of this sort would face pipes, or anything else that had a hole in it large enough for bar. I have not given minute particulars of bar, because I do not like to encroach too much on the valuable space of our "E. M.," but if A. F. Shakespear would like it, I will send sketch of bar and rest.

J. T. BLACKETT.

[76187.]—**Sulphuric Acid Manufacture.**—The constitution of the "chamber crystals" is regarded differently by different chemists. Some give it as N_2O_3, SO_4, SO_3; others regard it as $\left\{\begin{matrix} SO_2(NO_2) \\ O \\ SO_2(NO_2) \end{matrix}\right\}$. But, according to the best authorities, the composition of these (also called De la Prevostaye's crystals) varies, according to whether water is present or absent during their formation. If a small quantity of aqueous vapour is present, a body of intermediate composition results, having the formula of $SO_2 \left\{\begin{matrix} NO_2 \\ HO \end{matrix}\right.$; or, as others prefer writing it, $\left.\begin{matrix} NO \\ H \end{matrix}\right\} SO_4$. S. BOTTONE.

[76187.]—**Sulphuric Acid Manufacture.**—"Roscoe" is probably correct in giving the composition of the crystals as $SO_2 < \begin{matrix} O.No \\ O\,H. \end{matrix}$ What really happens inside the chambers is doubtful, and is dependent on the proportions in which the substances are introduced into the chambers. It is, however, to be noted that if SO_2, N_2O_4, and a limited supply of steam be passed into a flask, we get

$$\text{(i.)}\quad 2SO_2 + N_2O_4 + O + H_2O = 2SO_2 < \begin{matrix} O.NO \\ O\,H, \end{matrix}$$

i.e., nitrosyl-sulphuric acid, which, with further supply of steam, gives

$$\text{(ii.)}\quad SO_2 < \begin{matrix} O.NO \\ O\,H \end{matrix} + H_2O = SO_2 < \begin{matrix} OH \\ OH \end{matrix} + NO.OH$$

the latter decomposing into HNO_2 and NO. The oxidation

$$SO_2 + HNO_3 = HSO_3 . NO_2$$

does take place under certain conditions—viz., when SO_2 is passed into strongly cooled anhydrous HNO_3. But as these conditions do not hold in the manufacture of H_2SO_4, your supposition is not correct. The formula given by "Sexton"—viz.,

$$O \left\{\begin{matrix} SO_2 . O . NO \\ SO_2 . O . NO \end{matrix}\right. \text{(anhydride of } HSO_3NO_2\text{)}$$

is certainly not correct for the "crystals of the chamber," though the anhydride may be formed some time during the process, for we know that the chamber-acid crystals, when heated beyond their fusion point—viz., 73° C., break up into H_2SO_4, N_2O_3, and the anhydride in question.

IOTA DASH.

[76192.]—**Phonograph.**—The ribs on the wax are probably due to the edge of the turning-tool being at a slight angle to the axis of the main shaft. It should, of course, be perfectly parallel to that axis. The stylus can be fixed to the ferrotype plate by shellac dissolved in methylated spirit. The indentations made on the wax are very slight, many of them not being visible with the naked eye. The causes of indistinct pronunciation are several. First, the groove made by the recording stylus may be too narrow, so that the repeating stylus rubs against the sides of the groove, thus damping many of the vibrations. The cutting-edge of the recording stylus, in this case, must be made slightly wider, or the knob on the repeating stylus smaller. Second, the reproducing-stylus may not be sufficiently polished where it makes contact with the wax. A powerful lens should be used to examine this stylus, as any roughness will scratch the wax instead of riding over the little elevations. W. GILLETT.

[76193.]—**Alcohol.**—To MR. BOTTONE.—When absolute alcohol is mixed with water, real chemical combination, accompanied by heat, and contraction in volume (which is to a certain extent disguised by the expansion due to the rise in temperature) takes place. Thus equal volumes of alcohol, sp.g. 0·825 and water, at a temperature of 50° Fahr., when suddenly mixed, rise in temperature to 70° Fahr., while a contraction of nearly 4 per cent. takes place. Equal volumes of proof spirit, sp.g. 0 920, and water, at 50° Fahr., give rise to a temperature of 60° Fahr., the contraction being, at the same time, a little over 2 per cent. You will find a very full account of this matter, with tables of contraction, specific gravities, &c., of the resulting mixture in Muspratt's "Chemistry in the Arts and Manufactures." S. BOTTONE.

[76193.]—**Alcohol.**—When alcohol is added to water there occurs a diminution of volume, accompanied by rise of temperature. The maximum contraction of volume is reached when 46 parts, by weight, of alcohol (C_2H_6O) and 54 parts, by weight, of water (H_2O) are mixed. These weights correspond to the formula $C_2H_6O + 3H_2O$, as if a definite chemical hydrate were formed. The explanation of such cases of solution (?) is most difficult; in fact, the whole question of solution is now being considered by our most advanced scientists. When proof spirit (49 p.c. by weight of real C_2H_6O) is formed by the addition of the necessary amount of water, the conditions for maximum contraction are nearly reached. After that there would be but small contraction when (say) equal parts of water and proof spirit were added. I don't know of any rule for such a calculation as suggested by your question: Why not try by an actual experiment? Had I the proof spirit I could soon find out, and am willing to try the experiment, if you forward some proof spirit to me.

IOTA DASH.

[76197.]—**Electric Light.**—A small Siemens dynamo, with laminated armature, costing £3, and taking ⅓H.P. to drive, would suit you. Cost of three lamps, 15s.; cost of dynamo to light three lamps, £5; power required, ⅓H.P.; price of Bailey water-motor, £10 to £12. S. BOTTONE.

[76198.]—**Bunsen v. Daniell Batteries.**—As recently as p. 366 of this volume I gave full directions for making the battery that I consider the best adapted for plating on a small scale; but if you do gilding only you will find the Bunsen more satisfactory. It is much easier to get a good colour (which is all-important with gilt work) with the higher E.M.F. of the Bunsen than with the Daniell.

Brighton. T. C. SMITH.

[76198.]—**Bunsen v. Daniell Batteries.**—The Bunsen will do for gilding; it is cleaner than the Daniell with respect to the zinc, but the fumes given off from the nitric acid are rather obnoxious. The Daniell is a very good cell, and well adapted for silver-plating or gilding; but the zinc gets very dirty after a good day's work. Both require (after each day's work) to be taken down, zinc cleaned, reamalgamated, if necessary, and the cell which contained it to be filled with water, the acid having been poured into a jug for use next time. The usual form of a Daniell cell is zinc rod, or cylinder, in porous cell, with dilute sulphuric acid, water 10, acid two parts. The outer cell contains a copper cylinder with saturated solution of sulphate of copper, fed by means of crystals of same, contained on a shelf or in a pocket perforated, riveted to copper cylinder.

S. ROBERT BONNEY, Electroplater, &c.

[76199.]—**Battery Cells.**—Give the inside of jar one or two coats of good hard copal varnish; or make it thoroughly hot and soak with paraffin wax. As battery jars, or at least jars that answer very well, are so cheap, it is hardly worth while to go to any expense with the one you have, especially if you only want one. I have no experience with paper cells; but should think that if thoroughly soaked, while hot, with paraffin wax they would be waterproof; or you might try varnishing both the inside and outside.

Brighton. T. C. SMITH.

[76200.]—**Accumulators.**—Your cells will probably have a capacity of 10 ampère hours. The voltage of each cell is, of course, about two volts. For charging, each cell must have 2·45 volts. If coupled in parallel, all the cells can be charged from a source having this E.M.F.; but if in series, the E.M.F, must be as many times 2·5 volts as you have cells in series. A current of from two to four ampères will be sufficient if the cells are in series; but if in parallel, must be multiplied by the number of cells in parallel. Two quart Bunsens would charge them in parallel, but not in series. As you do not state the voltage of your 10c.p. lamp, I cannot specify the number of cells required. Allow one cell for every two volts marked on your lamp.

S. BOTTONE.

[76201.]—**To Mr. Bottone.**—The case itself being in contact with one pole of the battery through the right-hand binding-screw and the point 1, the hour-hand completes the circuit on arriving at point 2, which is adjustable at any position, and which consists virtually of a fine insulated wire, terminating in a light springy-hooked tip, sufficiently firm to make contact, but not stiff enough to stop the watch.

S. BOTTONE.

[76203.]—**Growth after Death.**—This is an old and well-authenticated fact. I attribute the sudden and rapid increase of hair and nails to an excessive secretion of phosphoric acid in persons of peculiar constitution.

EOS.

[76204.]—**Electric Lamp for Bicycle.**—A small drum armature shunt-wound dynamo, with a couple of cells of Cathcart's accumulators, answer perfectly.

S. BOTTONE.

[76210.]—**Torsion Balance.**—The fallacy lies in "Student's" assumption that "three times as much force must be required to deflect the needle through 90° as is required to deflect it through 30°." Remember the torsion on the wire is directly proportional to the force which it balances, and may denote that force; but since the earth's field does not change in direction, the couple acting on the needle is proportional to the sine of the angle of deflection from the meridian, and not to the angle itself.

IOTA DASH.

[76214.]—**Dynamo and Motor.**—Seventy-five volts nine ampères are equal to 675 watts. Allowing for loss in transmission, and for conversion of energy in the motor, you might expect to get ½H.P. If you wind the armature of your motor with 6lb. of No. 17 d.c.c., and the field magnets with 10lb. No. 14, coupled in series, you will get good results, provided, of course, that you have good, large leads, so as not to waste current.

S. BOTTONE.

[76215.]—**Gas-Engine.**—There is no method so simple and reliable as the heated tube as now used with all the best engines. Electricity (especially if generated by batteries) is very troublesome and liable to fail when it is most wanted.

Brighton. T. C. Smith.

[76215.]—**Gas-Engine.**—In earlier days of gas-engine construction this was tried; but, my informant says, without results that were considered satisfactory. But suppose a satisfactory working of an engine should be got by firing by electricity, where would the advantage be, putting aside the extra cost, for it is certain that gas would have to be much more costly than at present to advocate the use of electricity for firing in place of the ignition tube, such as used in Crossley's engines? These are heated by a small atmospheric burner. The consumption of gas in a 2H.P. engine, I should think, would cost about 3d. per day of ten hours at the outside.

S. ROBERT BONNEY.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75691. Electrical, p. 229.
75694. Logarithms, 229.
75698. "Berliner" and "Fiddler" Violins, 229.
75709. Gas-Making Machine, 229.
75726. Double Bass, 230.

75924. Strain on Engine Belt, p. 315.
75926. Foundations, 315.
75927. Small Biunial, 315.
75935. Electro-Magnet, 316.
75949. Gas-Engine, 316.
75964. Coating Iron with Brass, 316.
75966. Making Sulphate of Ammonia, 316.
75969. Hydrochloric Acid, 317.

AIR ploughs, V-shaped contrivances, to be placed on the front of engines of fast express trains, are the latest scheme to get more speed, by overcoming much of the natural resistance of the air to the front of the locomotive. The plough extends from a few inches above the track to the top of the smokestack, the sharp edge of course in front. "Shovelling fog" is a common expression among railroad men, but ploughing wind is a new thing in railroad agriculture.

QUERIES.

[76216.]—**Winding Motor for Boat.**—Will Mr. Bottone or others kindly tell me the size and quantity of wire to wind upon the armature and fields of the following motor, to be worked by four plunging chromic-acid batteries in 15ft. boat? Laminated H armature 3in. diam. and 3in. long, with channel for wire 1⅜ long by ⅝ deep; two round cast-iron fields 1⅞ diam. by 3⅜ long; to be series-wound. Can you suggest any modifications of above to improve the efficiency? About what power would above conditions develop? It is proposed to gear down in speed from motor to propeller shaft. Full directions will greatly oblige.—B. R. W.

[76217.]—**Laminated H Armature.**—Will Mr. Bottone or others please tell me if thin plates of malleable iron would make a good H armature for electro-motor? They can be cast with a thin boss upon one side of each to get the separation. If they would answer, please state what thickness the plates might be, and how much space between each plate for an armature 3in. diam.?—B.

[76218.]—**Bristol Steamships.**—Can anyone give information about the large steamships built at Bristol some fifty years ago. The first was the Great Western, and I have a vague idea there was a second built of iron, larger than the Great Western, and fitted with a screw propeller. I cannot recollect her name, and my impression is that she came to grief in going down the Avon. Also, what vessel was it that ran aground in Bantry Bay? I think Capt. Hoskins was the commander of one of them. —M. W. G.

[76219.]—**Oil Stove Cookery.**—Having bought an oil stove which fails in one particular, can any reader assist me? The stove cooks capitally, but will not bake bread, for which purpose it was obtained. Loaves in the ordinary tins are burnt on top and white underneath, not rising at all, as they cannot rise when the top is once hard. In an ordinary Lancashire oven the baking proceeds from the bottom of the bread, thus permitting it to rise. Cakes placed on the oven shelf are similarly underdone, so that the loaf tin is not to blame. The lamps are at the side, and the heat is greatest at the sides and top. The kitchen oven in my house has the very same defect. It is a close range. The fire goes over the top, but does not circulate so as to heat the bottom of the oven. I presume it is an old design. The stove was then got, as we prefer home-baked bread.—DERBY CASTLE.

[76220.]—**Electro-Motor.**—I have 100 watts from a battery, and wish to run a motor at 1,000 revolutions per minute. I intend to use only one magnet, the two extremities connected to pole-pieces, between which runs the armature. Please give length and diameter of magnet bar, and also size of armature, with wire for each.—GRATEFUL.

[76221.]—**Spritsail versus Gaff and Boom.**—I am fitting out for coast cruising, a 30ft. threequarter-decker boat, late a ship's lifeboat. I propose to rig her with a sprit mainsail and small mizzen, as I shall generally cruise alone or short-handed. I have always been used to cutter-rigged craft, and have never sailed with a spritsail, but I am struck with the apparent easy handling of a craft so rigged. Boatmen in the lower Thames whom I have consulted are about equally divided for and against the spritsail, but nearly all say it is dangerous in rough water. Will some practical reader give me in a few words the case pro and con.?—D. BLACKBURN.

[76222.]—**Hand-Lever Tricycle.**—In the "E.M." of Sept. 13th, 1889 (page 57, letter 30349), I see a Mr. L. W. Willis speaks of a hand lever-tricycle fitted up as a small bath chair with one lever only, which does both the steering and propelling. I am greatly in need of such a vehicle, and should be much obliged if Mr. Willis would kindly give the sketch promised.—D. D. K.

[76223.] — **Terrestrial Orbital Velocity.** — Should not the following method yield the correct orbital velocity of the earth? Look up in *Nautical Almanac* for the day in question the variation per hour in the sun's R.A., multiply by 15 to get its arcual value, and then taking from the same source the semi-diameter of the sun for that day in angular measurement (of which the value in miles is known), to compute the orbital velocity of the earth per hour in miles is to the semi-diameter of the sun in miles as the sun's variation in R.A. per hour in arc is to the angular measurement of the sun's semi-diameter for the day in question. Having arrived at this, what is the method of determining the velocity of approach or recession of the earth per hour to or from any star?—J. M. B.

[76224.]—**Gearing.**—Could any reader inform me of a book on gears and motions of every kind; a present day work I should prefer?—HOARI.

[76225.]— **Crucible.** — Could any of your readers oblige by giving information regarding the way of separating gold from silver? I have two pieces of gold from two pots just melted in both cases—the silver or lead is mixed up with it. Can it be separated by remelting with salt or anything with it? Also would be much obliged for address of assayers, or buyers of old pots, paint burnt off containing gold, &c.—CRUCIBLE.

[76226.]—**Induction Coil.**—The writer would be much obliged for particulars of a good modern induction coil to give about a 6in. or 7in. spark. That mentioned by Mr. Ernest Baugh in MECHANIC of Oct. 11th, 1886, would be about right. Is there any advantage in the Pyke and Barnett method of construction? Having made various coils, I know from experience that the construction of a coil of this size is not to be lightly undertaken, and so am anxious to get the best designs before starting. Is there a good book on coils?—T. B.

[76227.]—**Coil Boiler.**—Can any reader answer the following questions for the benefit of some working mechanics? viz.:—We are working a single flue Lancashire boiler, 19ft. by 5ft. 6in., at 60lb., and using best hard coal, and firing every 20 minutes, consuming 50cwt. per 24 hours, which we are obliged to do to drive an engine indicating 30H P. We know our boiler is too small. What size ought we to get and what kind and quantity of coal should we be able to use with a proper size boiler?—M. C. I. S.

[76228.]—**Cataract.**—Can any reader speak (either from personal experience, or from that of some intimate friend or relation) as to the alleged ability in some, if not all, cases of homœopathy to cure cataract? Has it a chance of curing genuine cataract, or would the time, trouble, and expense of trying such treatment be wasted? I make this inquiry on behalf of a dear friend in whom an oculist has diagnosed cataract of both eyes, and from whom it has been deemed best to withhold the true state of affairs for the present.—GYP.

[76229.]—**Violin Belly.**—I am making a violin in accordance with the instructions given by Mr. Pickering in the "E.M." I am, however, in doubt as to the kind of wood for the belly, called Swiss pine. Is this wood red or white deal, and is it the same wood as spruce fir? How can I distinguish it from other kinds of deal?—G. H.

[76230.]—**Round Hay Stack.**—How can I find the cubic yards in a round hay stack 21yds. round by 3yds. high on the outside (from the bottom of the thatching, not to the top point) in the centre? How can I measure a round stack of any dimensions? Should like reply by simple rule, not beyond decimals I mean. Is there any general rule by which dealers buy and sell round stacks for trussing; not bought by weight, but by measurement? Good trusses could only be obtained by once going through the stack; then what about the outside rounded pieces.—EX-MIDLAND.

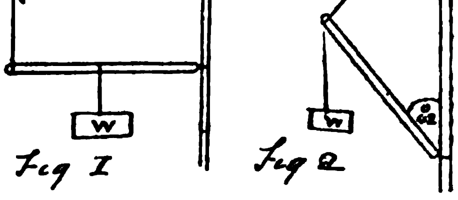
[76231.]—**To F.R.A.S.**—Will you kindly explain the meaning of the words: "The horizontal force is given in C.G.S. measure." See p. 26 of "Companion to the Observatory."—G.

[76232.]—**Hand-Bell Casting.**—In "E.M.," Feb. 20, 1891, "R. T." says:—"Use good moulding sand, and run metal hot." What is the mixture?—H. B. S.

[76233.]—**Organ.**—Could any reader inform me how the air is admitted to the 8ft. reeds of an American organ to form the celeste without having to sharpen one set as in the old way and flatten the other? Also should two sets be used in the same way to form celeste?—JOINER.

[76234.]—**Thermopile.**—To MR. BOTTONE. — With reference to the thermopile with No. 16 wires mentioned in your book, I twisted and soldered a pair of No. 8 wires, and heated the junction at the top of a Duplex lamp-chimney, but I only obtain half an ampère on the short circuit. I calculated that I should obtain two ampères, since the No. 8 wires were six times as thick as No. 16, which, as you say, give one-third of an ampère. Kindly say where the fault lies. My pair is 11in. long.—THERMOPILE.

[76235.]—**Breaking Weight of Spar.**—Suppose a round beam or spar—pitch pine—be supported horizontally by a rope at one end, and secured at the other end by a bolt in a perpendicular spar, with a weight hung in the centre, what weight would break it? Length of spar 4ft., diam. at centre 12in., at the ends 10in. (sketch, Fig. 1).



Again, suppose the same spar be elevated (Fig. 2) and a weight hung from the top end, what weight would break the spar in that position? What is the rule for finding this?—SAILOR.

[76236.]—**Neighbours' Pianos.** — Can any clever correspondent tell me the best means of deadening the sound of a loud piano in an adjoining house. The piano, which is one of the loudest made, is placed quite close to the wall which divides my house from my neighbour's, and it can be heard with terrible distinctness all over the house. Remonstrance is useless, but I thought the following method might mitigate the evil. I shall be glad to know the opinion of others. I propose to erect a false wall of lath and plaster about 3in. off the existing brick wall, the upright scantlings being nailed to the wall, with a packing of felt where they touch it. I should also fill the space between the lath and plaster and the old wall with sawdust. I should prefer to use thin wood boards instead of plaster, with the space packed with sawdust as before; but probably plaster would be a greater non-conductor. Any correspondent who could satisfactorily solve this question would confer a great benefit on the many afflicted by "the next door piano."—F. K.

[76237.]—**Carbon.**—Can carbon be deposited from any liquid by electrolysis?—RICHARD BROWN.

[76238.]—**Recharging Dry Cells.**—I have three "E.C.C." dry cells which have become exhausted. Please give instructions for recharging them as secondary cells. —R.

[76239.] — **To Mr. Bottone.** — A Voss electrical machine which I had from Becker and Co. gave very good results when first received some five years ago. It now, however, refuses to give the smallest spark, although I give it strong initial charges, and every part appears as perfect as when I bought it. Do you think the shellac has deteriorated in the time? I shall be very glad if you can suggest a remedy.—JACQUES.

[76240.]—**Electrical.**—To A. D. SOUTHAM.—In the "E.M.," Dec. 4, 1891, says: "Buy Prof. Ayrton's 'Practical Electricity,' 5s. 8d. cash." Where can I get the book for that price? Is that the same book as published by Cassell, London, whose price is 7s. 6d.? Will Mr. Southam tell me where lies the difference between an electro motor and a dynamo, and how can one be converted into the other? Does the above book give descriptions of making motors and dynamos?—ALEXANDER.

[76241.]—**Casting in Type-Metal and Cores.**—I have a quantity of type-metal, and I want to know can I melt it in a plumbago crucible in an ordinary grate, cast it in plaster of Paris, or in a mixture of plaster and coke dust? What size should the core prints be, or how much smaller than the holes in the casting ought the cored holes to be? For instance, the nose of my lathe mandrel is 1¼in. outside thread. What size should the cored hole be, say, in a face plate for that sized nose? How am I to make cores? What are the proportions of the materials?—Alexander.

[76242.]—**Engine for Lathe.**—Would a ½H.P. engine drive a 4½in. back-geared lathe for wood or light metal work? What ought to be the size and class of boiler for such a power, and what the steam pressure?—Alexander.

[76243.]—**Elastic Composition.**—What proportion of glue and treacle should I use to make a tough elastic substance such as the flexible comic faces used to be made of? Also what proportion of chromic acid or bichromate potash will render the same insoluble? Should the glue be soaked in water before being wetted with the treacle?—W. P.

[76244.]—**Stamping Soap.**—Can any reader assist me in trying to find out where I can get a machine to stamp a composition similar to Monkey Brand soap with a trade mark upon it, and any information as to what state the composition should be in for stamping, as I have a composition that is superior to anything in the market for cleaning purposes?—Clitheroe Castle.

[76245.]—**Smelting Iron.**—Is natural gas used in America for smelting iron for ordinary foundry work? If so, a rough description of furnace will oblige. Is the gas burnt under pressure mixed with air from fan, forming, in fact, a series of powerful Bunsen burners? If not, is there any reason why gas should not be so used except its cost? If a small gas furnace can be constructed to melt 14lb. weight of iron, why should not a larger one melt one ton? Could Dowson gas be so applied?—Yesallaw.

[76246.]—**Spontaneous Combustion.**—In No. 1374 it is stated, among other "Hints to Chemists," that powdered rosin may produce spontaneous combustion. We use a considerable quantity of rosin, and our plan is to empty a barrel at a time into a large bin. There is always a lot of fine dust at bottom of bin and among the lumps of rosin. Do we run any serious risk of fire through spontaneous combustion?—Yesallaw.

[76247.]—**Charging Dry Cells.**—Would Mr. Bottone or some other electrician kindly show me the way of charging some dry cells that require charging, and how shall I know when the cell is fully charged?—E. B. F.

[76248.]—**Sulphur in Coal-gas.**—Will some one kindly inform how to determe sulphur in coal-gas quickly and trustworthily?—Agros.

[76249.]—**Agricultural Mechanics.**—Can some reader give me information concerning the above for the Royal Agricultural Society's examination; also the land surveying? What books should be read, &c.?—Agros.

[76250.]—**To Mr. Bottone.**—Could you give me the dimensions for a 2in spark induction coil? I have got a lot of 16 B.W.G. and 36 B.W.G. wire, c.c., and I would like to use it. Need I put paper between each layer of wire? Also what size condenser should I use?—E. Wilson.

[76251.]—**Sunset on Chimborazo.**—What values of dip and refraction should be taken when calculating time of sunset on summit of this mountain, which is 20,498ft. high? Also where can refraction be found tabulated for zenith distances greater than 90°?—Chrysomela.

[76252.]—**Self-centring Chuck.**—I have a 4in. Cushman's geared chuck. The central pivot around which the scroll works has unfortunately got broken from its connection with the front plate. I would thank some reader for a hint how to cut the grooves for the jaws to work in a new plate, or what best I can do with the chuck.—J. R.

[76253.]—**Gilding Bevelled Photo. Mounts.**—Will any reader give me a little instruction how to gild the bevelled edges of picture mounts for mounting photographs, &c.?—Amateur Framer.

[76254.]—**Phonograph.**—Will some one give us some hints on constructing the recording and reproducing styluses, and the composition of the wax? Doubtless Mr. Gillett's esteemed articles have set many aspiring amateurs to work. Why should not the needles be made altogether lighter and more delicate than Mr. G. gives it, or is a pivoted lever stylus likely to answer better? My diaphragms are of goldbeater's skin and ferrotype plate. I cannot obtain thin glass. Perhaps Mr. Suggett will assist us. I want to make the machine render itself audible without the tubes. Has the last-named gentleman succeeded in that?—Experimenter.

[76255.]—**Ocarina.**—Can any of our readers give me any information about the ocarina? It was spoken of a good deal some years ago, and I believe a number of performers produced some excellant music at the Crystal Palace. I want to know (*a*) the sizes of the different instruments, and the compass of each, (*b*) the manner in which the tone is produced, whether by blowing, as in the flute, or in the flageolet?—Evelyn.

[76256.]—**Galvanising.**—I have tried according to directions given in back numbers, but can only get a rough, scabby, thick coat of zinc. Can any one give me a hint as to the reason? Have used scrap zinc.—S. B.

[76257.]—**Engine Query.**—Having two engines, one with 40in. cylinder, 5ft. stroke, geared two to one, the pinion on crank shaft in each case; one with 40in. cylinder, 4ft. stroke, geared three to one. Which engine will develop the most power, working at a pressure of 70lb. per square inch, and what is the horse-power of each engine, with and without gearing?—123.

[76258.]—**Comets.**—Will any of "ours" in the know please say if the comet of about 1873 was a periodic one, and if so, when is it due in our sky again? This is rather a vague query, but I have no means of ascertaining the exact year. It was a very brilliant comet, and had a very large tail. Also about when are there any other large comets supposed to be visible here?—Am. Astro.

[76259.]—**Blacksmith's Forge.**—Will some kind reader tell me the best way of supplying blast to same for all-round jobs, whether by double-blast bellows or a fan? If by the latter, please give size of same. About to commence.—Business.

[76260.]—**Diabetes.**—Will some of the kind readers of "Ours," who understands the above disease, please advise on the following: My doctor tells me I am suffering from diabetes, and says I am to eat nothing that contains sugar or starch. Now I am not chemist enough to distinguish the vegetables that contain those two articles from those that do not. Kindly give me a list of vegetable foods that I may eat with safety. I am a working man, with an average wage of 30s. per week, with a few more than myself depending upon it. What can I eat in lieu of ordinary bread? I do not touch alcoholic drink nor tobacco.—One who Suffers.

[76261.]—**Drum Armature.**—To Mr. Bottone.—Will you kindly inform me as to the amount of wire and No. of gauge to make a drum armature for the magnets of one of your 20c.p. dynamos wound with about 4½lb. or No. 20 B.W.G. to give about 25 volts.—C. R. B.

[76262.]—**Serpentine Marble Turning and Polishing.**—Will some reader of the "E.M." inform me how to polish small serpentine ornaments; also the best cement to stick the stone to the lathe-chuck with? The workers at the Lizard (Cornwall) use cement that looks very much like soap, and smells of resin. Will the dust of the stone be any harm to the lathe bearings?—W. R. W.

[76263.]—**Silver Casting.**—Will Mr. Fletcher kindly tell me the best material to make mould in for getting fine silver castings, such as small dogs, &c., for scarf pins and other ornaments of jewelry? I have tried using plaster of Paris and moulder's sand mixed together. I have been informed that the above mixture is very much used in the trade, but I have failed with it. Probably it is my own fault; but no doubt you can throw some light on this matter. Hoping I am not asking too great a favour.—English Mechanic.

[76264.]—**Piping.**—Would any reader say what amount and size of piping I should require to heat a room 60ft. long by 15ft. wide, 11ft. high, to 60°, the piping would have to go down the centre of the room? I have a three horse boiler I only use about six hours a day, and I thought if I could get to know how many lengths I should require, it would be a great help. I am not able to work out a formula. I thought of taking steam at 20lb, and returning the condensed water back to the boiler through the back-pressure valve, and also is the water off a galvanised roof any detriment to the boiler, or is hard water best?—S. Ride.

[76265.]—**Astronomy.**—Will "F.R.A.S." or any other authority on the subject kindly say if Mary Somerville's "Connection of the Physical Sciences" (third edition) is a good work to read up? Do the theories and general matter contained in it still hold good? I do not expect the figures to be correct. Thanks in anticipation.—Am. Astro.

[76266.]—**London College of Preceptors.**—Will some of your readers kindly tell me what are the best textbooks to use to pass 2nd division examination of the above college, and two extras, chemistry and physiology?—Student.

[76267.]—**Violin—Position of Soundpost and Name of Maker.**—Would Mr. Pickering or some other experienced person say if there is any definite rule for putting up the soundpost of a violin so that the best possible tone the instrument is capable of may be produced? In p. 149 Vol. LIV. the usual position is given as ¼in. behind the right foot of the bridge. What then is the position of the bridge on which that of the soundpost depends? My violin is labelled Raffaele Trapani Napoli, 1815. Is anything known as to the general character of the work of this maker?—E. E. M.

[76268.]—**Minimum Thermometer.**—In the minimum thermometer (1) why is alcohol used? and (2) how is it that the index moves with the alcohol when contracting under cold, but remains stationary when the alcohol expands under heat?—Puzzled.

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*** *All communications should be addressed to the* Editor *of the* English Mechanic, *332, Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, January 6, and unacknowledged elsewhere:—

Leroy and Co.—Onyx Engraver.—C. G.—A. W. B.—Grantham Crank Co.—Budge.—W. H. Milligan.—A. B.—Ferrum.—Youngster.—P. B. S.—Worth.—J. L. M.—Horologist.—J.—Optics.—W. H.—Robert Law.—G. J. B.—T. C. Smith.—S. W. Newcomb. C. G. M. Bennett.—T. G. Elger.

Swindlers at Work Again. (We once more warn readers to be careful in remitting money to unknown advertisers. The last dodge of the Long Firm is to reply to those who advertise in our "Wanted" column, and to offer to send goods on receipt of cash. The address given is in a respectable street in the W. district, where, if people call, as one reader was wise enough to do, instead of sending cash by post, they will find it is simply a place where letters are taken in. Our repeated advice is never send cash to people you do not know, except by P.O.O. payable ten days after date, and stop payment of the order if you do not get your goods in the interval.)—F. W. H. (The matter is explained in any of the textbooks on the subject, and some years ago was debated in our columns. The tires are coned, and the outer rail of the curve being elevated, the wheels get round with a little slip. The elevation, though primarily for another purpose, helps; but the wheels running on the outside rail of the curve run on their largest diameters, whilst those on the inner rail run on their smallest diameters, which practically compensates for the difference in length of the two rails.)—Conning Tower. (Yes, steel can be cast as smooth as cast iron; but if you have any improved method, why not go to a steel caster's and see some of his products? If your method produces better work, he might probably take it up. A great deal depends on the nature of the casting.)—Puzzled. (What do you mean by "learn astronomy"—theoretical or practical? There are plenty of works on the subject, and much information in back volumes. If you mean theoretical, you must learn plane and spherical trigonometry, conic sections, the calculus, and besides those, master the best treatises on the subject.)—Penchant. (The explanation of electrical terms was given only a few weeks ago. See various replies numbered 75884; but any textbook of the science explains what is meant by volts, ampères, &c.)—Anxious. (If by battery about ten times as much as by gas. See many replies in back volumes—even in recent numbers.)—One in a Fix. (Use a Leclanché battery for bell work.)—B. and M. R. (Niaudet's "Treatise on Electric Batteries," Spon, 125, Strand, W.C., probably contains the fullest details about thermopiles; but there is nothing devoted specially to them as far as we know. We have given all the useful forms in back volumes.)—Dum Spiro Spero. (It would be necessary to see the place, or have plans of it, before giving an estimate. An approximate idea of the cost can be obtained from many replies in back numbers.)—W. C. Fentum. (It depends on the size of the plates, and they must be somewhere of about the same dimensions. Several dry batteries so-called are in use. See the indices.)—R. F. (Learn to play the chords; that is all that is necessary. You will find something about vamping in the manuals, and in recent numbers.)—Efil. (If you refer to your back numbers you will find that nearly all reflecting telescopes are now made with specula of silver on glass. You do not require such productions for a camera obscura.)—Legally Ignorant. (A partnership without any written agreement may be terminated by six months' notice on either side. Partnerships without written agreements are risky things. In case of dispute the consequences will probably be mutual dissatisfaction, litigation, and much expense.)—Herne Hill. (Fog signals on railways are detonators to apprise the driver of the position of the semaphores he cannot see. Many devices have been suggested, and you can see descriptions of them at the Patent Office Library.)—A. E. W. (There is only one way to make wood-engravings that we know of, and that is, to learn the art like any other.)—Young Engineer. (There is no examination necessary to be passed to be an engineer. If you want to become a member or associate of the Institution of Civil Engineers, write to the secretary at the office, 17, Great George-street, S.W.)—Stratford Works. (No wonder you were ashamed to put your name to your letter.)—H. Lomas. (We believe they were much the same as those of other makers; but we cannot spare space to ask for details of advertised medical or electrical apparatus. Why not ask the maker?)—Soro. (We are quite ready to publish any information you have to give—your other letter will appear next week. Never you mind what other people know or don't know. Give any facts you have, and leave our readers to judge, and don't call names.)—W. J. B. (In type.)—G. J. B. (Please send another drawing of Fig. 1.)

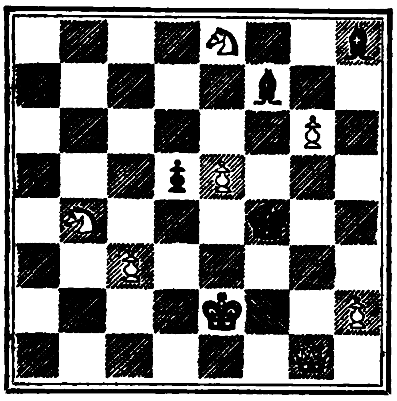
One of a Thousand.—"I procured one of your Electropathic Belts when I was suffering so severely from general debility and chronic indigestion. It effected a decided improvement after a week's wear, and I am now infinitely better. My digestive powers are much stronger, and I have less lassitude." The above is an extract from a letter recently received from Mr. Charles Sibery, 1, Queen-street Lane, Dover. All who are interested in the cure of disease by Electricity should call or write at once for descriptive pamphlet and book of testimonials, which may be had free on application to the Medical Battery Company, Limited, 52, Oxford-street, London, W. No charge is made for consultation either personally or by letter.

CHESS.

All communications for this column to be sent to the CHESS EDITOR, at the office, 332, Strand.

PROBLEM MCCLXXXVIII.—By W. T. HURLEY.

Black.



White. [8 + 4.

White to play and mate in three moves.

SOLUTION TO 1286.

White.	*Black.*
1. Kt-Q 2.	1. K-Q 4 or 5 (*a*).
2. Q-Q 8 (ch).	2. K moves.
3. Kt mates.	
	(*a*) 1. B-Q Kt sq.
2. Q-K 3 (ch), &c.	

NOTICES TO CORRESPONDENTS.

CORRECT solutions to 1286 by J. F. Slade and A. Anderson (dual); to 1285 by W. L. Martin, R. W. Houghton, H. Fellows (out of the ordinary), A. C. Hurley, T. H. Billington (key not in best style, but duals cleverly avoided), and T. Guest.

A. G. FELLOWS and J. P. Taylor are thanked for problems.

T. GUEST.—We reciprocate your good wishes—sorry to hear of your illness. Oddly enough, others sent the same solution as yours to 1283.

H. P. HOSKEN.—1286 is quite correct, it is your attempt which is wrong.

"CHESS ENDINGS," edited and arranged by E. Freeborough (Kegan Paul, Trench, Trübner, and Co.) is now published. A work of this description has for a long time been much needed. So far as we have examined it, for systematic arrangement, it leaves nothing to be desired. Of course much of the matter is old in it, but valuable and curious positions have been collected from various quarters. The work will be found much more thorough and practically useful than Horwitz and Kling's "Chess Endings," a new edition of which appeared some years ago. As the editor observes, it is as important to know how to deal with the forces at our command in an end game, as at the beginning, and many a game has been lost through the player's ignorance of the proper manipulation of the pieces.

WE subjoin a curious position in which black, with the move can draw, but 1. ...... B-Kt 5 is the only move. White: K-Q B 5, Kt-Q 4, Ps-Q R 5, Q-Kt 4. Black: K-Q R 3, B-Q 8. If 1. ...... B-R 5; 2. Kt-B 6, and wins; if 1. ...... B-R 4; 2. P-Kt 5 (ch) and wins. 1. ...... B-Kt 5; 2. Kt-B 6, B-K 7; 3. Kt-K 5, B-Kt 4; 4. Kt-B 4, B-Q 2; 5. Kt-Q 6, B-Kt 5, a draw.

WE hope to give a fuller notice of the book on further examination of its contents. We merely add now that the get-up is excellent. The diagrams are copious, so that in many cases the student can dispense with board and men. The editor has, we see, here and there quoted some charming problems, showing the occasional points of contact between problems and end games; see, for instance, positions 179 and 181. The work may be obtained from Mr. G. Freeborough, 9, Parliament-street, Hull, price, 6s. 8d. postage free.

OUR EXCHANGE COLUMN.

The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.

Wanted, good useful **Exchange** and part cash for following goods. Bradford's Vowel Y WASHING MACHINE and WRINGER, equal to new.—Below.

Two handsome plated brass **Duplex Lamps**. 29in. high to burners, cut glass vases, never used; Tangye's Pulley Block, 10 cwt., and chains.

Bench Drilling Machine, with 22in. flywheel; welded iron bath boiler, 12in. wide, never used; Mechanical Telephone, and 50 yards wire.

Seventy Magnetic and other **Indicator Movements**, Magic Lantern, 2in. condenser, 50 slides, Mechanical Chromatrope, &c.; portable Electric Bell, ordinary Electric Bell, wire, battery, and push.

Gramme Series Dynamo, 50a. 50v., splendid machine, two double carbon Brush Arc Lamps, hangers and globes, quantity second-hand cable.

2H.P. **Horizontal Engine**, with vertical 3H.P. boiler and all fittings, good maker, in good order guaranteed, four pairs quite new Acme skates.

New **Ediswan Lamp**, brass holders, switches, roses, brackets, bought for cash or exchanged.—BOWRON.

Any kind of small **Electric Apparatus** bought.—G. BOWRON, 93, Praed-street, London, W.

Oscillating **Marine Engine**, cylinders each 1⅛in. by 1in. Exchange for small lathe, tools, or offers.—BROCKHURST, Church Stretton, Shropshire.

Important notice.—100 gross of **Whitworth Taps**, PLUG and TAPER, made of best cast steel, from 1-16, 3-32, 1-8, 5-32, 6-32, 7-32, new.—Below.

Six large size **Ebonite Leclanche Batteries**, Fletcher Gas Furnace, Hot-Air Engine, Simplex Dynamo, laminated armature wound, 30c.p.—A. KING, James-street, Sheerness.

Leading Screw, 3ft. 9in. by ⅞in. diameter, ⅜in. pitch, double thread. Offers. Anything wanted, four-jaw or other good chuck, suit 3½in. lathe.—Below.

Wanted, set Model Engine Castings and Forgings in their ordinary metal (not all brass). Offers.—H. GOULDING, 31, Marine Approach, South Shields.

Pair 1 by 1½in. stroke slide-valve **Cylinders**, by Bateman, suit marine or locomotive engine, worth £2; one pair 3½ and two pairs 1¼ locomotive wheels; Roger fret machine. Exchange. H. S. GOODMAN, 23, Mill Hill-road, Acton, W.

Smith's **Bellows**, Engine Indicator, Steam Gauge Gasholder, Safety Valve to spare. Wanted, Drilling Machine, Wheel Cutter, Shaper, &c.—S. HEWETT, South Norwood, Surrey.

Copying Apparatus, two of best sorts, and cash. Would exchange for Drawing Instruments, Engineering, photographic, or electric things.—S. HEWETT, South Norwood, Surrey.

Mechanical Telephones.—Three pairs Judson's Telephones, require no battery, talk splendidly 300yds., cost 42s. pair. Exchange to 15s.—BRAUN, 9, South-street, Finsbury.

Splendid Cylinder **Electrical Machine**, 12in. solid brass framework and mountings, cost £6 10s., also Electric Motor, cost £3 3s., at King Mendham, in good condition, and nickel keyless watch, cost 17s., capital Timekeeper. Will exchange the above for a powerful Wimshurst or Plate machine.—Apply, N., 1, Clarence-terrace, Bideford.

Lathe.—Wanted 3 or 4in. centre Foot Lathe, by good maker, with tools, chucks, &c. Exchange and cash, W. HUTCHINSON, Liversedge, Yorkshire.

Microscopic Slides.—Exchange 3 doz. first-class mounted slides for anything useful to the value of 24s.—WM. CLAPHAM, 3, Otter-street, Kirkstall-road, Leeds.

Vols. XLV. to LII. "**English Mechanic**," clean, complete. Exchange for any four vols. previous Vol. XXVI or offers.—DOUGLAS, 2, St. Cuthbert's-place, Gateshead.

Large "Vox Celeste" **Musical Box** (Nicole freres) Plays 18 selections on three barrels which fit in separate case. Self-playing. What offers exchange to value of £12.—M., 21, Bristol-gardens, Maida Vale, London.

Flute, Splendid tone, German silver keys, in case complete. Offers, or exchange anything useful, cost £1 15.—JAS. R KELLY, 3, Dale street, Haslingden.

Safety, 1½ tires, solid back, cushion front; ball hubs, bracket, and pedals; exchange 5in. lathe.—MASON, 13, Tavistock-terrace, Holloway, N.

Organ Soundboard, mahogany, 28 pallets, 3 stops; also 4 stops, 28 pallets; Venetian swell (small); Reed stop, 54 pipes CC to F; Bellows and Frame, pipes, &c. A good Bourdon 16ft. CCC to F (small scale) as part exchange. Offers requested. No cards.—ALEX, 47, Halliford-street, Islington.

Small **Pistol**, few coins, two years' "ENGLISH MECHANIC" Want Magneto Machine.—J. W. DRABBLE, The Mount, Matlock.

8·0 ft. Gilt and Silvered' **Picture Cord**, New Pulvermacher Galvanic' Chain Battery, Two dozen Carbon Plates, static electrical apparatus. Exchange anything.—W. YOUNG, Aylesbury.

Coventry **Machinists** Co. 54 "Special Club Bicycle," listed £18 10s., good as new.—Below.

"**Engineers**," for 1891, also about 1cwt. of old mechanical papers Exchange for small screw-cutting foot lathe.—F. EDGE, Hurcott-road, Kidderminster.

All about **Incubators**: Wright's "**Poultry**," bound in Morocco and gold, cost over two guineas. Wanted Baugham's lathe drill chuck, stocks and dies. Offers.—Below.

Back Poppet and **Hand-rest** for a 5in. Lathe, complete. Castings back wheels and pulley for 4½ Lathe, 8in. Circular Saw. Wanted 7lb. No. 20 d.c.c. copper wire, and ½lb. No. 20 silk covered wire:

Photographic Chemicals. Pint bottle Collodion, and a quarter pint Iodising solution. Wanted, Dynamo Castings, 1½ diameter, laminated armature punchings, Sieman's type.—ALEXANDER HALL, 20, South Mall, Cork.

Will exchange large **Magic Lantern**, 10 slides, complete in case, for Lathe value £3.—ARTHUR REID, 17, Queen's-road, Coventry.

Violin, in case, splendid tone, exchange for 3-jaw chuck, or offers to value £1.—J. T. JONES, 5, Ball-court, Giltspur-street, City.

Ariston Organette with nineteen 1s. 6d. latest and popular tunes, cost little over £4 six months back, and will now dispose of it at 37s. 6d. A genuine bargain. Guaranteed perfect Seen sale or exchange. Wanted, good English Concertina.—C. STUART, 39, Russell-square, London, W.C.

Ward and Lock's "**Universal Instructor**," 43 parts, complete. Cassell's "British Battles," 35 parts, complete, bargains. Offers.—R. S., 15, Ruth-street, Bolton.

85 New **Files**, sizes 8in. and 6in. flat, round, and half-round tapers, cost 14s. What offers?—E. GOODYEAR, Radnor Park, Dalmuir, Glasgow.

Dynamo, 50c.p. adjustable Brushes, split Bearings, by Jones, eight fairy lamps, silver fairy lamp, scarf pin and accumulator, four large lamps, 12 small glass accumulators, 1½ dozen pocket accumulator cases, galvanometer, cable, &c., £4 value, exchange, worth double.—DAVIS, 22, Fernhead-road, Paddington, London.

Wanted, First Class **Violin**. Must be good tone. Exchange ½ h.p. Engine with Boiler, and Violin in case.—C. ADAMS, 3, Beverley-road, Colchester.

Stocks, Dies, and Taps, Screw-Plate and Taps and BRASS CYLINDER 1 ⅝in by 3in. Exchange for Mail Cart Wheel, and Fret Machine, or offers. Particulars. E. ANDREWS, 50, Marshfield-road, Goole, Yorkshire.

Exchange **Medium Sewing Machine**, no better made, brand new, all improvements, for good diamond frame Safety Bicycle, by good maker; no rubbish, Premier, Swift, Rover, preferred, on approval. LAWTON, Grosvenor-square, Uppermill.

"**The Encyclopædia of Practical Carpentry** AND JOINERY." Cost 38s. Wanted, Scroll Chuck, or offers.—CHAFFEY, Aldwick Cottage, Windham-road, Bournemouth.

Gas Engine, Manchester make, one-man power, in good working order. useful offers invited, no cards; or Wimshurst's.—DIBLEY, Blandford, Dorset.

New "**Auto-Harp**," Medical Coil and appliances, Double Barrel Breechloading Gun, 12 bore; Banjo, English Lever Watch. Rob Roy Canoe. What offers.—COX, "Old Post Office," Parkstone, Dorset.

Wanted Pair **Telephones**, complete. Stereoscopic Transparencies on glass. Also Dynamo 120c.p., and good safety. Offers.—COX, Parkstone.

Exchange Vols XLIX. to LIII. "**English Mechanic**," unbound, clean, and "British Journal of Photography" from May 1890, to May 1891, for one pound of 38's silk covered wire.

Pair **Telephones**, mahogany cases, good order for Vacuum tubes, or anything electrical, or offers. HORWOOD, Coalshaw-green, Hollinwood, near Oldham.

Horizontal Engine, Cylinder 4in. bore, 7in. stroke, with bed plate and part fittings. What offers?—Below.

Horizontal Engine, Cylinder 4½in. bore, 8in. stroke, with part fitings. What offers in lathe or small Engine, or tools?—Below. For further particulars apply.—JAMES ALLAN, No. 2, Hicks buildings, Walker New-road, Newcastle-on-Tyne.

Tricycle, Cripper, first class machine, almost new. Bicycle steering, 36in. side wheel, 28in. front, ball bearings throughout, except pedals. Exchange.—W. HUTCHINSON, Liversedge, Yorkshire.

Sportsman's Rifle, 380 bore, new, by celebrated makers, cleaning rod, brush, and bag, cost £5, also 5 new 4in. and 4½in Electric Bells, offers?—Below.

"**Engineer**," from March to present, with supplements Manchester Ship Canal, Chicago Exhibition; exchange for 2lb. 26 silk covered wire.—RANDLE, Crown-street, Kettering.

Large size ½-plate "**Demon**" **Camera**, achromatic lens, instantaneous shutter, and printing frame, exchange for ¼-plate lens. Offers.—COOK, Newman-road, Sudbury, Suffolk.

Fretwork Patterns, 14 assorted full size, also one volume of "The Amateur" for 1891. Offers to R. STEEDMAN, Waterside, Coleraine.

Lathe-Heads about 6in. centre, single-geared, three-speed wooden pulley, in good order. Exchange for anything useful.—Below.

Companion **Lathe** and **Fret Saw** combined, quite new, never been used. Offers invited.—GEORGE GRANT, Burn-cruinach, Gartly, N.B.

Rapid Rectilinear Lens, 7 by 5, new condition, costing 37s. 6d. with case of stops. Exchange for good 7 by 5 wide-angle Lens.—S. CLARKE, Wormwood Hill, Kirton Lindsey.

Powerful **Trayser Harmonium**, cost 28 guineas, ten stops, knee swell, new. Part exchange, Mechanical or Photographic; also Steamboat Hull for exchange.—SCRIVEN, Chelmsford.

Dulcimer, splendid. Bargain. Triple wires, in case complete. Must sell, going abroad. What offers.—GLOUGH, 29, Canal-road, Hereford.

Splendid **Oboe**, cocoa, 13 German silver keys, rings, tips, continental pitch, perfect condition, in walnut case.—65, Fisherton, Salisbury.

Mahogany **Tudor Bedstead**, very good one. Wanted, Galvanised Iron Roofing to value £2.—SUTCLIFFE, Darwin-street, Buxton.

Silver Watch, good timekeeper, old, 10s. Want Electric Bells, or anything useful.—E. MIDDLETON, 65, New Compton-street, Soho.

Photographic Enlarging Apparatus, copper and brass, four-wick lamp, 8in. condensers, new December, 1891, cost 12 guineas. Exchange Safety, or what offers? Photograph on application.—BROOKHEAD, 136, Marine Parade, Brighton.

Stereoscopic Hand **Camera**, home made, Lancaster view lenses. Can be used for ¼ plates at will. Exchange any under-mentioned articles. Will send on approval.

Good Banjo, Guitar, or **Mandolin**, English Concertina, or Violin, 5in. compound condenser, or 1½ Thornton-Pickard time shutter.—DAVIS, College-road, Cork.

Tangye's **Governors**, Borland's Injector, 6in. Steam Gauge, 2 pairs gauge cocks, stocks Large Ratchet Brace. Exchange Emery Wheels.—GEO. GRAY, Tudhoe, Durham.

Electric Motor and **Battery**, will drive lathe. Exchange for Safety Bicycle or 2½H.P. Horizontal Boiler, to value £3.—ALBERT CROUCH, Chard.

Magneto-Electric Machine, in box, cost 15s., good order, adjustable current, suit invalids. Exchange good copying apparatus, or offers.—J. W. DEAR, Baldock.

Drawing Instruments, all Stanley's make, cost £5, in Mahogany Case, all latest improvements, suitable for very exact work. What offers?—J. W. DEAR, Baldock.

Many large **Drawings**, coloured, &c., of Locomotives and details; also lecturer's diagrams of Beam and Marine Engines. List sent. Exchange offers.—J. W. DEAR, Baldock.

"**Electricity in the Service of Man**," new condition, and 16-cell Battery. Wanted, pair of chemist's scales.—H., 104, Leighton-road, N.W.

First-class **Dynamo**, will light six arc lamps. Exchange for good Gas Engine to the value of £30.—ENGINEER, 117, City-road, London.

Wanted, small Air-condensing **Syringe**. Exchange ELECTRICAL APPARATUS or books to value.—G. LARNER, Darenth Dartford.

Muspratt's "**Chemistry Applied to the Arts**," seven Vols. complete, Vol. "Engineering," about 18 parts "Amateur Work," "Faraday's Natural Forces." Exchange books or offers.—Above.

Wanted, Gas or Steam **Engine** about 2 horse-power. Exchange Bayliss and Thomas' Eureka TANDEM TRICYCLE, also half-diamond Safety, nearly new.—ENGINEER, 38, Derby-road, West Croydon, Surrey.

Quantity best cast tool-steel, new **Files**, Whitworth taps, bright steel rods. Want Watch, good timekeeper.—ADVERTISER, 3, Buckingham-street, Great Portland-street, London.

Wanted, 2 or 3in. self-centring **Chuck**. Exchange to value.—W. H. F., 4, Vine Cottages, Acton, Middlesex.

Six-air **Musical Box**, by Nicole Frères, cost £6. Exchange to value 30s., or offers.—R. GORNALL, Damside, Pilling, via Garstang.

Splendid diamond framed cushion tyred **Safety** BICYCLE, only been ridden a few times Exchange to value £10, or offers.—RD. GORNALL, Damside, Pilling, Garstang.

Seven years' nine months' "**Mechanics**," up to July last, unbound. What offers? Anything useful.—G. WEST, 6, Benslow, Hitchin, Herts.

Wanted, any the **Following**:—Trying Plane, Jack Plane, Match Plane, Rip Saw; also any books on saw filing.—S. J. WESTLAKE, Woodhall, Exbourne, Devon.

Large Persian Cat (male), handsome and clean, beautiful long, dark hair, nine months old. Exchange offers.—Mrs. Bowers, 74, Goldstone-road, Hove, Sussex.

Clarke's Magneto-Electric Machine (five large magnets), Incandescent Lamps, Batteries, also light Sparkbrook Tricycle, good condition. What offers?—Davis, 87, Fernhead-road, Paddington, London.

Whitworth Stocks and Dies (patent) for ¼, 5-16, ⅜, 7-16, ½ and ⅝, all in splendid condition. Exchange.—Pearce, Kent House, Crystal Palace-road, Dulwich.

Slide-Rest, fit 4½in. or 5in. lathe; also a 4½in. Mandrel Head. Wanted, twist drills and good chucks, files, steel, &c. —See above.

Bench Planing Machine, 15in. long, by 6in. square, divided for angles, perfect model of a larger and does useful work. Offers.—As above.

Wanted, good American Organ. Exchange 4½in. Slide-rest, small planing machine, stocks and dies, lathe heads, &c.—87, Crystal Palace-road, Dulwich.

Lathe-Bed for screw-cutting lathe, planed up, and gap pieces fitted, length 5ft., weight 1½cwt. Exchange or offers.—Address above.

Wanted, an Engine and Boiler about 1½H.P., loco. type, as used in travelling roundabouts. Offers 6in. screw-cutting lathe.—Address above.

New Ediswan Lamps, brass holders, switches, roses, wire, &c., bought for cash or exchange.—Bowron.

Any kind of small Electrical Apparatus bought. G. Bowron, 93, Praed-street, London, W.

"**Yachts and Yachting**," by Vanderdecken, published 21s. Wildfowler' "Shooting and Fishing Trips" (2 vols), published 21s. Wanted vols of Rivington's "Building Construction," Holtzapffels "Turning."—W. Dawson, 66, Southampton-row, London, W.C.

THE SIXPENNY SALE COLUMN.

Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.

New Illustrated Price List of Screws, Bolts and Nuts for Model Work, drawn to actual size, sent on receipt of stamp. —Morris Cohen, 128, Kirkgate, Leeds.

Millar's Electric Depot, 14, Deansgate, Manchester.—Best of everything electrical. Large stock. Low prices. Catalogues 3d.

Wheel-cutting and Dividing to 12 inches diameter, in brass only.—Gibson, Belinda-street, Hunslet, Leeds.

Manchester Electrical Stores.—Bentley and Co., 17, Newton-street. Bells, Cells, Wires, Fittings. Best and cheapest.

"**Heat is Simply an Overflow from the Earth.**" Post 2d.—Humphreys, Cambria-street, King's-road Fulham.

Geo. F. Chutter, Engineer, Birmingham, oldest established works in the trade. Electro plating and Polishing Plants.

Dynamos, highest efficiency, vats, fittings, and every requisite for Plating and Polishing all metals. Estimates free

Kidney Complaints, stone, gravel, inflammation, Botanic receipt, and full instructions 7 stamps.—Botanic, 136, Stockwell-road, S.W.

Brass Name Plate, 9 by 4½in., engraved, 4s. 6d. Any size to order.—Gilkes' Engraving Works, Reading.

Brass Window Plate Manufacturer.—Any shape or style engraved, complete. Lowest prices.—Gilkes' Engraving Works, Reading.

Stencil Plates for sack, box, and ticket marking. Brushes and inks.—Gilkes' Engraving Works, Reading.

Tam o' Shanter Hones.—Fine, medium, sharp qualities—razor, knife, joiner's—1s. 3d., 1s. 6d., and 2s., according to size, post free. Try these famous hones.—Tam o' Shanter Hone Co., Dalmore, Stair, Ayrshire.

Turning Woods.—Ebony, boxwood, zebra, lignum vitæ, rosewood. 6s. and 10s. parcels assorted.—Harger Bros., Settle, Yorks.

Fretwork and Carving.—Catalogue of all tools and materials with 1,000 illustrations, 6d.—Harger Bros., Settle.

Repousse, leather, picture framing, and burntwood work. List of tools and materials free.—Harger Bros. Settle.

"**Practical Dynamo Building: How to Wind for any Output,**" by Frederick Walker. Illustrated. Second edition. 2s., postage 1½d.—Iliffe, 3, St. Bride-street, E.C.

"**Tables and Memoranda for Electrical Engineers,**" by Frederick Walker. Illustrated. Interleaved white paper for notes. 2s., postage 1d.—Iliffe, 3, St. Bride-street, E.C.

Gut Bands for Lathes, Steel Hooks and Eyes. Cheapest house. Send stamp for eighth edition.—Below.

80 pages, 161 illustrations, latest improved **Tools.** Reduced prices. — Lunt, Tool Merchant, 297, Hackney-road, London, E.

Brands, Steel Stamps, Stencil Plates.—Chas. R. Hall, 63, Paradise-street, Liverpool.

Lathe Chuck, self-centring, takes ⅛ wire, to ⅜ drill. Marvellous value. 4s. 3d. free.—Below.

Economic by-pass workshop **Gas Tap.** Great saver of gas. Post free, 1s. 2d.

Bell Gimlets, steel, 18 to 30in. long, 1s. 6d., post free; bench Drilling Machine, complete, 10s. 6d.

Pocket Speed Counters, up to 5,000, 7s. 6d. free. Stocks and dies from 4s. set.

Terminals for 3in. bells, 12s. 6d. gross; Bell Cases from 7s. doz.; Brass Pushes, 3in., 8s.

Send 4d. and trade card.—**Catalogue**, Bells, Parts, Sundries. Fitter's Guide Book, 1s.—Baughan and Co., Charlbury.

Enlarged Portraits, ready for framing, for 2s. Send photo. and P.O. and 3d. postage.—Studio, Harrold, Bedford.

Fine 8in. **Equatorial Refractor**, 24in. circles, by Troughton and Simms, driving clock, complete; also observatory, suitable for above.

4in. **Refractor**, 4½in. Reflector, Gregorian, 8in. Reflector, Newtonian; all without stands.

Double-prism **Spectroscope**, with circle and vernier, almost new.

One 6in. **Object Glass**, without cell; one 18in. glass speculum, unsilvered; one 14in. glass speculum, unsilvered; one 8in. Reflector, Newtonian, with glass speculum, unsilvered.—Apply to J. M. Bryson, Optician, Prince's-street, Edinburgh, or to J. B McIntosh, S.S.C., 15, Young-street, Edinburgh.

Model Boiler, vertical steel tubular, size 6½in. by 13½in., tested to 50lb. pressure, brass fittings, perfec order, nearly new, price 17s.—Lawn, Nailsworth, Gloucestershire.

Write for **King, Mendham, and Co.'s** (Bristol) new Illustrated Catalogue, 6d. Acknowledged to be invaluable to amateurs. See front page.

"**The Wimshurst Machine,**" by W. P. Mendham, gives theory of action and many experiments. Post free, 13d.—King, Mendham, and Co.

Telephones and parts of same, and Carbon Transmitters.—King, Mendham, and Co., Bristol (see front page).

Sign-Writing Made Easy; also diagrams for marking out eight full-size alphabets, 1s.—Coulthard, Darlington-street, Bath.

Decorators' Stencils.—100 for 2s. 6d.; 60 large sheets, complete stock-in-trade.—Coulthard, Darlington-street, Bath (late Bournemouth).

Fretwork, Carving, and **Repoussé Designs.**—100 of either, 1s.; 200 Turning Designs, 1s.—Coulthard, Darlington-street, Bath.

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The **Forge** is fitted with powerful double-blast bellows, &c., for repairing mechanics' tools, brazing, &c

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The Workshop Recipe Book. Contains 500 valuable trade recipes, with instructions, most useful to all workpeople. Free, 1s. 3d.—J. Tomlin, Queen's-road, Barnsley, Yorkshire.

Castings.—Grand new Catalogue of Horizontal, Launch, and Vertical Engine Castings, Drilling Machine and Fan Castings, one stamp.—J. Tomlin, Engineer, Queen's-road, Barnsley, Yorkshire.

Malleable Iron Castings by our new process. Clean, sound, and strong as steel.—Dronfield Casting Company, Sheffield.

Anyone Wishing a New and Useful Article brought before the public, send particulars to—Gilbert and Company, 234, New Cross-road, London.

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Aneroids, open face, silvered, 30s.; good quality Pocket, 48s., first-class value. See catalogue, three stamps.

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Opera Glasses. Black Duchess, 5s. 6d.; Russian Leather, 15s. 6d. Morocco Lemaire, 14s. 6d.; Pearl, 21s. Particulars on catalogue.

Microscopes.—Student's Own, 5s. 6d.; Student, 60s.; Telescopes. Boy's Own, 5s. 3d.; Tourist, 10s. 6d.; Army, 35s.—Francois, Ryland-road.

Agricultural **Engine**, hinged funnel, 41s.; Fire Engine, 11s. 6d.: Locomotives, Fury, 5s. and 6s.; Ajax, 5s.; Ariel, 36s. 66 patterns on catalogue, three stamps.—Francois.

Bottom and Trolling Rod, ringed and fitted for winch, 5s.; Hickory do, four joints, two tops, 7s. 6d.; Hickory General, 12s. 6d., 13s. 6d., 14s. 6d., in partition bag, with spike. Hickory Fly Rods, 4s., 4s. 6d., 6s. 3d., 8s. 3d., 10s. 6d., 21s.

Salmon Rod, 21s.; Bamboo Cane, 14ft., 9s. 6d.—Francois, Ryland-road, Birmingham.

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Eight **Arc Lamps** in good order, £1 each; about 3,000 carbons, 70s. lot.—Below.

Three **Jablochkoff Arc Lamps**, on ornamental brackets, £3 the lot. Suitable for outdoor work.—Cremer, Chesham.

An assortment of new **Gas Heating and Cooking** Stoves for sale cheap.—Apply Cremer and Cheeld.

Double cotton-covered **Wire**, 16 B.W.G., 10d.; 30, 2s. 6d.; 34, 3s. per lb.—Below.

Silk Covered, 28 B.W.G., 4s.; 30, 4s. 6d.; 32, 5s.; 36, 8s.; 40, 13s. per lb.—Below.

Cardew Voltmeter, Woodhouse Ammeter. Quantity assorted Terminals, Bells, Batteries, Accumulators, Switches, &c.—Cremer and Cheeld, Chesham.

Second-hand **Electric Clock**, Hot-Air Engines, Ruhmkorff and Medical Coils, Dynamos, Motors, Accumulators.—Bowron.

Crystal Palace Electrical Exhibition, January 1892.—G. Bowron's stand is No. 171, North Nave.

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Electro-Motors from 5s.; Castings from 1s.; Dynamos from 15s.; Castings from 3s.

The 15s. **Dynamo** will light six 4-volt lamps.

Electric Bells from 2s. 6d.; Pushes from 4d.; Ruhmkorff's from 6s. 6d.; Vacuum Tubes from 1s.

Now ready, **Illustrated List** of Dynamos, Models, &c., post free, 1½d.—G. Bowron, 93, Praed-street, W.

Injectors, simple and reliable; a boy can use them, 21s., 30s., 42s. Liberal trade discount.

Injectors.—The 21s. size will supply any boiler up to 4H.P.—Powell, Engineer, Tunbridge Wells.

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The Science Co-operative Supply, Purchas[illegible] Hire, and Exchange. Largest and cheapest Scientific Store [illegible] London. Established 1862.

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Batteries and Accumulators for all purposes.—No untried novelties, but substantial, durable articles, of highest efficiency and convenience. Cheapness unmatched.

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Medical Electricity.—Every approved Faradic, Voltaic, Magnetic, Influence Machine, Belt, Bath, Test, Electrode, and Instruction Book.

Electric Wires.—Copper, Iron, German Silver, and Platinum. Cheapest new, half-price secondhand; [illegible]

Air-Pumps, Mechanics, Hydrostatics, Sound, Heat Apparatus, Mineralogical Collections, Models of Crystals. [illegible] other Lecture Necessaries.

Optics.—All kinds of Lenses, Prisms, Reflectors, Electric, Lime, Magnesium, Oil Lights, Telescopes, Microscopes, Spectroscopes, Polariscopes, Lanterns, &c.

Accessories innumerable for Exhibitions. Grand effects in Electricity, Light, Heat, Chemistry, Conjuring, at low prices. Lenses from 2d.

Photography.—First-class Cameras, Lenses, specially cheap Portrait, Enlarging, Lanterns, Lamps, Condensers [illegible], Backs, Stands, Accessories.

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Lathes.—Numerous good Bench and Foot, from [illegible] Watch and Clockmaker's Mandrels and Tools, Lapidaries', [illegible] Fret and Circular Saws, Slide-rests, Chucks.

Engines.—Half, one, two, four-horse. Scores of good Models, best Boilers, Cylinders, Pumps, Gauges, Cocks.

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Acton Vale Engineering Works, London, W., for Special Machines, and every description best work, moderate prices.

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Models.—Send for Lucas and Davies' Illustrated Catalogue, engines, castings, forgings, &c., post free four stamps.

Special Attention paid to castings, as to moulding and quality of metal. The best in the trade.

The Designs are of modern engines, all types. Triple expansion, locomotive, &c. Boilers of all kinds.

Ship and Boat Models for experimental purposes built on any given lines in wood or metal.

Models of every description adjusted or repaired and put in working order. Best workmanship. Lowest prices.

Lucas and Davies, Mechanical and Scientific Model Makers, 67, Farringdon-road, E.C. Experiments carried out.

Mackies, Limited, Sole Manufacturers of Mackie's Patent Spring Pulleys, 80,000 in use.—Berks Iron Works, Reading.

Designs Finished and Working Drawings made from rough sketches. Inventors' ideas worked out. Terms moderate.—Harrerd, 25, Percy-road, Shepherd's Bush, W.

Stained Glass Window Lead.—Moore, 35, Castle-street East, Oxford-street, London, W.

Mica or Talc Cut for all purposes. Mica covers, chimneys, &c.—C. Johnson, 140, Charing Cross-road, W.C.

Biunial Lantern, 4in. condensers, [illegible], and dis-solver, complete, £7.—4, Hillside-road, Tulse Hill.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, JANUARY 15, 1892.

PRACTICAL ELECTRIC-LIGHT FITTING.—XI.

By F. C. ALLSOP.

Author of "Practical Electric-Bell Fitting," "Telephones: their Construction and Fitting," "Electric-Bell Construction," &c.

Wood Cleats and Casing.

AS a further protection against mechanical injury, and in order that the wires may be fixed in a neat and workmanlike manner, they must be run in specially prepared wood casing. This casing consists of continuous lengths of wood about 12ft. long and 1⅛in. to 6in. wide, on one side of which are cut two grooves, at such distances from one another that there is a continuous fillet between them of not less than ⅜in. in width in the case of the small casings, and 2in. in the larger sizes. An ornamental lid is provided, which holds the wires in the grooves, the fillet quite preventing their coming together, and short-circuits thus arising.

A simpler way of fixing the wires and the one that was almost universally employed before the introduction of casing, is by means of wood cleats, a form of which is shown in section in Fig. 84. They are made of hard wood, and vary in length from 1½in. to 5in. or 6in., and ½in. to ¾in. in width, according to the size of wire they have to carry. Two grooves are cut in the cleat for the wires, and the hole through which passes the screw that fastens it down is between these two grooves. In fixing wires by means of cleats, the cleats are placed along the wires at intervals of about 12in., and the wires stretched up taut before the last two or three turns to the screws in the cleats are given. The size of the grooves in the cleats should be a little smaller than the wires they are going to hold, otherwise the wires cannot be stretched and a neat job made. Fig. 85 shows a metal clip, the use of which is similar to that of the cleat, except that a separate clip is required for each wire. This method of fixing the wires by wood cleats or clips is rarely used now, it being only suitable for temporary work, or for mills and factories, though even here it will be found advantageous to use proper wood casing. In private houses the use of cleats is quite inadmissible, as is also fastening the wires by staples after the manner employed in electric-bell and telephone fitting.

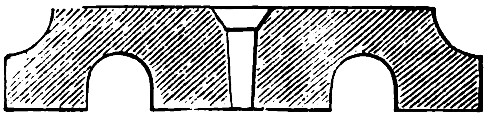


FIG. 84.

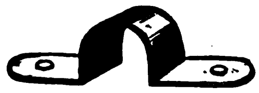


FIG. 85.

For all first-class electric light work, casing made out of the best American whitewood must be employed, and in selecting such casing, particular attention should be paid to see that the different lengths are free from knots, and have a good clean finish. A glance will generally suffice to ascertain this. In good casing the grooves and faces of the casing should be perfectly smooth and even. With the inferior qualities of wood or bad moulding machinery it is impossible to obtain this, so all lengths showing tufts or roughness should be rejected. Electric light casings are also to be obtained in yellow deal; but except for mills and factories, or where cheapness is a great desideratum, such should not be employed. Yellow deal is not near so hard as whitewood, and where "surface work" is employed, does not allow of such a neat job being made.

Fig. 86 shows a sample board of electric light casings, on which are fixed six different-size casings, with covers complete. The form of cover shown is the ordinary or plain pattern, but fancy or special patterns can of course be obtained. The following table shows the width, size of grooves, and width of fillet of the different size casings, and the gauge of wire they are intended to hold.

Conductors.		Casing.		
Size of wire, B.W.G.	No. of 16c.p. 100 volt lamps on wire.	Total width.	Size of groove.	Width of Fillet.
18	1 or 2	1⅛	3/16	⅜
16	4	1½	3/16	⅝
7/20	10	1¾	4/16	¾
7/18	20	2	⅜	1
7/16	33	2½	½	1
7/14	50	3	⅝	1
19/16	88	3¾	¾	1¼
19/14	145	4½	⅞	1½

The size of grooves given are for cables and wires with an average thickness of insulation. With very heavy or specially-insulated conductors the next size larger casing must be employed.

Where the building to be wired is in a finished state, there will, of course, be a large amount of surface work, and fancy moulded casing will frequently have to be employed. Very often the contractor will have to match samples specially designed by the architect, or supply such fancy patterns as will match the ordinary mouldings of the rooms, and harmonise with the general decorations.

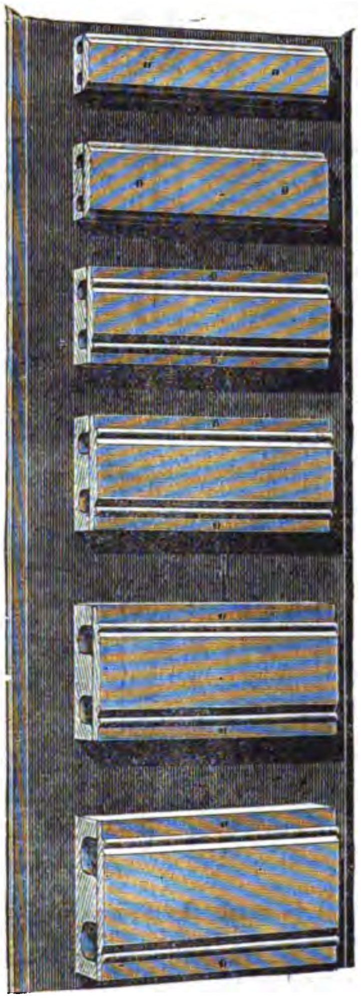


FIG. 86.

A form of the fancy-moulded casing, very useful for running wires along the top of the walls, or at the top of the dado, where the style of decoration will admit, is shown in Fig. 87. This form of casing has no base to it, the wires being merely laid in the grooves, and the casing screwed to the wall.

In wiring a building, the course for the wires having been decided upon, a hole is cut through such walls and floors as are in the path of the wires, and the casing afterwards fixed by screws, or, in the case of brick walls, by long French nails, for which the wall has been previously plugged. There are three ways in which the casing may be run—1st, on the surface of the walls, as shown in Fig. 88, which is a section of the casing and wall; 2nd, partially sunk, leaving only the lid exposed, as in Fig. 89; or 3rd, it may be entirely sunk beneath the plaster, as shown in Fig. 90. The first method, which is known as "surface work," is the easiest, and least expensive. It is usually adopted in all houses that are wired in a finished state, and also in mills, factories, and similar buildings, where the sight of the casing is not objected to. In addition to its simplicity, it has the advantage of allowing every part of the wires to be readily accessible, an advantage that is only fully appreciated either by the contractor or householder after having experienced the amount of trouble and inconvenience caused by the renewal of a faulty wire when the work is sunk beneath the plaster. In the second method, or "partially sunk work" (Fig. 89) grooves or channels are cut in the plaster (if the house is in a finished state) into which the casing is fixed, the cutting-away afterwards being made good by a plasterer. It has a somewhat neater appearance than "surface work," while it retains all the advantages as to accessibility. This method is generally adopted in buildings that are wired in carcase, though in finished houses advantage is often taken of the opportunity afforded while redecorating to sink the wires in the walls. The third method (Fig. 90) is called "concealed work," and is the one usually adopted in such parts of the house where the sight of the casing is objected to, or for houses wired in carcase. The casing is fixed directly to the brick wall, and the plaster run right over. If the casing is of large size, it will frequently be necessary to chase the bricks to allow it to sink deep enough. As to which method should be employed, of course nearly everything depends on the style and arrangement of the building, and it is very seldom that one method entirely is kept to throughout. In most cases a combination of all three will be necessary, concealed work in the principal rooms, and either surface or partially-sunk

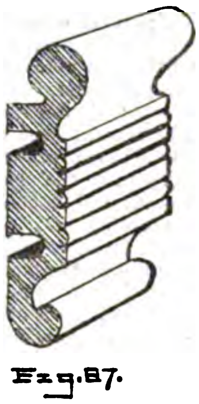


Fig. 87.

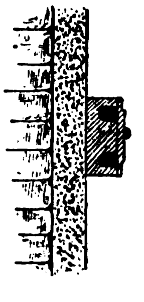


FIG. 88.

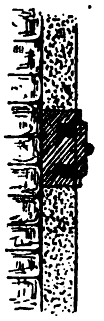


FIG 89

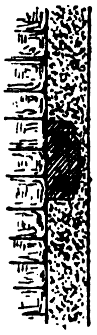


FIG. 90.

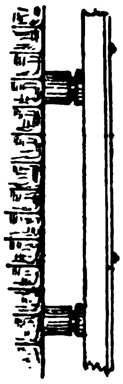


FIG. 91.

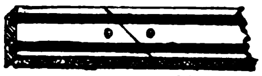


FIG. 94.

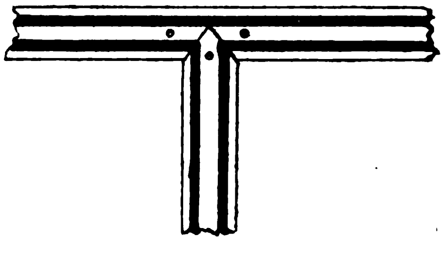


FIG. 97.

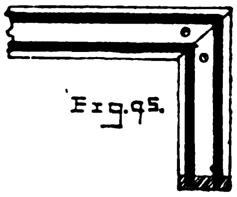


FIG. 95.

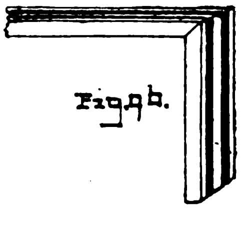


FIG. 96.

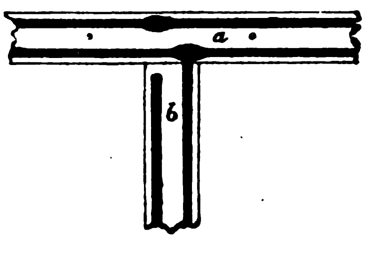


FIG. 98.

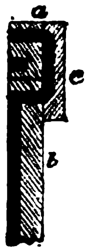


FIG. 99

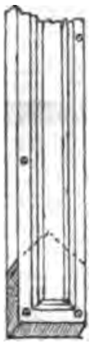


FIG. 100.

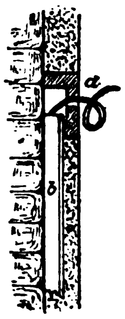


FIG. 101.

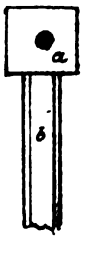


FIG. 102.

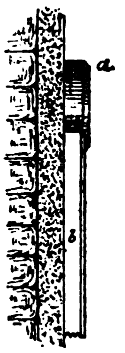


FIG. 103.

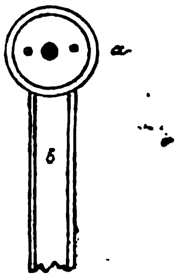


FIG. 104.

work in the basement and other unimportant parts of the house. Generally speaking, it is as well to avoid concealed work as much as possible; but where it is employed an effort should be made to get as straight a run as possible, and also to use rather large casing, in order to facilitate the drawing-in of a new wire should the insulation of one break down.

In damp situations, such as in breweries and factories, the casing should be supported off the walls by small porcelain insulators, as in Fig. 91, the same screw that is used to fix the casing passing through the centre of the insulator and holding it in place.

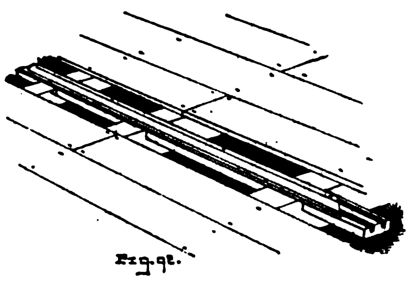


FIG. 92.

In running casing in "surface work" it should be run at the top of skirtings, round the framing of doors, &c., in fact, generally speaking, follow all angles, bends, and decorations of the room. In getting to electroliers in the centre of the room, the casing should not be taken across the ceiling, but under the floor of the room above, and the wires dropped down through a hole in the plaster to the fitting below. The method of running the casing under floors is shown in Fig. 92; that is, in cases where the direction of the wires is parallel with the floor boards. In Fig. 92 it will be seen a floor board is taken up and the joist notched sufficiently to take the casing and lid, so that the floor-board can be replaced after the casing is run. Care should be taken to see that the casing is so arranged as to come in the centre of the board, and also that the board when replaced is screwed, and not nailed, down, as the former prevents wet getting to the casing, such as from washing the floors; while the latter allows the board to be readily taken up at any future time for inspecting the wires. If the casing is of large size, this notching the joists cannot be done, owing to its weakening them, so in this case the casing must be fixed to the underside of the joists by special brackets. Where the wires run across the room at right angles to the floor-boards there is, of course, a clear run, and the casing must be screwed to the sides of the joists. To do this it will be necessary to take up a short length of every fourth or fifth floor-board, and the wires having been drawn under, short lengths of casing are fastened to the portion above the boards, and the different lengths slipped along the wires, till all that under the boards is cased; that is, presuming the casing cannot be passed along in one length.

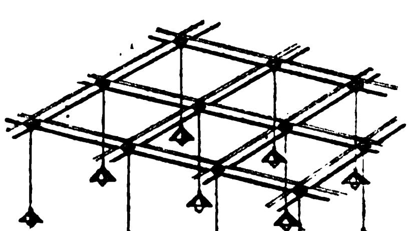


FIG. 93.

In some instances, such as in shops, offices, &c., crossing the ceiling with the casings to reach the fittings in the centre will not be objected to, and if a little care is taken to artistically arrange the lamps a very good job can be made. Fancy moulded casing should be used, and this should be run so as to appear part of the decorations. This is not always an easy matter, but in many cases can be done with the most pleasing results. A very good way that is frequently employed is to run the casing across the ceiling so as to cut it into panels, as shown in Fig. 93, a ceiling-rose and pendant light being placed at each intersection. Of course, there would not be wires in all of this casing, a greater part of it being dummy casing run to complete the panels. In crossing to a light in the centre of a corridor the casing should be run right across the ceiling to the opposite wall, as this will be found to have a better appearance than if the casing came from one wall only.

The running of casing is usually done by carpenters, two men fixing the casing, while the wireman follows on with the wires, laying them in the grooves, and making the necessary joints, the cover of the casing afterwards being screwed on by the carpenters. The usual carpenter's tools are required for running casing, those more frequently in requisition being a tenon-saw (which should be kept sharp), and a mitre-block. The casing is screwed to the wall by screws passing through the centre of the fillet, care being taken to see that long, slight screws are used, and that they are put centrally between the wires. The presence of screws or any metal work between the conductors is obviously disadvantageous, as they tend to bridge across the interval between them; therefore, no more screws or nails should be used than are absolutely necessary, and in screwing on the lid the screws should, in the larger size casings, be placed at the edges of the cover, as shown in Fig. 86. In joining the lengths of casing it is best to mitre the ends, as in Fig. 94, since this allows of a more solid junction being made. Where the casing turns at right angles, the ends must also be mitred and joined, as shown in Fig. 95, and as in Fig. 96 when the casing is on the flat, as it would be if coming from under the floor, and passing down the wall.

Fig. 97 shows how the casing is joined when it is necessary to tee a piece on, such as is the case in dropping down to a switch. The casing on the right comes from the mains and runs on the left to the lamp, the bottom piece dropping down to the switch. Figs. 98 and 99 show the method of joining the casing when taking off a connection to a lamp and switch. Fig. 99 is a section of Fig. 98. Here it will be seen the positive wire crosses the negative, and precautions must be taken to prevent its passing too close. The end of the casing *b*, it will be seen, butts on to the casing *a*, while a special grooved block, *c*, is screwed to the back of *a* and *b*. The bottom groove of the casing *a* is joined to the right-hand side one of *b*, while the top groove of *a* passes through a hole to the groove in the block *c*, and comes up through a hole in the left-hand groove of *b*. Thus the positive wire passes at the back of the negative, there being woodwork all the way between. Whenever the casing turns at right angles, the inner sides of the groove at the bend should be eased with a sharp chisel to allow the wire to set nicely at the angle, for it must be remembered that the wires cannot be bent to too sharp an angle. Also, where joints in the wire will be necessary, the grooves must be slightly enlarged for these joints, as shown in Fig. 98. The lid of the casing is fastened to the cover by screwing, small brass round-head screws being the best for this purpose, and all joints in the lid should be mitred as described for the casing. Where the casing ends abruptly, a small block of wood should be inserted, as shown in Fig. 100, and the lid carried over it, the moulding being continued round as shown.

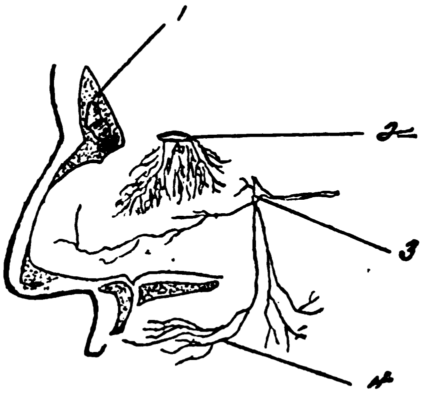
While the casing is being run, wood blocks must also be fixed, to which the switches and fittings are afterwards fastened. With "concealed work" the method of doing this is shown in Figs. 101 and 102, Fig. 101 being a section of Fig. 102. A square wood block, *a*, is procured, the back of which is grooved to receive the casing *b*, and the ends of the wires are brought out through a hole as shown. The block is nailed to the wall with stout floor brads, and the face of the block comes flush with the surface of the plaster. Figs. 103 and 104 show how the blocks are fixed in "surface work," special round, polished walnut or mahogany blocks being used. Fig. 103 is a section of Fig. 104. In the figures, *a* is the block and *b* the casing, which, it will be noticed, is stopped at the edge of the block, the end of the casing being cut round so as to fit hard up against it. The two wires come through a hole in the centre of the block, the block being fixed by the two screws shown.

In damp places, or where it is desired to take extra precautions, the casing and lid should be served with a coat of shellac varnish both inside and out, and then left to thoroughly dry before being erected. Another coat is frequently given when the casing is fixed and the wires in place, and a third after the lid is on. This entirely prevents the casing afterwards absorbing moisture, as might otherwise be the case.

PRACTICAL MICROSCOPY FOR STUDENTS.—XV.

By FREDERICK DAVIS, B.Sc.

THE sense of smell is intimately acquainted with the sense of taste; so much so, that many people devoid of the sense of smell are also devoid of that of taste. The nose is the active organ for the sense of smell. Its parts may be described as, firstly, an anterior portion called the "anterior nares," and a hinder portion termed the "posterior nares."



Section of Nose, showing Right Nasal Chamber.

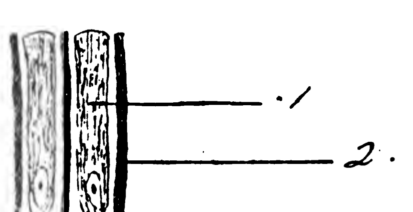
1, Bone; 2, Olfactory lobe of brain with nerves; 3, Branches of fifth cranial nerve serving nose; and 4, Palate.

The anterior nares is divided into two parts by a bone called the "septum." Above this, separating the nose from the cranial cavity, is the cribriform bone, which is perforated for the purpose of permitting the branches of the olfactory nerve to arrive at the top of the air passage, and thus by sniffing we have the sensation known as smell.

In ordinary breathing the odoriferous particles do not rise sufficiently high in the nose to touch the olfactory nerve, and consequently smell does not occur unless an extra inspiration, or so-called sniffing, is indulged in.

The inside of the anterior nose is supplied with little scroll-like bones termed the superior, middle, and inferior turbinal bones. These exist upon the outside of each nasal chamber, and are covered by the mucous membrane.

The nose is separated from the mouth by the palate. The chief organs of smell are really the olfactory cells, which are extensions of the olfactory nerves; it would appear, therefore, branches of the olfactory nerves, terminating each in an olfactory cell; that the odoriferous particles must first influence the cell, and the cell conduct the impression to the nerve itself. The upper portion of the nasal chambers are lined with mucous membrane, rich in epithelial cells, the form of which we have previously studied as columnar or cylindrical. The nerves of the organ are chiefly situated at the upper portion; indeed, the mucous membrane covering the superior and middle turbinal bones, together with the tops of the septum, is richly endowed with branches of the nerves from the olfactory bulb. The lower portion of the nose, that is, the inferior turbinal bone, is covered with ciliated epithelium, and is supplied with nerve branches from the fifth cranial.



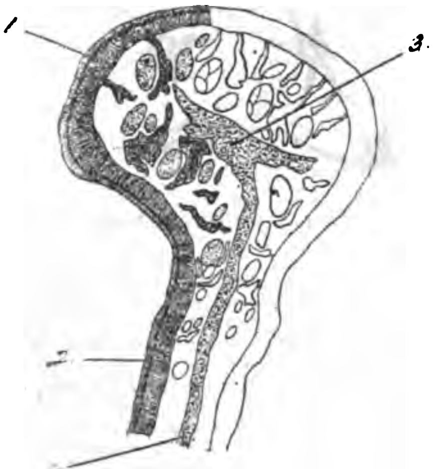
Olfactory Cells.

1, Epithelial cells; 2, Olfactory cells.

The microscopical student will observe the nerves of the upper portion of the nose are those known as non-medullated; it is also curious the upper portion of the epithelium should be destitute of cilia, while the inferior portion is so richly supplied. The student will now understand how it is that in foggy weather the lower portion of the nose, as it were, filters the air in its passage over and through the cilia, and, therefore, how the basal portion of the nose is rendered black by the organic matter which the fog contained. The accompanying sketch will render clear the position of the olfactory cells in connection with the epithelium.

The senses we have so far reviewed cannot be stated to be in any way complicated; but the sense of hearing and its organisation is, to say the least, not simple, but, together with the sense of sight, somewhat complex. The "ear" is, as a matter of convenience for purposes of study, divided into three parts: Firstly, the "external"; secondly, the "middle"; and, thirdly, the "internal" ear. The former of these is of very little interest to the microscopist, excepting from the fact that the skin which lines the passage from the "pinna" inwards along the external auditory meatus is supplied upon its outer parts with a number of glands, which secrete the wax of the ear, termed cerumen. The student should carefully apply himself to the structure of these glands. The middle ear or "tympanum" is of no interest to the microscopist; the student, therefore, desiring a knowledge of its structure is referred to physiological works.

The internal ear is most interesting, and, although its physiology will not be entered into here, a sketch is given of the parts with which the microscopist may be expected to have some acquaintance. The section shown is magnificent, about four hundred diameters, and made through the scalia media of a subject dead about six hours. It sufficiently explains itself. Turning our attention to the structure of the eye, we have one of the most beautiful studies for the microscopist. Each eyeball is hollow and spherical, opaque, and of a whitish colour, excepting in front, where it is perfectly transparent. If we cut the eyeball entirely through with a sharp razor, or scalpel, we shall find it to be possessed of three distinct coats. These are termed—starting from the outside—the sclerotic, the choroid, and the retina, respectively. The last of these is a beautiful layer of nerves, netted together, forming a kind of mesh-work, and extending over the back and sides of the interior.

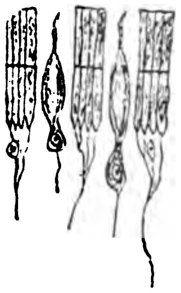


Section through the Olfactory Region.

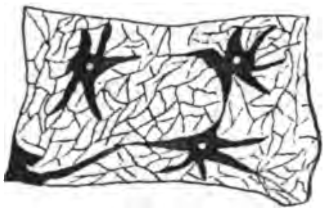
1, Thick epithelium; 2, Thin epithelium; 3, Bone.

If we cut through the front portion of the eye, namely, the transparent part, or cornea, we find, situated immediately beneath, a space filled with aqueous humour, deriving its name from the fact of its watery character. Immediately behind this, we have what is known as the "crystalline lens"; this is more dense in character than the former, but still transparent; and directly behind the crystalline lens we find the "vitreous humour," which fills the entire internal cavity of the eyebal Respecting density, it is intermediate in charact between the crystalline lens and the aqueous humour.

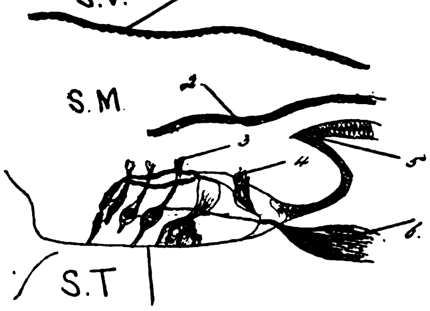
In examining microscopically each individual coat, we shall observe the "sclerotic" is composed of tough fibrous tissue. The choroid coat is, as we found, internal to the "sclerotic," and consists of two layers, an outer vascular membrane and an inner layer of polygonal cells, charged with brown or black pigment. The choroid, as it nears the edges of the cornea, arranges itself in folds, termed the ciliary processes. In the public mind there appears to be some little doubt as to the exact position of the "iris"; we will endeavour, therefore, to look into this closely, and clear away any doubts which may exist. We saw that immediately behind the "cornea" we found the space filled with aqueous humour; if we carefully remove the aqueous humour, we shall see behind it a kind of muscular curtain, in some cases one colour, and in others another colour, depending upon the individual from whom the eye was removed. It is to this the name of iris is, and should be, applied, so that we see in the centre of the iris, or coloured portion, we have the pupil—the pupil existing for the purpose of admitting the eye or retina, which is, as it were, the screen upon which the image looked at is thrown. We have behind the iris the portion previously described as the crystalline lens. It has the power of refracting light to a great extent. Now, if the student will closely examine this lens, he will find it to be composed of fibres arranged in layers or plates—in fact, if he hardens its substance by boiling in water, he will be able to peel off the layers, seriatim.



Section of Retina, showing Rods and Cones.



Section of Choroid Coat, showing Pigment Cells.



Section through Scala Media of Ear.

1, Reissner's membrane; 2, Membrane tectoria; 3 and 4, Hair cells, with hairs projecting; 6, Cochlea nerve; 7, Basilar membrane; 5, Crista Spiralis, S.V. Scala Vestibuli, S.M. Scala Media, S.T. Scala Tympani.

The lens is held in position by a special ligament. I have found in days gone by that the eye from a boiled mackerel is very good for demonstrating the peeling of the layers in the crystalline lens. Between the ciliary processes and the sclerotic we have a mass of muscular fibres, which, upon examination, will be found to be unstriped. This constitutes the ciliary muscle, which regulates the size of the pupil of the eye when a strong or weak light is thrown upon it. Of course, generally speaking, the stronger the light the smaller the pupil, and vice-versâ, excepting by special treatment, as, for instance, when the ciliary muscle is paralysed by some drug, such as physostigmine, atropine, &c., for medical examination, certain drugs having the power to dilate or contract the ciliary muscle as required.

It is an observed fact that, generally speaking, opium eaters, or laudanum takers, have very small pupils, sometimes not exceeding the point of a pin's head. We stated the "retina" covered the whole of the back and sides of the internal eye; it is in this way the optic nerve enters the back of the eye, through the sclerotic and choroid layers, and then, extending itself, forms the retina. The point of entry of the optic nerve is termed the "blind-spot," because this spot is insensible to light. The spot most sensible to light in the eye is that known as the "Macula lutea," or yellow spot; in the centre of this spot we have a little depression termed the "fovea-centralis."

To clearly understand its position, if we cut across an entire human eye in a vertical manner, so as to divide into anterior and posterior halves, we shall see upon the posterior half, nearly facing the pupil of the eye, this "yellow spot" I have stated "human" eye because in some animals this spot is not present. The portion of the eye of greatest interest to the microscopist is undoubtedly the retina; but before it can be subjected to microscopical examination special treatment is required. The eye must first be soaked for the space of at least three weeks in "Muller's fluid," the sclerotic having been previously pierced that the fluid may the better penetrate its substance. After becoming well hardened, remove very carefully the retina, or a portion of it, by means of a needle, being exceedingly careful not to tear it in any way, then imbed in wax, and cut a *thin* section, perpendicularly. This may then be placed in spirit, and floated off, &c., as in preparing the section of the spinal cord previously described. Stain with carmine solution, soak in spirit, then in absolute alcohol, clear, and finish the mounting as usual.

It will be found the rods and cones of this section will exhibit themselves well by this treatment. It will also be observed they are most abundant in the immediate vicinity of the "yellow spot," and least abundant around the entrance of the optic nerve or blind spot. In the section here depicted we have a layer consisting of an immense number of cylindrical bodies termed "rods," arranged perpendicularly to the retina's surface, and other pyriform bodies, termed the "cones." The outer granular layer is composed of a number of granules, and passing from these granules nerve fibres; it will be noticed also the nerve fibres pass through the inner granular layer to the ganglionic corpuscles. The optic nerve will be observed to be possessed in its centre of one comparatively large artery, which, of course, supplies it with its blood. Muller's fluid is composed of bichromate of potash, two and a half parts sulphate of soda, one part dissolved in distilled water to form one hundred parts.

A CARPENTER'S BENCH.

THE carpenter's bench as shown in Fig. 1 is more suitable for an amateur than a professional, as the latter generally has ample room in the workshop for all tools. The accompanying illustration might well be called a "Multum in Parvo," the idea being to make as much use of the spaces about the bench for storing the tools, so that I claim where the amateur has not much space to spare, this is a great advantage.

The bench as drawn is 8ft. long, 27in. wide, and 2ft. 6in. high, not including the top. The great idea in a bench is that it must be firm and strong; a bench that shakes or springs when working upon it is no use; consequently the material used must be of a substantial character. The general idea of Fig. 1 is, first, a fair size bench; secondly, a cupboard formed underneath for keeping planes, &c.; a shelf at the end for glue pot and oddments; thirdly, a rack fixed at the back for chisels, gouges, gimlets, &c. This not only means being able to find one's tools when wanted, but also it ensures the chance of having a clear bench for working on; and finally, there is still space left underneath for shavings.

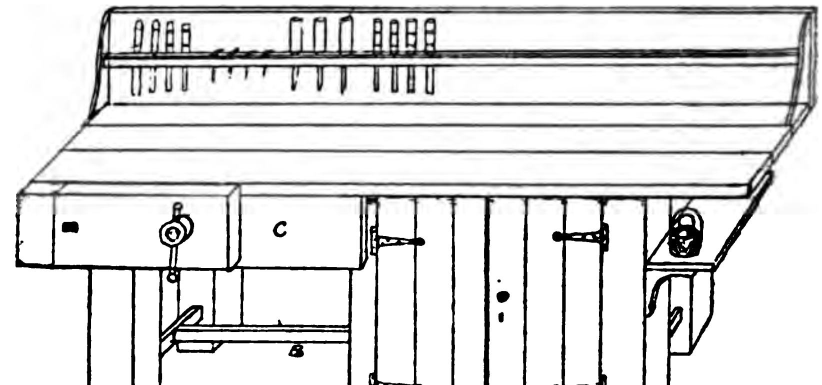


Fig 1

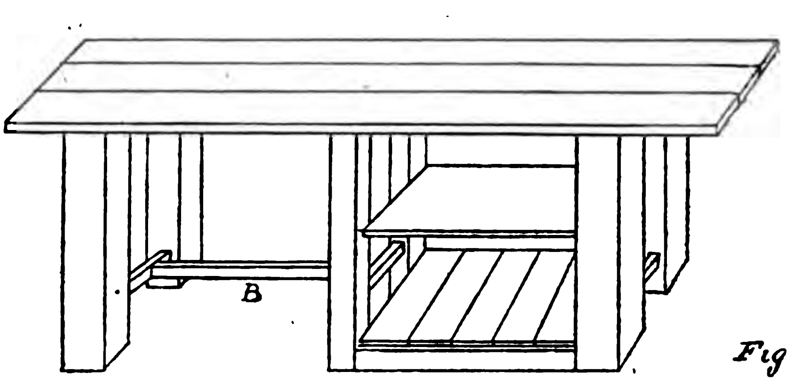


Fig 2

Fig. 2 shows the interior of cupboard; but in order to proceed to make the bench, I must refer my reader to Figs. 3 and 4, showing the legs of bench. These are 5in. sq., 2ft. 6in. long, the cross-piece of the same size stuff and 25in. long, the idea being that the bench top must overlap the legs 1in. in front. Fig. 4 shows the method of fixing the cross-piece to the legs by what is known as halving, and fixed together with stout screws or nails. The lower rail A (Fig. 3) is of 3in. by 2in. quartering, mortised each end into the legs, as shown. The centre legs and cross-piece are of 3in. stuff, with lower rail 3in. by 2in., the lengths the same as the larger legs. The bottom of cupboard is raised from the ground, and rests on pieces 2in. square, mortised into centre and end legs both back and front, and measures 2ft. 6in. long when fixed. The large legs are 6ft. apart, out to out, and, having placed them at their respective distances, the proper length of the stretcher-bar B (Fig. 2) can be arrived at, which is morticed into the lower bars A on end and centre legs.

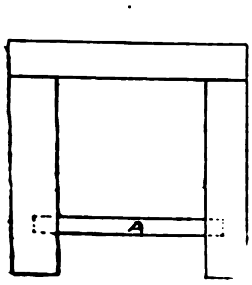


Fig 3

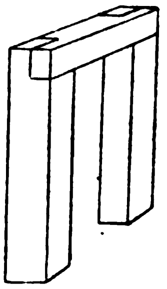


Fig 4

The bench-top is formed of three 9in. boards, 1¼in. thick, planed on the top side and edges, or could be planed both sides, so that at any future time it could be turned should the top side become much cut about; and I have found the best way is to fix each board separately with screws (starting with the front one, which, as has been mentioned, overlaps the legs 1in.); by this means, should the wood be new, the joints will in time open, then the second and third board can be unscrewed, and jointed up close again. In the event of boards of less thickness being used, I should recommend that they are braced underneath between the legs, to prevent any spring, fixing the braces with screws. The cupboard should be lined throughout with matchboarding, which is the neatest and least expensive for this purpose, including the floor, leaving a rebate of ¾in. in the front for the doors. These are also easily made of matchboard, ¾in., with cross-pieces inside, each door being 1ft. 3in. wide, and hung with two pairs of 8in. japanned hinges, known as cross-garnets. One shelf inside, fixed on fillets and so placed that the door shuts on to it.

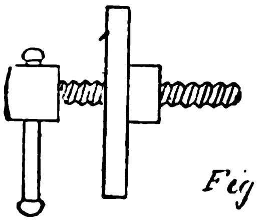


Fig 5

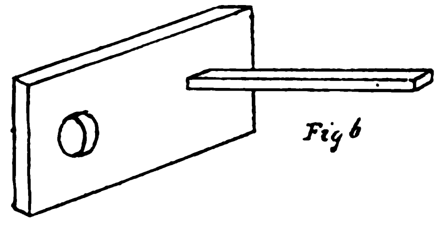


Fig 6

The front board C is 9in. by 1in., screwed on to the end and middle leg, and fitting flush with the ridge of the bench, and against which the bench screw is fixed (see Fig. 5). The wood constituting the bench vice should be at least 2in. thick, 18in. by 9in. wide. The runner (shown in Fig. 6) should be the same length as the bench screw, fitting into a loose box. This is the ordinary method of fitting a bench screw, but the chances are when clamping any piece of wood the bench vice will become strained, and the parallelism between the bench front and bench vice not regular. A very good method is to have the runner below and in a line with the bench screw (see Figs. 7 and 8), but in event of this being used, the bench-board C must be fixed vertically, as the leg is too thick for the screw and runner to work through. The board at the back for the tool-rack is 11in. wide, ¾in. thick, screwed on the edge of the top and strengthened by wooden brackets at each end; a small bracket is fixed on the right-hand legs for the glue-pot, nail-box, &c., which will, I think, complete the bench with one exception—viz, the bench stop, of which there are various kinds to be obtained from the tool dealers.

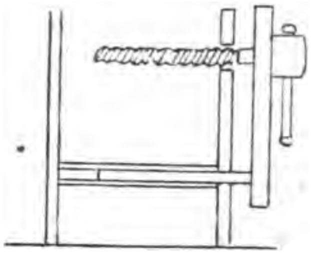


Fig 7

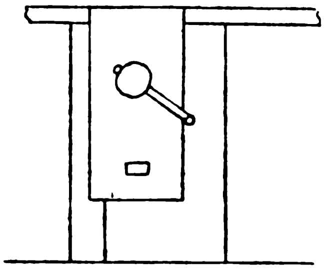


Fig 8

S. Walter Newcomb.

THE OPTICAL LANTERN: ITS CONSTRUCTION AND USE.—VIII.

By CHAS. A. PARKER.

Preparation of Oxygen and Hydrogen Gases.

THE limelight, which is of English origin, may be said to date from the days of the eminent scientist, Sir Humphrey Davy, who, in the course of some experiments with explosive gases, found that a great many substances hitherto regarded as infusible could be readily melted by a mixture of oxygen and hydrogen gases forced through a fine jet at great pressure. The apparatus employed in these experiments was an ingenious form of blowpipe—invented by a philosophical instrument maker named Newman—in which the gases were expelled through the nozzle or burner of the containing vessel by means of a force-pump. With this blowpipe it was found possible to obtain a powerful flame capable of readily fusing some of the most refractory substances, including platina, lapis lazuli, emerald, rock crystal, quartz, flint, talc, alumina, and lime—the latter, when subjected to the influence of the flame, emitting a most powerful and dazzling light. As the result of subsequent experiments, Lieut. Drummond, R.E., in the course of a paper communicated to the Royal Society in 1826, advocated the use of this light in signalling operations, and, as a consequence, it came to be generally known by the name of the "Drummond," or lime light.

Before entering upon a description of the various methods of producing the gases and the apparatus employed in so doing, it may, perhaps, be advisable to give a brief *résumé* of the operations involved in preparing oxygen gas from chlorate of potash, which is the method almost universally adopted by the majority of lanternists of the present day. From what has already been said, it will be understood that the illuminating properties of the limelight emanate from a cylinder of unslaked lime, which is rendered incandescent by the impact upon its surface of a stream of oxygen gas that is either blown through, or mixed with, a hydrogen or other flame, the light thus produced, which scarcely exceeds the size of a pea, being remarkable for its steadiness and intensity. Oxygen, which is the most important of the two gases, is readily produced by placing over a gas-stove or an ordinary fire a metal retort charged with a mixture of chlorate of potash and black oxide of manganese. In a very short time oxygen gas is evolved in great abundance, and may be conducted to a wash-bottle containing water by means of a suitable length of rubber tubing led from the delivery tube of the retort. In passing through the water the gas becomes cooled and purified, and may be passed from thence through another length of tubing direct into a large, wedge-shaped bag of mackintosh or indiarubber cloth. This bag, when filled with gas, is placed between a pair of hinged pressure-boards, and upon a narrow shelf attached to the upper board several heavy weights are placed, for the purpose of forcing the gas out of the bag at the required rate, through suitable tubing, direct to the jet. The other gas used in conjunction with the oxygen, which is called hydrogen, may be easily prepared by the action of dilute sulphuric acid upon scrap zinc, the gas as generated being passed through a purifier direct into the gas-bag, ready for use, from whence it is forced through suitable tubing to the jet at a uniform pressure with the oxygen. As will be subsequently shown, there are several other flames which may be substituted for the hydrogen, in order to maintain the combustion; but with any of these lights an abundant supply of oxygen is of first importance, for although this gas does not burn of itself, it is a great supporter of combustion, and as such is consequently employed for the purpose of intensifying or enriching other flames.

When oxygen and hydrogen gases were used in the production of the limelight, it was formerly the rule to combine them in a separate cell or chamber, from which they were led direct to the jet; but as these gases form a highly-explosive mixture when combined, the plan was not infrequently attended by much damage and loss of life, which led to its being discarded in favour of the arrangement in use at the present time, in which the gases are not mixed until they arrive by separate pipes, at the nozzle of the burner. The gases, upon being ignited, give very little light, but an intense heat, which will almost instantly melt the most obdurate metals, and upon approaching a piece of lime sufficiently near for the flame to play upon it, the lime is speedily rendered incandescent, in which condition it emits an intense light, which is aptly termed the "lime-light."

Having given an outline of the operations involved in the preparation of the gases for the limelight, it behoves us to describe the same in detail, commencing with the oxygen, which can be made in several different ways, most of which are, however, merely of interest to the experimentalist. The word "oxygen," which is derived from the Greek, means literally "acid producer," and was given to this element on account of the belief of the acidity of all acids being due to the presence of oxygen, and although the fallacy of this supposition has since been proved, the name is still retained as a well-known or useful appellation. When we consider that oxygen forms at least 75 per cent. of our globe, it naturally follows that it should be possible to obtain it from a variety of substances in many different ways. But although it surrounds us in such abundance, it is not so easy to obtain it in an uncombined form, as it is invariably associated with other bodies, so that we are confined to comparatively few processes for its production, usually selecting those from which it can be obtained with the greatest ease and cheapness. As the manner in which it is prepared does not affect the gas in the least, it is useful for the operator to be acquainted with other methods of preparing it besides one, as this is sometimes very handy in cases of emergency.

First Process.—When this gas was first discovered by Dr. Priestly in 1774, he obtained it from the red oxide of mercury. This substance, when heated, rapidly darkens, and then separates into its two constituents, mercury and oxygen, the latter being given off as a colourless gas. This method is, however, only of interest to the experimentalist, as the cost of the material precludes the possibility of its practical utility. *Second Process.*—If peroxide of manganese is subjected to a powerful heat in an iron retort, it gives off oxygen freely, and when the action has ceased the peroxide may be exposed to the action of the atmosphere, from which it will absorb sufficient oxygen to enable the process to be repeated. *Third Process.*—Equal parts of black oxide of manganese and sulphuric acid put into a glass retort and then heated will freely evolve oxygen. *Fourth Process.*—Put three parts of bichromate of potash and four parts of sulphuric acid into a glass retort, and then apply a gentle heat, when the gas will come off in a sufficiently pure state to be at once conveyed to the gas-bag.

The *fifth process*, which is simple and cleanly, is also perfectly safe, and may occasionally be found useful when chlorate of potash is unobtainable, as the only materials required will be some ordinary bleaching powder (chloride of lime) and peroxide of cobalt. Put a pound of fresh chloride of lime into a suitable vessel, and cover this with a quart of cold water, stirring it up frequently for about an hour, in order to dissolve as much as possible of the lime. Now strain off the water carefully, and pour it over another pound of lime, which is treated the same as before, a third and fourth treatment also being possible when a considerable quantity of gas is required. The solution should now be filtered through a piece of calico into a bottle of suitable size, as it should be borne in mind that a bright and clear solution always gives the best results. A Winchester quart bottle will be found very useful for this purpose; the thinner the glass the better, as it will then be less liable to crack when warmed.

Now add to the liquid contained in the bottle a small quantity of a solution of peroxide of cobalt, prepared in the manner about to be described, and then quickly stop the mouth of the bottle with a good sound cork, to which a bent-glass or metal tube has been attached for the purpose of carrying off the gas. A suitable length of rubber tubing should now be brought from the delivery-tube and then connected with the gas-bag; but in this, as in every other method of oxygen-gas making, the first portions should always be allowed to run to waste. The gas will come off immediately; but if the bottle is immersed in hot water of the temperature of about 100° to 120°, the delivery of the gas will be greatly accelerated—a higher temperature than this should not be applied to a thick glass bottle. When the action has once commenced, it will continue until all the gas has been evolved, and as it is never violent there is consequently no danger. There may be a slight frothing at first, but this will soon subside. When the action has quite ceased, the solution may be poured into a basin and then diluted with water, and as soon as the peroxide of cobalt has subsided, it may be washed and preserved moist ready for use again and again in the same manner.

To prepare the peroxide of cobalt mentioned above, dissolve 50 grains of nitrate of cobalt in an ounce of water, and then add chloride of lime to the clear solution until it ceases to throw down a precipitate. This precipitate, which is a dark-brown colour, is the peroxide of cobalt, and may be washed and preserved ready for use in a bottle containing a small quantity of water. The above method of preparing oxygen is very useful to adopt when the operator is unable to procure chlorate of potash—as chloride of lime can generally be obtained in almost any out-of-the-way place—and it will not be much trouble for the lanternist to find a place in the lantern-case for a bottle containing the peroxide of cobalt.

Sixth Process.—We now come to the method of making oxygen gas from chlorate of potash, which is now almost universally adopted by all lanternists who make their own gas. Chlorate of potash contains chlorine 35·5 parts; potassium 39·1 parts, and oxygen 48 parts by weight. This substance, when exposed to heat, fuses at 400°, and liberates oxygen freely at 600°, so much so in fact, that it becomes necessary to control its violence by the addition of some such substance as sand, black oxide of copper, or more frequently black oxide of manganese. The chlorate of potash should be mixed together with the black oxide of manganese in the proportion of 2lb. of chlorate to 1lb. of manganese: but the exact proportions are immaterial, indeed, a great many lanternists mix them entirely by guesswork. The manganese should be crushed in a powder, as lump manganese necessitates a higher degree of heat; but it is best to use the chlorate in the form of crystals, which should not be broken unless they are of unusual size. If the chlorate is powdered as well as the manganese, the gas is apt to come off with too great a rush, which is apt to choke the delivery-tube of the retort. The mixture should be heaped together upon a sheet of paper, of convenient size, and then thoroughly incorporated by means of a stick of wood or a bone paper-knife, after which the black mixture thus formed will be ready for immediate use. The mixture may be stored in a wide-mouthed glass bottle of known capacity, as it will then be a simple matter to measure out the quantity required for the production of a given number of cubic feet without the trouble of weighing it.

Retorts suitable for oxygen gas-making are constructed of iron or copper, brazed together in the form of a cone, which is provided with a convex bottom. A removable brass cap is attached to the top of the retort by means of a screw thread, and from the side of this projects a short length of wrought-iron tube for the purpose of carrying off the gas as fast as it is generated, an indiarubber tube subsequently connecting this with the purifier. A great many retorts now made are provided with safety-valves at the top, in order to guard against any explosion caused by the delivery tubes becoming choked. The best form of safety-valve takes the form of a short tube fitted with a cork, which flies out if the pressure becomes too great; but if the delivery tube of an ordinary retort is made reasonably wide, there need be no fear of such a mishap occurring. Before use it is of great importance to see that the retort is perfectly dry, and entirely free from any bits of paper, straw, or other ignitable foreign matter. This is a necessary precaution, as a new retort is liable to contain a few traces of packing straw, or dust, and if such substances are present, they will in all probability cause the chlorate to ignite when the retort is heated, and such a mishap occurring in the presence of a large body of oxygen, would be attended by an explosion of a more or less serious nature.

All being ready, the requisite quantity of the mixture is emptied into the retort by means of a paper funnel, care being taken not to leave any of the crystals adhering to the upper connections of the retort, after which the branch pipe is screwed down tight with a small leather or asbestos rubber washer between the joint, in order to make it air-tight, and thus prevent any escape of gas. When the retort has been charged, it should be placed over a moderate fire, or, better still, a Fletcher's ring gas burner, as the flame, and consequently the gas, will be under proper control, enabling the correct degree of heat to be maintained, so that the gas can be regulated to a nicety. The retort is now connected with the wash-bottle by means of a piece of stout rubber tubing about 3ft. or 4ft. long, one end of which is now drawn for about a couple of inches over the delivery tube of the retort, the other end being afterwards attached in a like manner to the inlet pipe of the wash-bottle or purifier.

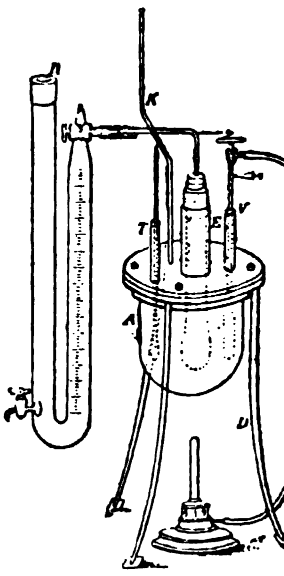
For the first named, an ordinary wide-mouthed Winchester quart bottle will be found to answer very well, provided that the cork is fitted with a couple of metal, or glass, tubes to serve as inlet and outlet pipes for the gas. These tubes should be so arranged that when the bottle is connected with the retort, the inlet pipe conveying the gas into the bottle shall dip down nearly to the bottom of the liquid, with about 3in. of the lower portion of the tubing pierced with half-a-dozen small holes in order to prevent any violent ebullition; the other tube, which leads the gas out of the bottle to the bag, being cut off flush with the cork on the inside. A purifier employed for the same purpose can also be had, made in zinc, the inlet and outlet pipes being arranged in precisely the same manner as a wash-bottle, either of these, when in use, being three-parts filled with cold water.

From the above it will be understood that the gas, in entering the wash-bottle, or purifier, by means of the inlet-pipe, bubbles through the water, and in so doing becomes cooled and freed from any impurities that may have come over with it, the gas making its exit from the bottle by means of the other tube, which is connected with the gas-bag by means of another suitable length of rubber tubing.

(*To be continued.*)

ANALYSIS OF BEESWAX.

An adulteration of beeswax with less than 6 per cent. of ceresin or paraffin cannot be detected with certainty by any of the ordinary methods, because the relations between the free fatty acid and saponifiable and unsaponifiable matters in genuine beeswax vary within somewhat considerable limits. The detection of smaller quantities of these adulterants can only be made possible by a direct determination of the hydrocarbons present, and the author describes a modification of a method recently brought out by A. and P. Buisine (this journal, 1891, 52 and 729) with that object. The method is based on the observation of Dumas and Stas, that if a saponified wax be heated with potash lime, the fatty alcohols are decomposed with formation of fatty acids and evolution of hydrogen, the volume of which becomes a measure of the fatty alcohols present, while the hydrocarbons may be dissolved out of the residue and weighed. The recent improvements of the method consist in the simplification of the apparatus, and a more exact knowledge of the conditions to be observed. From 2 to 10 grammes of the wax are saponified by melting with potash lime. The solid dry soap is then powdered and well mixed with three times its weight of potash lime, and placed in a strong pear-shaped flask, in which it is heated to 250° for two hours. The apparatus for conducting this operation is shown in the sketch. A is an iron vessel, with a lid fastened down by screws, and filled with mercury. The flask or eprouvette E is connected, gas-tight, with a Hofmann's burette, H, for measuring the hydrogen evolved. T is a thermometer, and V a temperature regulator. K is a condensing tube for mercury vapour. The author recommends that the heating at 250° be continued for three hours to secure completion of the reaction, after which the flask is allowed to cool, and is broken up to liberate the residual mass, which is then powdered and extracted with petroleum spirit in a Soxhlet apparatus. The residue left on evaporation of the petroleum spirit is dried at 110° and weighed.



Genuine beeswax examined by this method gives always some hydrocarbons; but the experience of the author and other observers is to the effect that the quantity is almost invariably between 12·5 and 14·5 per cent. The mean of these quantities, or 13·5, must therefore be deducted from the total hydrocarbon found, and the difference is the amount of hydrocarbon added by way of adulteration. The results of numerous analyses accompany the article.—C. Mangold, in *Chem. Zeit.*, *Jour. Soc. Chem. Ind.*

ELEMENTARY PRINCIPLES GOVERNING THE EFFICIENCY OF SPECTROSCOPES FOR ASTRONOMICAL PURPOSES.—II.*

By James E. Keeler.

We have shown that for certain objects a small telescope gives as bright a spectra as a large one; indeed the small one has the advantage, since its object-glass is thinner and absorbs less light. The beginner might then naturally ask why a large telescope is desirable for spectroscopic work. The answer is that for such objects there is no advantage in a large telescope, but all objects which we have to examine are not extended surfaces like the sun and moon.

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[*] From the *Sidereal Messenger.*

The case which is furthest removed from that which we have considered, is that of a star. The image lens may then be properly called a condensing lens, since the brightness of the spectrum, as well as that of the image, will depend on the aperture of the lens. In a stellar image we cannot discriminate between quantity of light and brightness. The spectroscope slit is in all cases so narrow as just to include the image, and all the light of the star goes into the spectrum. Hence increasing the aperture and focal length of the collimator does not increase the brightness, although, as the same slit-width then subtends a smaller angle, it increases the purity of the spectrum.

The other extreme in the character of the source of light is when the angular magnitude of the object is as great as the angular aperture of the telescope. Seen from the slit, such an object would completely fill the opening occupied by the object-glass, and the removal of the object-glass would increase its apparent brightness. The brightness of the sky spectrum, for instance, is greater when the object-glass of a telescope is removed. It is obvious that for such objects better results can be obtained without a telescope.

A practical case of this kind occurs in astronomy. For observing the spectrum of the aurora, or of the zodiacal light, no telescope should be used. The aperture of the spectroscope should be as large as possible, and (from considerations of convenience and portability) the collimator and observing telescope should be short.

The same construction may be extended to meet the case of bodies of no larger angular magnitude than the sun and moon. If the angular aperture of the collimator is $\frac{1}{2}$°, i.e., if the focal length is 115 times the aperture, the solar spectrum obtained with a given spectroscope when the collimator is pointed to the sun is the brightest possible. The telescope or image lens is here dispensed with. Considerable advantage may sometimes be gained by applying this principle, particularly in laboratory work where a heliostat is used, and where the use of a long collimator is attended with no inconvenience. In measures of the heating effect in different parts of the spectrum, for which rock salt lenses and prisms are used, the saving of an additional lens is a matter of some importance.

It will be a noted that a spectroscope of this construction is necessarily an *integrating* spectroscope, and it cannot be used to study the spectrum of any particular part of the luminous source. An attempt to apply the same principle to the other heavenly bodies presenting sensible discs would be rendered futile by the excessive length of collimator required.

We have still to consider the case of bodies of small angular magnitude like the planets.

In this case the image of the object does not cover the entire length of the slit. To form a clear idea of the conditions of efficiency which depend upon the size of the telescope, let us suppose that we have a spectroscope attached to a telescope of considerable size, and have adjusted the slit so as to obtain a satisfactory degree of brightness and purity in the spectrum.

If we now imagine the telescope to become smaller, preserving the same angular aperture, the brightness and purity of the spectrum will remain unchanged, but the width of the spectrum, which is determined by the diameter of the image on the slit, will diminish. Now the visibility of an object depends upon its size, as well as upon its brightness, and a long line is easier to see than a short one, when the length of either is inconsiderable. The breadth of the smaller image can be increased by means of a cylindrical lens, but only by a proportionate loss of brightness. Hence we conclude that for spectroscopic observations of small bodies, such as the planets and their satellites, the head of a comet, and smaller planetary nebulæ, a large telescope is desirable.

We come now to the consideration of more complex sources of light. One of the most interesting cases is that of the solar prominences, in which we have luminous bodies emitting light of definite wave-lengths, ordinarily invisible on account of the glare from the brilliant white light of the sky. The most obvious method for making the prominences visible in the spectroscope is to weaken the continuous sky spectrum by employing a high dispersion. If the object were simply to see the bright lines of a prominence, the same end might theoretically be attained by using a narrow slit, for narrowing the slit diminishes the brightness of the continuous spectrum without altering that of the bright lines. The slit might, then, however, be so narrow that the bright lines would be invisible on account of insufficient breadth. By using a spectroscope of greater aperture and a higher magnifying power, the slit would not have to be so narrow, and the lines might be seen, but it is evident that the size of the spectroscope to fulfil these conditions, when the bright lines are relatively faint, might transcend all practicable limits. Moreover, we desire to see the whole prominence, and hence must use a wide slit. The only available method, then, is to use a very high dispersion.

On account of the smaller image of the prominence when a short telescope is employed, and consequently smaller slit-width required, a telescope of moderate dimensions is more suitable for observing prominences than a large one.

Another case of extreme interest is that of the corona. The conditions of efficiency for an instrument to be used in observations of the corona during a total eclipse have been determined by Professor Hastings,[*] who has shown that for such observations a spectroscope with large aperture is required.

The necessity of a large aperture will appear from the following considerations. The spectroscope must be capable of showing dark lines in a continuous spectrum, as well as bright lines on the same background. We have just seen that sufficient contrast between the light of the bright lines and that of the continuous spectrum can be obtained by using a high dispersion with wide slit, or by using a spectroscope of large aperture (and correspondingly high magnifying power) and a narrow slit. Now dark lines cannot be seen with a wide slit—i.e., a slit whose angular width exceeds a few minutes of arc; hence to show dark lines as well as bright lines in a continuous spectrum, we must use the second of the two methods just mentioned. From a review of numerous reports of observations of total eclipses, Prof. Hastings concluded that an aperture of less than half an inch was ill suited for observations of the corona, while anything over three-quarters of an inch, if properly designed in other respects, would make an effective instrument.

I have found the bright lines in the spectra of some stars to become invisible if more than a very moderate dispersion is used, probably because they are really somewhat diffuse bands, which widen with increase of dispersion.

The conclusions which we have so far reached, relating to the efficiency of the telespectroscope, may now be summed up, as below. It should be noted that they are based upon the principles of common geometrical optics, it being assumed that they are not carried to the limit at which a consideration of the finite length of a light-wave is necessary.

A. 1. In all cases the collimator should have the same angular aperture as the telescope.

B. When the object observed is a luminous surface of considerable angular magnitude, such as the sun, moon, or a large nebula:

2. The brightness of the spectrum is independent of the angular aperture of the telescope.

3. The brightness is independent of the linear aperture of the telescope.

4. The efficiency of the spectroscope as regards brightness is determined by its aperture—i.e., by the effective aperture of the collimator, the other parts of the instrument being of such dimensions as to transmit a beam of the same diameter.

C. When the object is of very large angular magnitude, as the sky illuminated by sunlight, the aurora, or the zodiacal light.

5. The spectra of objects whose angular magnitude is greater than the angular aperture of the telescope are best observed without a telescope.

6. The efficiency of a spectroscope for such objects, so far as brightness is concerned, depends upon the aperture of the spectroscope.

7. The same method may be extended to the sun and moon by using a sufficiently long collimator.

D. When the object is a star.

8. The brightness of a star spectrum is proportional to the area of the telescope objective, and independent of the aperture of the spectroscope.

9. The purity of the spectrum is proportional to the length of the collimator.

E. When the object is a body of but small angular magnitude, such as a planet, head of a comet, satellite, small nebula, sun-spot, &c.

10. For spectroscopic observations of such small objects a large telescope is desirable.

F. The case of the solar prominences seen in full daylight.

11. A spectroscope of high dispersive power should be used for observing the solar prominences.

12. A telescope of moderate dimensions is more suitable than a very large one.

G. The case of the corona during a total solar eclipse.

13. A spectroscope of large aperture with an observing telescope of correspondingly high manifying power is most efficient for seeing both bright lines and dark lines in the continuous spectrum of the corona.

As remarked at the beginning of this article, the principles just summarised cannot be applied with mathematical exactness. The conditions of efficiency are different, for instance, for large and for small surfaces; but the dividing line between large and small surfaces cannot be sharply drawn. In this respect the rules which have been given do not differ from many others, occurring in physical science, which, notwithstanding their limitations, are correct and useful in their broad application.

We may now consider the practical bearing of these principles on the construction of spectroscopes. The size of the telescope may be left out of the question, as this is usually fixed by other considerations, independent of the use of the spectroscope. An aperture of less than 10in., however, will hardly be sufficient for studying the spectra of stars.

On referring to the principles which have been established it will be seen that a large aperture is one of the conditions of efficiency for nearly every kind of spectroscope. The same condition will also in a great measure determine the size and weight, and hence also the cost of the instrument. As the prisms must be of such size as to transmit the emergent beam from the collimator, and as their weight varies as the cube of their linear dimensions, the aperture cannot be made very great without making the instrument unmanageable; it is therefore necessary to use a moderate aperture, and a number of small prisms instead of one large one, notwithstanding the theoretical advantage of the latter. An aperture of 1in., which, with a telescope of ordinary construction, will imply a focal length for the collimator of about 15in., may be taken as suitable for a 12in. telescope. For larger telescopes the aperture of the spectroscope may be increased, but for even the largest it is likely that a spectroscope of much over 2in. aperture would, if sufficiently rigid, prove to be too heavy a burden. The case of grating spectroscopes is somewhat different, increase in the size of the grating not being attended with increased weight and absorption of light, while the efficiency of the instrument becomes much greater.

Experience seems to show that the most effective form of prism for star spectroscopes is the compound or Rutherfurd prism, made up of a heavy flint glass prism with a large refracting angle (usually 90°), and two crown-glass prisms cemented one on each face of the flint glass with Canada balsam. Without the two small prisms, light could not be made to pass through the large one.

The investigations of Lord Rayleigh throw some doubt on the generally accepted superiority of the compound prism. The greater refracting angle and length of base which may be given to the flint glass seem to be a hardly sufficient compensation for the negative effect of the crown glass. One definite advantage that may be stated is that very heavy flint glass, which is subject to oxidation on exposure to the air, may be used in the construction of the compound prism, as the perishable flint glass is protected by the hard crown. For photographic purposes such very dense flint is highly objectionable, as it has a strong yellow tinge.

A compound prism used on the large star spectroscope of the Lick Observatory has a dispersive power more than three times as great as that of a single 60° prism of white flint glass.

Two compound prisms are used in the Potsdam spectrograph for determining the motions of stars in the line of sight. It is not likely that a greater number could be used advantageously in eye observations.

The half-prism which is sometimes used for astronomical purposes, has a number of disadvantages as compared with the form just described. The purity of the spectrum is not so great as with other prisms giving the same dispersion; the emergent beam is laterally displaced, and if, as usually is the case, the observing telescope is in line with the collimator, the spectrum is formed by eccentric pencils, increasing the difficulty of avoiding errors of parallax and other small displacements; when several prisms are used, the emergent beam becomes very narrow, and only a correspondingly small part of the objective of the observing telescope is used, greatly to the detriment of good definition. The direct view is also a disadvantage in observing objects near the zenith, which are otherwise most favourably situated. On these grounds, and perhaps some others, preference should be given to the Rutherfurd prism.

For faint objects giving a continuous spectrum a high dispersion cannot be used, and the spectroscope should therefore be arranged to carry a single 60° prism.

When only a single prism, either simple or compound, or a grating is used, the observing telescope can be made to point to a centre of motion which is in the prolongation of the collimator axis and in the axis of the deviated ray. With more than one compound prism the beam of light is displaced laterally so far that either the centre or the position of the observing telescope must be changed. Thus, if a great range of dispersive power is required, the construction of the instrument is considerably complicated; but in a first-class instrument designed for various kinds of work such an arrangement is necessary. When the train of four compound prisms is used on Prof. Young's new spectroscope, the observing telescope is held by a pair of brackets, the necessary rigidity being secured by a brace extending to the upper end of the collimator.

For solar work a diffraction grating will generally be used, the loss of light as compared with a prism train being in this case of no importance. I have recently shown* that a grating can also be used to great advantage in observation of nebulæ giving a bright-line spectrum. For observation of stars with a grating, a very large telescope aperture is necessary. But for the remarkable brilliancy of the gratings which in the last few years have been ruled by Rowland on sufaces prepared by Brashear, such observations would be quite impossible.

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[*] Caroline Island Report, p. 110.

[*] *Publications* of the Astronomical Society of the Pacific, No. 11.

The objectives of the collimator and observing telescope should preferably be made of Jena glass, as such objectives, when properly corrected, have so little chromatic aberration that all parts of the spectrum except the extreme ends have practically the same focus. No adjustment of the observing telescope is required in passing from one part of the spectrum to another, an advantage which adds greatly to the convenience as well as to the accuracy of the observations. To diminish the loss of light by reflection, the object-glasses, if small (as they always are in a star spectroscope), may be cemented with Canada balsam.

It is usual to make the collimator and the observing telescope of the same focal length. If, however, the collimator is unusually long, say, 20in. or more, the most effective eyepiece for an equally long observing telescope must have an equivalent focal length of several inches, and this, according to my experience, is undesirable, if precise measurements are required, on account of the effect of changes in the accommodation of the eye. I therefore prefer a shorter observing telescope and deeper eyepieces to obtain the same magnifying power. Ten or twelve inches is a convenient focal length. These remarks obviously apply only to visual observations, and they do not apply to solar spectroscopes, on which much higher magnifying powers are used than that which gives the maximum brightness.

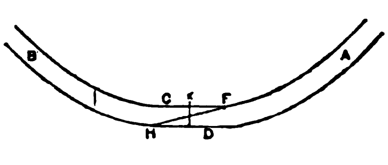
The eyepieces of the observing telescope should be achromatic, in order to have the micrometer wires as nearly as possible in focus for all parts of the spectrum. It is impossible to fulfil this condition exactly—at least, without a specially-constructed eyepiece, as the eye itself is not perfectly achromatic.

(*To be continued.*)

WELDING TIRES.*

THERE is no work which the jobbing blacksmith is called upon to perform that requires more care or skill than the welding and resetting of tires. In parts of the country in which the roads are dry and sandy, and the heat of summer is high and extends over a period of several months, the action of the heat is twofold; in the first place, it shrinks the felloes to a great degree, and, secondly, it expands the iron. In both ways, therefore, heat loosens the tire and makes resetting a necessity.

In the majority of shops there is no such appliance as a tire-shrinker, and the tire must be cut and rewelded. It is difficult to understand why it is so; but the fact exists that in a majority of small shops there is a strong prejudice against that mode of shortening a tire, and the smith has convinced many of his customers that the method is a bad one. This has made the introduction of this valuable adjunct almost impossible. The result is that welding must be resorted to, and many blacksmiths experience serious trouble in getting a good weld, even when, to all appearances, it is all right.



The defect is generally at the outside point of the weld, on the head. It is true that there are far too many blacksmiths who do not understand how to weld a tire properly; but even those who are generally successful sometimes fail through inattention or the use of a faulty method. The average tire, when welded, shows the outer point only partially joined. Sometimes it appears as if the point had been chilled and pounded down into, not welded to, the portion under it.

My method is a simple one, and never fails if followed as I direct. The accompanying illustration will help to explain it. A is the part of the tire held by the smith, the end of which is the outer or lower point of the scarf. B is the other end of the tire, C the upper part of the scarf, D the lower part, H the outer, and F the inner point. Before these are prepared, all details as to length, &c., should have been attended to.

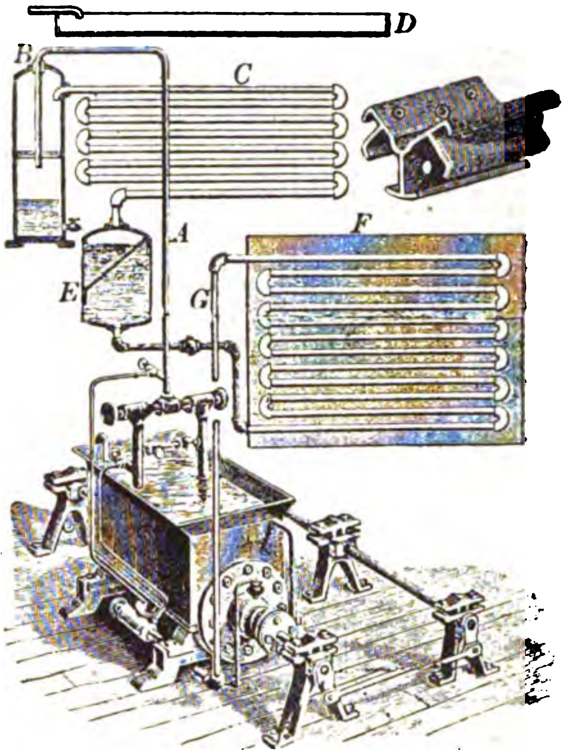
Prepare the outer point, section D, so that the outer portion shall rest full length upon the anvil, all the taper being put upon the upper or inner side of the tire, while the outside is perfectly flat. Next prepare the bevel of the end B, making it fit the other bevel accurately. Be careful to leave a sufficient quantity of material to make up for all losses from heating, allowing extra fulness for at least 2in. on each side of the weld. Punch a small hole through the part B at *x*. Then place the upper section upon the lower in its proper position, and mark off and punch a hole through the lower section. Insert a rivet, reheat to a clear, red heat, and rivet closely, taking care that the points are in their proper position. If a steel tire is used, apply a flux heat up to a welding heat, and with a wire brush remove all flux and dirt of every kind before beginning to weld.

Here it is proper to state that the face of the anvil needs looking to. Lack of care with regard to that causes much of the trouble met with in welding. Remember that the end of the piece to be welded is drawn down very thin, and it quickly cools below a welding heat when it is exposed to the air or comes in contact with a body colder than itself. If placed upon an anvil that has a cold face, the slight chill which results will prevent a perfect weld. Therefore see that the face of the anvil has a temperature of at least 100°, before the tire is placed upon it for welding.

Having secured the proper heat, and a perfectly clean surface, place the tire upon the anvil, and begin pounding at F, working gradually toward and up to H. By working in this way, the welding is begun at the point where the iron is most likely to lose its malleability, and it works out the flux and any other foreign substances that may be between the plates. After making a perfect weld on the flat, turn and pound the edges before the welding heat is gone. If the tire is of steel or very thin iron, I do not recommend working the edges. A better way is to remove all surplus material with a cold chisel and a file. When all is trued up to the proper thickness and width, reheat and reduce to the proper shape, using a light hammer for the purpose.

The blacksmith who will follow this method closely, using a clean fire when making his heat, will find no difficulty in making a clean, strong, and even weld, no matter whether the tire be heavy or light, iron or steel.

AN IMPROVED ICE MACHINE.



THE illustration represents an ice machine designed to be run with comparatively small power, without leakage of gas. It has been patented by Messrs. Frank L. Fonda, Robert C. Roach, and Walter H. Underwood, of Hutchinson, Kansas. The operating shaft is journalled in stuffing-boxes in the ends of a cylinder within which is secured a spider, shown in the small view, there being a fixed wing on the shaft within the cylinder, and the shaft being connected by crank arms and links with the main driving shaft, whereby an oscillating movement is given to the cylinder shaft and its wing, to compress gas within the cylinder in the space above the spider. The several arms of the spider extend from one end of the cylinder to the other and form longitudinal chambers, in the top one of which the wing oscillates, moving close to the top surfaces of the spider arms on each side, to fully expel all the contents of the chamber. The two bottom chambers are connected by apertures in the web of the spider to form a single suction chamber, while the chambers immediately above, one on each side, are discharge chambers for the compressed fluid, the suction chambers being connected with the compression chamber by suction valves, and the discharge chambers being connected with it by discharge valves. To keep the compression chamber cool it is surmounted by an open tank supplied with water from a suitable source and having an overflow pipe to carry off the surplus. Into one of the bottom chambers leads a fluid inlet-pipe, with a valve to regulate the amount of fluid sucked in, and from the discharge chambers at the top two pipes lead upward through the water in the reservoir to a transverse-valved pipe, from which extends upwards the pipe A, discharging into an oil-trap, B, in which is a horizontal strainer or sieve, the lower compartment receiving the oil, and having a draw-off cock. From the upper compartment a pipe extends to the coil C, forming a condenser, in connection with a spraying tank, D, above. The other end of the coil connects with a filter, E, in which a diagonally-arranged strainer filled with filtering material is designed to purify the fluid or freezing mixture, the pipe from the bottom of the filter leading to a brine tank, F, in which the brine is cooled in the usual manner. The pipe G leads from the brine tank to the suction-pipe, whereby the used gas is drawn back into the cylinder to be again compressed in the same manner as before, the operation being continuous and the fluid being used over and over again. The construction of the entire machine is designed to be very durable and simple. Further particulars in regard to it may be obtained by addressing R. C. Roach, Secretary, No. 16, First-avenue West, Hutchinson, Kansas.

COMPLEMENTARY AND SUPPLEMENTARY COLOURS.

AT the London Institution on Monday last Prof. Silvanus P. Thompson lectured on "Complementary and Snpplementary Colours." In approaching the subject he said that it was absolutely essential with regard to all questions of colour that we should distinguish between the physical fact and the physiological effect upon ourselves. Colour was so largely a matter of personal estimation that unless one was very careful, one gave to the colour the attributes which only belonged to the impressions themselves. For instance, let them take complementary colours. The distinction universally attached to the word complementary in this sense was that a colour was said to be complementary to another colour if, when properly combined with it, it produced a white light. They had to go back to Sir Isaac Newton for this, when it was first recognised that a white light was not a simple, but a compound one. He proved that by not only separating it up into its constituents, but by performing the converse experiment of taking particular constituent lights, and showing that the result of the mixture was to produce a white light. Many discoveries had been made since, the most important being that of Dr. Young, that the sensations by which we received colour were only of three kinds—that we had three distinct colour senses, as it were. There was a great deal of misunderstanding about this matter of primary colour senses. It was supposed that there were three primary colours in nature, whereas they were really something in ourselves—the perception for red, for a rather yellowish green, and for something which lay between blue and violet. Another theory had been put forward different from that of Young's: that the colours were red and blue and lemon, and many persons who had not studied the subject deeply were still under the impression that they were blue and red and yellow, and that all colours could be compounded out of these. But it would be seen that this was distinctly contradicted. Take the paint-box. What the artist did when he washed a wash of gamboge over the paper was to cover up some of its surface, and when over that he put a wash of, say, Prussian blue, he went another step in the direction of making it black. He had stopped off only the blue, the white, and a little of the red by shading it over with the gamboge, and when he put the blue wash over he stopped off other colours, and between the two the consequence was that only one colour would come through this wash, and that was green. That was not mixing the light, for if he took an actual yellow and an actual blue light, and showed them by means of the lantern on the screen, by no amount of trouble could he get a green. They would, on the contrary, always go very near producing a white, for the simple reason that they were complementaty colours. The colours of the prismatic spectrum were then thrown on the screen, and the professor pointed out that there were seven shades—red, orange, yellow, green, blue, indigo, and violet. For his own part, however, he saw no indigo, but a shade between full blue and full green, a colour which he proposed to name peacock. Among these tints which they obtained in the spectrum they had a number of very beautiful colours, but they had not the number of colours which an artist would desire. They had no purple, no brown, no slate-greys, no citron. Those they had in the prismatic spectrum were really primary colours. To come back to the question of complementaries, he had a table showing the complementary colours of various others. For instance, the complementary of crimson was moss-green, that of scarlet peacock, that of orange turquoise. The complementary, in fact, of any one colour in the prism was the mixture of all the rest, and that was the way in which a table of the kind was compiled. The professor then performed an interesting experiment, showing that coloured glasses did not really possess the colours which they had to the eye, but that the effect was produced by their stopping off all the other colours. Thus the light of the lantern showing through both a red and a blue glass was white, because the red glass stopped off every colour but red, and the blue glass every colour but blue. And it was just the same with pigments. A similar experiment was performed with coloured liquids in bottles. Next, the more familiar one of producing white by whirling round a disc painted in two complementary colours, was achieved, and then what the Professor described as a rather difficult experiment was performed, in which complementary colours were produced by separating the spectrum into its various parts by means of the lantern. Another way was to employ a double image prism, which produced very beautiful results; and still another way, even better than any of these, was by the process called polarisation of light. The first to apply this particular process to the dissection of complementary colours was the distinguished Viennese, Prof. Hans Brücke, whose death took place only last week. Before proceeding with experiments in this particular process, however, the Professor explained how it was that after looking attentively at one colour for some time another colour would appear if the gaze were transferred to a white or even a dark surface. The reason was that one fatigued that portion of a nervous system which was sensitive to a particular colour, and having lost the balance of one's sensations one was sensitive to anything but that colour. The same thing was shown by the shadow of a disc on a coloured ground, the shadow gradually changing colour until it became the complementary colour of the background. The experiments were brought to a close by some very beautiful effects in the polarisation of light. In conclusion, the Professor said with regard to supplementary colours, that their investigation had hardly yet begun, but he hopes to do something in that direction.

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* By "VULCAN," in *Blacksmith and Wheelwright.*

SCIENTIFIC SOCIETIES.

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ROYAL ASTRONOMICAL SOCIETY.

THE January meeting was held on Friday, the 8th inst., Mr. E. J. Stone in the chair. Mr. E. H. Lees, of Orbost, Victoria, Australia; Don J. de Mendizábal Tamborrel, of 13, Calle de Jésus, Mexico; Prof. J. S. Slater, of Seabpore, Calcutta; Mr. Arthur Thornton, of Giggleswick School, Yorkshire; and Wm. L. Watson, of Ayton, Abernethy, Perthshire, were elected Fellows of the Society.

It was proposed by Mr. Ranyard, and seconded by Mr. Cottam, and carried unanimously, that the President be requested to convey to the representatives of the late Sir G. B. Airy an expression of the sympathy of the Council and Fellows of the Society in their bereavement.

Mr. H. H. Turner read a paper by Mr. E. E. Barnard, on the "Phenomena of the Transit of the First Satellite of Jupiter, and Observations of the Red Spots on the Planet." Some three months ago, Mr. Barnard, in company with Mr. Burnham, while observing a transit of the first satellite across the planet, noticed that the disc appeared to be split into two. It was suggested by Mr. Stanley Williams, who was observing the planet on the same evening, that possibly the double appearance was caused by the satellite passing near to a dark spot, which Mr. Williams had noted upon the disc of the planet. Mr. Barnard stated that this theory was untenable, for the satellite was observed to be double by himself and Mr. Burnham, who watched the transit with him for a period of three-quarters of an hour (when they were interrupted by visitors), during which period the satellite moved across a considerable portion of the disc of Jupiter.

The Astronomer Royal read a paper on the relation between diameter of image, duration of exposure, and brightness of object in photographs of stars, taken at the Royal Observatory, Greenwich. He said: This paper is, I am afraid, rather necessarily full of figures, but I will endeavour to give a good account of it. In the first place, before explaining the results arrived at, it will be well to exhibit on the screen some of the photographs which have been made. In this investigation, the object has been to take on the same plate a series of images of stars with different exposures. The plate has been shifted between each exposure, and the length of the successive exposures have been sometimes arranged in geometrical progression and sometimes in arithmetical progression. It has been suggested that the diameter of the image representing the star varies as the fourth root of the duration of the exposure; but this does not appear to be the case—it appears to lie somewhere between the fourth root and the square root. The law is, no doubt, not a general one; but only refers to the particular instrument used, and is ne doubt affected by circumstances such as the dewing of the object-glass during the exposure. The next question was, How does the brightness of an object photographed cause the diameter of the disc to vary with the exposure? In making these experiments, we have assumed that the photographic action varies directly as the exposure, and directly as the brightness. The discussion which I have made, and which I cannot enter into very completely here, leads me to the conclusion that that law as to photographic action is substantially true. I find certain comparatively small variations between the results obtained, as is not surprising, for there are very considerable discordances between photographic determinations and visual determinations of the brightness of stars. If we have a star of the 9th mag., it may be something like an 8th-mag. star photometrically, or a 10th visually. When we have such a large range as that taking a small number of stars, we cannot expect that we shall eliminate these disturbances. There is also the disturbance due to the night, and the clearness of the air. There may be a slight deposit of dew on the object-glass, or little atmospheric tremors which will also have their effect, so that it is not surprising that there are considerable discrepancies. I will put down the results I have obtained on the black-board from the different star magnitudes. I have discussed these photographs by comparing them with the Oxford star magnitudes.

Mr. Ranyard: I do not know whether the meeting or whether the Astronomer-Royal has noticed it, but he did not mention the fact that there is a very great difference in the sharpness of the edges of the star discs, corresponding to short and long exposures. It was very evident in the photographs thrown upon the screen, that the longer the exposure the softer and more nebulous is the edge of the disc. The short exposures give very much sharper-edged star discs, and that, no doubt, accounts for what the Astronomer-Royal said, that the estimates of magnitude are better determined from short than from the long exposures. I noticed this a long time ago, and recently, on examining Dr. Max Wolf's photographs of the Milky Way, and comparing the stars with Prof. Pickering's spectroscopic catalogue, I found that there was a marked difference in the sharpness of the edges of the discs of a star having the first type of spectrum (which are naturally somewhat bluer, or richer in rays at the ultra-violet end of the spectrum), and stars having a second, or solar, type of spectrum. This is, no doubt, due to the fact that Dr. Max Wolf's photographic camera is not perfectly corrected for achromatism, especially for the ultra-violet region, but it enables one very readily to pick out these stars of the first or Sirius type of spectrum. He happened to be using a very much shorter focus lens, in which the achromatic dispersion is not as well corrected as in the lens which the Astronomer Royal has been using, and of course the effects were much exaggerated. The law as to diameter of discs mentioned by the Astronomer Royal must be looked upon as empirical, for it must change from instrument to instrument. When a bright star is outside the field of a telescope you see a bright region of the heavens coming into the field before the star itself appears, due to diffusion of light in the earth's atmosphere, and possibly to want of polish of surface of the object-glass. It is evident that a star disc which is brightest at the centre degrades rapidly into an illuminated field. At first the decrease of brightness from the central image is very rapid, and afterwards it is more gradual. The size and brightness of the nebulous field about a star must depend upon the dispersion of light within the lenses of the object-glass as well as upon the good figuring of the lenses, even upon the clearness of the atmosphere. With regard to the figures written down upon the black-board by the Astronomer Royal, I was pleased to see that they bore out the law with regard to the intensity of the photographic image which I communicated to the society in 1885. The figures really do not differ from unity by as large a percentage as Prof. Pritchard's star magnitudes frequently differ from those of Prof. Pickering. I have closely compared the two catalogues, and there are frequent differences of $\frac{3}{10}$ths of a magnitude, which corresponds to a difference of 50 per cent. in the amount of the light. Consequently I look upon the Astronomer Royal's results as confirming my law as to the density of the photographic image and the time of exposure. If the Astronomer Royal wants to find some good determinations of the magnitudes of small stars, he will find several measures by Prof. Pickering of the stars near the Pole and of the stars in the Pleiades and other clusters.

WESTERN MICROSCOPICAL CLUB.

THE January meeting of this society was held at the house of the new hon. secretary, Mr. W. F. Gwinnell, F.G.S., of Upper Mall, Hammersmith. After the usual tea and coffee, and preliminary business proceedings, the host introduced the subject of "Rocks of Animal Origin," which he illustrated with many interesting specimens of limestones, coprolites, bone beds, and shell marls. A number of rock sections were pictured on a screen by means of a micro-lantern apparatus, and photographs of some others were shown by an ordinary lantern. Pointing out that the vast majority of animal species consist of soft living tissues, supported on, or encased by, harder not-living parts, which constitute an endo-skeleton in the former case, and in the latter an exo-skeleton, test, or shell, he showed that it is only such skeletons which can, by their comparative indestructibility, form any permanent constituents of rocks. Again, it is only animals which are sufficiently gregarious that can accumulate their exuviæ over an area large enough to form deposits which deserve the name rock. With the exception of guano, due to sea-birds, and occasional cave deposits of a similar nature, due mostly to bats, it is only certain aquatic animals which fulfil the requisite conditions. Some of these live in fresh water, but most are marine, and either floating in the surface waters, like the Foraminifera and Polycistinæ, or attached to the rocky sea-bottom, or to their dead ancestors, like the corals, crinoids, and the gregarious mollusca. Coming next to the nature of the mineral matters which chiefly or largely make up the hard tissues of animals, and which are capable of preservation in or as rocks, he specially referred to (1) Silica, which, in the non-crystalline state, forms the spicules of many sponges, the lovely shells of the Polycistinæ, and the frustules or cases of the equally lovely diatoms, which, though now referred to the Algæ, are fittingly referred to here. (2) Carbonate of lime, which, either as calcite, or as aragonite, forms the shells of the Foraminifera, the spicules of many sponges, the endo-skeletons of the corals and polyzoans, and the tests or shells of the great majority of the Mollusca and the Crustacea, and hence gives origin to the great mass of, probably all, limestones. (3) Phosphate of lime, which, though present in some invertebrate forms of animal life, is a special feature of the bony skeleton of the Vertebrata. Bone beds and coprolite beds of various ages were instanced as deposits largely of this material. The conditions of occurrence of these three substances in remote Azoic times, ere life began, was next considered. Silica, the most abundant constituent of all original or igneous rocks, forms about 70 per cent. of acidic and 50 per cent. of basic rocks, the intermediate class averaging 60 per cent. Its partial solubility in natural waters readily supplies the wants of organisms requiring it, and whose tissues are constantly bathed by or permeated by it. Phosphate of lime, like silica, is a constituent, though a very minor one, of most igneous rocks, which usually show, in microscopic slides, small crystals of apatite. Doubtless these are a chief source, indirectly, of this compound in the vertebrate skeleton. Carbonate of lime, unlike the preceding, is not a constituent of unaltered igneous rocks. Doubtless its lime is derived from the plagioclase felspars, hornblende, &c., but its carbon, as carbonic acid gas, was not at first "fixed air," but formed a considerable percentage of the earth's primeval atmosphere. The condensation of aqueous vapour to form the primitive oceans as the earth's surface cooled below the boiling point of water, resulted in the soluble carbon dioxide being brought into contact with the silicates, which thereby became slowly converted into carbonates, thus keeping up a supply of carbonate of lime, but thereby depleting our atmosphere of its carbonic acid gas, a process which must lead to the diminution of vegetable life, and hence of animal life, until both become extinct.

In the discussion which followed the exhibition of rock sections and specimens, Professors J. F. Blake, M A., F.G.S., and A. W. Stokes, F.C.S., General McMahon, F.G.S., and Colonel Petrie raised some points of much interest, and gave some experiences among the limestones and marbles of India and Italy, which greatly aided less travelled members in understanding the metamorphic changes in these rocks. Mr. E. Swain, F.G.S., forwarded some weathered blocks of encrinitical and nummulitic origin, which were much admired.

An instrument invented at Georgetown College, known as the photochronograph, is said to record with accuracy the time occupied by a star in its transit across the meridian.

Rain-Making. — According to the *Times of India*, Mr. Wolfe-Murray's rain-making experiments in Madras have been attended by a success so remarkable as to suggest the occurrence of a singularly fortuitous coincidence rather than a triumph of science over nature. The centre chosen for the experiment was Cuddapah, where the rainfall is always scanty, and, neither kites nor balloons being available, the dynamite was placed on a ridge of flat rocks 2,400ft. above the sea-level, and a couple of hundred feet above the plain. A hundred pounds of dynamite were used in all, ten packages of 10lb. each being ranged on the rocks at intervals of 60 yards, and fired by time-fuses at intervals of one minute. Nine of the packages were successfully exploded, and six hours later, while the sun was still shining, there came a magnificent shower of rain, such, it is stated, as has hardly been experienced in the district during the present year. The shower lasted half an hour, and was confined to the region affected by the explosions, which Mr. Wolfe-Murray deems a conclusive proof of the success of the experiment. As the total cost was only 200 rupees, it will not be a difficult matter to verify these conditions in other districts.

Tramway Extensions.—The London County Council will ask Parliament next session to assent to a scheme which they have in hand for the construction of a tramway, forming a junction with the existing lines of the London Tramways Company, passing over Westminster Bridge and along the Victoria Embankment as far as the South-Eastern Railway Bridge at Charing Cross. The London Tramway Company failed in obtaining Parliamentary sanction to a similar scheme last session. The company have a Bill in Parliament by one clause of which they seek power to lease tramways from the County Council, so that if both bodies are able to carry out their ideas the tramway company will be able to lease from the County Council the line of tramway over Westminster Bridge and along the Embankment. The other objects of the company's Bill are the construction of a new tramway beginning in the Peckham-road to form a junction with the Camberwell and Dulwich tramways. Other new tramways are proposed to be constructed from Peckham Rye Common to Queen's-road, Peckham, there joining the existing tramways; from Stamford-hill, along Upper Clapton-road; from Theobalds-road, along Vernon-place and the south side of Bloomsbury-square, to Bury-street; from the existing tramways of the North Metropolitan Tramway Company in Clerkenwell-road, opposite the Holborn Town-hall, to High-street, Islington, there to form a junction with the lines opposite the Angel; along Bethnal Green-road, terminating in Cambridge-road; along Great Eastern-street, across High-street, Shoreditch, and terminating in Commercial-street; in Stratford, between High-street and Martin-street; Barking-road, and in Tottenham High-street, from Seven Sisters-road to Northumberland Park-road.

SCIENTIFIC NEWS.

THE position of Wolf's comet on Jan. 30 will be for Berlin midnight R.A. 4h. 27m. 51s., S. Dec. 10° 4′ 5″; brightness as compared with unity at time of rediscovery, 1·81.

The *Monthly Notices* of the R.A.S. for December contain an interesting paper "On the Spectrographic Method of Determining the Velocity of Stars in the Line of Sight," by Prof. H. C. Vogel, of Potsdam, which will be of special service to those engaged in such work.

The death is announced of Albert James Bernays, Ph.D., Professor of Chemistry at St. Thomas's Hospital. The deceased was born in London in 1825, and was educated at King's College School and at Giessen, where he obtained the Ph.D. degree. He was a Fellow of the Chemical Society and of the Institute of Chemistry, Lecturer on Agricultural Chemistry, 1845, and Lecturer on Chemistry and Practical Chemistry at St. Mary's Hospital Medical School, 1854-60. He had been Lecturer on Chemistry, Practical Chemistry, and Practical Toxicology at St. Thomas's Hospital since 1860; was Public Analyst for St. Giles's, Camberwell, and St. Saviour's, Southwark; and late Examiner in Chemistry to the Colleges of Surgeons and Physicians. Dr. Bernays published "Household Chemistry," in three editions; "First Lines in Chemistry"; "Science of Home Life," 1862; "Notes for Students in Chemistry," 6th edition; "Notes on Analytical Chemistry for Students in Medicine," 3rd edition in separate form, 1889; "Food," 1876; "Chemistry," and various articles and pamphlets on hygiene, cremation, food, &c.

Mr. Edmund Johnson, F.S.S., who of recent years had taken an active part in promoting several useful exhibitions, especially in connection with food supply, died the other day at the age of fifty-six.

The death is announced from Vienna of Prof. Ernst Bruecke, the distinguished physiologist. He was a member of the Upper House of the Austrian Parliament.

Miss Gifford, the author of the "Marine Botanist," died at Minehead a few days ago. Her work was, and still remains, a standard textbook on the subject, and she was in communication with all the most distinguished students of sea-plants throughout the world.

The medals and funds to be given at the anniversary meeting of the Geological Society, on February 19, have been awarded as follows:—The Wollaston medal to Baron Ferdinand von Richthofen; the Murchison medal to Professor A. H. Green, F.R.S.; and the Lyell medal to Mr. George H. Morton; the balance of the proceeds of the Wollaston fund to Mr. Q. A. Derby; that of the Murchison fund to Mr. B. Thompson; that of the Lyell fund to Mr. E. A. Walford and Mr. J. W. Gregory; and a portion of the Barlow-Jameson fund to Professor C. Mayer-Eymar.

The following will be the Presidents of Sections at the Edinburgh Meeting of the British Association:—Mathematics and Physical Science, Prof. Arthur Schuster; Chemistry and Mineralogy, Prof. Herbert McLeod; Geology, Prof. Charles Lapworth; Geography, Prof. James Geikie; Economic Science and Statistics, the Hon. Sir C. H. Fremantle; Mechanical Science, Prof. W. C. Unwin; Biology, Prof. W. Rutherford; Anthropology, Prof. Alexander Macalister.

The formal installation of the Duke of Devonshire as Chancellor of the University of Cambridge will take place in the Easter term.

Prof. McKendrick's lectures on "Life in Motion," which he has been delivering at the Royal Institution, are to be published in book form, with many illustrations, by Messrs. A. and C. Black.

The Electrical Exhibition at the Crystal Palace promises to eclipse anything of the kind held there, or, indeed, elsewhere, as all the improvements in details devised since 1881 will be shown. The generating machinery, or dynamos, make a very complete exhibit, and include all the best-known and well-tried types of machines. Gas engines, so useful in driving dynamos, are fully represented, competition in that kind of engine being now very keen. The National Telephone Company have established an exchange in connection with their London head-quarters, and can put their patrons into communication with any subscribers on their system, or with several provincial towns in which operatic or other performances are preceeding. The writing telegraph will attract much attention, and the powerful "search light," exhibited by the Messrs. Crompton, will be a feature of the show, which will be chiefly remarkable for the diversity of the applications of electricity. Domestic electric-lighting is attended to by several firms, and medical electricity is specially illustrated by the Medical Battery Co., in whose exhibit are several of Mr. Harness's recently patented devices. Mosses and Mitchell exhibit a selection of articles made from their vulcanised fibre, which are very useful in connection with electrical work of various kinds. An excellent catalogue has been provided by the Directors of the Crystal Palace Company, with introductory articles in a popular style, descriptive of the exhibits in the various sections. In the north nave our readers will find an exhibit which will interest them, as Messrs. F. C. Allsop and Co. have there telephones of all descriptions in operation. But it is impossible to do justice to the exhibition in a short note: it must suffice to say that it will be one of the sights of the season, and that special articles must be devoted to the various sections.

A rather extraordinary affair in connection with electric lighting is reported from Liverpool, where, it is said, the frequenters of a fashionable shopping quarter were startled by the appearance of a jet of flame springing from between the flagstones of the sidewalks. The jet developed into a considerable blaze. A spectator says that at the time stated a loud explosion took place, and shortly afterwards flames issued from between the stones of the pavement a few yards up Parker-street. The force of the flame gradually increased, and the pavement was broken, and some fragments were shot high into the air. A constable threw a quantity of sand over the flagstones, between which the flames were issuing, and this prevented the flames from shooting up into the air. Some workmen of the Electric Lighting Company arrived, and a disconnection having been made, the flames were extinguished. The fire is supposed to have arisen from two of the electric wires coming into contact, generating a great heat, and setting fire to the tar and rope in which the wires are incased.

A method of producing caustic soda and chlorine by the aid of electricity is being introduced by a syndicate using special plant invented by Mr. J. Greenwood. He uses a compound anode composed of non-porous carbon plates, separated by, but in contact with, a metal coil to increase their conductivity. The diaphragm, which is said to render the recombination of the electrolysed products impossible, is comparable to a Venetian shutter stuffed with asbestos. In commencing to work, the electrolytic vessels are charged with a solution of common salt, through which a current is then passed, thus decomposing or splitting up the salt into its elements, chlorine and sodium. In the preparation of sodium, however, a secondary action takes place, hydrogen is evolved, and the sodium is converted into caustic soda.

The Saturday afternoon lectures at the South Kensington Museum, commencing at 3 p.m., will be as follows:—Jan 16, 23, Prof. A. W. Rücker, M.A., F.R.S., "Electricity and Light" (two lectures). Jan. 30, Feb. 6, Capt. W. de W. Abney, C.B., R.E., D.C.L., F.R.S. (1) "The Action of Light on Pigments"; (2) "Colour Blindness" (two lectures). Feb. 13, 20, 27, The Rev. George Forrest Browne, B.D., F.S.A., Canon of St. Paul's, Disney Professor of Archæology at Cambridge, "Early Christian Art: (1) Ireland, (2) Scotland and Mann, (3) England" (three lectures). March 5, Prof. W. C. Roberts-Austen, C.B., F.R.S. "Art Metal Work." March 12, Mr. C. V. Boys, F.R.S., "Electric Spark Photography." March 19, Prof. T. E. Thorpe, Ph.D., F.R.S., "A Colliery Explosion." March 26, April 2, Prof. J. Norman Lockyer, F.R.S., "Astronomy and Mythology of the Ancient Egyptians" (two lectures). Tickets can be obtained at the Museum entrances, price 1s. each lecture. Tickets for the entire course of twelve lectures, 10s.

"Photography in the Colours of Nature" was the title of a lecture delivered by Mr. F. E. Ives before the Franklin Institute last month.

Mr. Ives has laboured assiduously at this branch of photography for some years, and seems to have advanced further than anyone else.

In a little pamphlet before us, entitled "436½ Miles in 425¾ Minutes," we have an account of the performances on the New York Central and Hudson River Railroad, in which a description is given of the way in which "all the fast runs of the world" are eclipsed. The run was from New York to Buffalo on Sept. 14, 1891.

At a recent meeting of the Astronomical and Physical Society of Toronto, Canada, the honorary membership of the society was conferred upon that veteran spectroscopist, William Huggins, LL.D., F.R.S., Memb. Inst. of France, and president of the British Association; and corresponding membership upon Mr. J. Ellard Gore, F.R.A.S., M.R.I.A., of Ballysodare, Ireland, and Mr. William F. Denning, F.R.A.S., of Bristol, England. A paper on the Pleiades, contributed by Mr. J. E. Gore, was read. Mrs. R. A. Proctor, who was present by invitation, addressed the society for upwards of an hour on "The Lick Observatory and Its Work."

A course of ten practical lectures on "The Recent Applications of Electricity" was commenced by Dr. J. W. Waghorn, of the Royal Naval College, Greenwich, under the auspices of the University Extension Society, on the 14th inst. By the kind permission of the Battersea Library Commissioners, the lectures are given in the Public library, Lavender-hill, at 8 p.m. The subject will be illustrated by practical experiments and by the oxy-hydrogen lantern, and the certificate of the Joint Universities Board will be granted to successful students.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> "I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
> —*Montaigne's Essays.*

AURORA, JAN. 4.

[33061.]—I WAS rather surprised on looking through the ENGLISH MECHANIC this week, not to see any reference to the Aurora of last Monday night, Jan. 4th.

About 9 p.m. I was called out of doors by my brother, and in the north there was a glow of light, like the twilight, with a few streamers from it. At 10 p.m. the glow was still to be seen, but I did not notice any streamers; later, clouds prevented any further observation.

It would be very interesting to know whether any unusual magnetic disturbance was registered at Greenwich on that night.

Fishponds, Bristol. **G. Dermott Harding.**

THE QUADRANTIDS, JANUARY 2.

[33062.]—I KEPT watch for these meteors on the 2nd inst., and counted upwards of 90 between 9 p.m. and 4.30 a.m. The night, however, was overcast and cloudy at intervals. They were seen in all quarters of the sky looking northward, and diverged from the region below and between the tail of Ursa Major and the neck of Draco, the radiant being well marked by a stationary meteor at, say, 230° + 50°.

I also noticed several Draconids from near Z 265° + 69°, Ursa Minorids from 235° + 75°, a long enduring radiant of small meteors, now active since early in the autumn, Boötids from 207° + 18°, and Coma Berenicids from, say, 182° + 28°. As regards the latter, while the general direction was towards S.W., a pair of "twin" meteors shot across overhead, on parallel courses about 1½° apart from S.E. to N.W., a very fine sight indeed. I also noticed several large meteors from Leo.

About 3.30 a fine large rocket-like meteor, which may have been observed elsewhere, appeared from a radiant on or below the eastern horizon, at an angle of about 35°, passing towards S.W.

Altogether, the display was, I believe, a fairly good one. The autumn radiants now high up south and south-west, are not nearly so active as formerly, and are giving, so far as my observations go, but little or no results. The month of December was, however, not very good here for observing.

Dublin, Jan. 5. **W. H. Milligan.**

POWERS OF OBJECT-GLASSES.

[33063.] — WILL some of your astronomical readers kindly enlighten me on this matter of an object-glass bearing certain powers to the inch of aperture. We frequently read of 50, 60, 90, 100, &c., powers to the inch of diameter, the writers taking it for granted (so it appears) that a glass will bear a certain power to the inch, regardless of the size of aperture. Now we will say that 3in. of good aperture will bear 100 powers to the inch on stellar work (given so by authorities). Then 6in., which gives us four times the eighth of 3in., should give us four times three hundred, or twelve hundred. We know this is not true, and yet our authorities all virtually say it is—that is, it appears so to me.

In T. R. Clapham's interesting letter (32958) this inconsistency (as I see it) exists, for he says his o.g. of 1⅞in. will stand from 30 to 50 powers to the inch (almost). Then at the end of his letter he writes: "From my own twelve years of telescopic work I have rarely been able to use a higher magnifier than 50 to the inch of aperture." Now, his Grubb glass of 5½in. aperture will give him over six times the light that his 1⅞in. will give, yet he cannot use but little higher powers on it to the inch than on his smaller aperture. In a few words, if his less than 2in. opening will stand 50 to the inch (almost), then his 5½in. should stand over six times 50 or 300 to the inch. Now, there may be some very simple explanation for this inconsistency, but I have never read it, nor can I reason it out for myself; therefore, I would like to see the matter fully discussed and explained in your columns.

The idea has been suggested to me that as you increase the aperture, and with it the power, you also increase the undulations and tremblings of the atmosphere. This may be a partial and practical explanation, but not a theoretical or satisfactory one to me, for this would be virtually saying that the disturbance caused by the atmosphere varies in the same ratio as the areas of circles—would it not?

Bruddock, Pa., Dec. 24, 1891. **J. L. Park.**

SILVERING MIRRORS.

[33064.]—I AM obliged to Mr. Skelton for his remarks, and can assure him the use of the blotting-paper for drying is perfectly safe.

It is not because the edges are not clean that the water runs off, it is air films that acts more at the edge than elsewhere. It is true these parts where the air refuse to leave, often, though not always, silver with a stain; but it is not because the surface is not clean. A little of the potash solution will often effect a good contact with the water.

Martin's is a very good process, but the nitrate of ammonia is not a good keeper. The less rocking the better. Let mirror remain quiet till the bath is clear at top. Any process of silvering is liable not to act sometimes, and the reason is not easy to discover.

At the present time I should be in Edinburgh to set up a 12½in. equatorial, but cannot; everything is waiting through silvering failures. I know of no cause, except intense cold weather.

The polishing pad as large as mirror tickles my fancy. How can you press evenly a soft puffy cotton-wool pad from 6in. to 18in. diam.? There is no need of such a clumsy affair; an equal polish is a safe guide to equal rubbing. The large pad is bad in principle; don't use it. **G. Calver.**

P.S.—Since writing the above, to-day I have succeeded in getting a beautiful film to the 12½in., and this is the reason: Last night, after three days' failure, I put *everything* to be used in a warm room. This afternoon, in a temperature of 58°, those same chemicals that refused to give me anything but mud yesterday, to-day most willingly gave me the most beautiful silver films. I used the process in last week's issue, and used 400 grains of silver. I shall not polish it with a flippety-floppety pad 12½in. diam., but one less than 3in. As I have said elsewhere, the great thing is to have everything of same temerature, between 50° and 60° will do. A cold vessel will chill, and influence chemical action.—**G. C.**

THE BEST FORTY BOOKS.

[33065.]—SOME time ago the *Pall Mall Gazette* started a discussion on the subject of the best one hundred books, a number which would be too large to consider for my present purpose, as I wish only to give some information regarding the works which would probably be the most generally useful to the readers of the "E. M.," so as to save them the necessity of numerous queries and replies if they would refer to those at a library, or purchase them from a bookseller. I have myself experience of a great public library, which, including the reading of critical reviews, enables me to present the following forty-two books as probably the best obtainable in the several departments of knowledge, their last editions being understood.

1, The Century Dictionary of the English Language; 2, Chambers's Encyclopædia; 3, Ure's Dictionary of Arts and Manufactures; 4, Cooley's Cyclopædia of Practical Receipts; 5, Holtzapffel's Turning and Mechanical Manipulation; 6, Watts's Dictionary of Chemistry; 7, Spon's Encyclopædia of Industrial Arts; 8, Spon's Dictionary of Engineering; 9, Spon's Workshop Receipts; 10, Spon's Mechanic's Own Book; 11, Every Man his Own Mechanic; 12, Deschanel's Natural Philosophy; 13, Helmholtz's Lectures on Scientific Subjects; 14, Jamieson on Steam-Engines; 15, Newton's Principia; 16, Laplace's Celestial Mechanics; 17, Chauvenet's Practical Astronomy; 18, Loomis's Astronomy; 19, Lord Rayleigh's Theory of Sound; 20, Darwin's Origin of Species; 21, Bastian's Evolution and Origin of Life; 22, Humboldt's Cosmos; 23, Viollet-le-Duc's Dictionnaire de l'Architecture; 24, Demmin's Encyclopédie des Beaux Arts; 25, Dictionnaire de l'Académie des Beaux Arts; 26, Men of the Time; 27, Vapereau's Dictionnaire des Contemporains; 28, Brewer's Dictionary of Phrase and Fable; 29, Haydn's Dictionary of Dates; 30, Mill's Logic; 31, Grote's Treatise on Moral Ideas; 32, Sir W. Hamilton's Metaphysics; 33, Sir W. H.'s Philosophy; 34, Stirling's Hegelian System; 35, The Speaker's Commentary on the Bible; 36, Smith's Dictionary of the Bible; 37, Smith's Dictionary of Greek and Roman Biography and Mythology; 38, Blunt's Dictionary of Sects and Heresies; 39, Blunt's Theological Dictionary; 40, Lecky's History of Rationalism; 41, Voltaire' Philosophical Dictionary; 42, Bayle's Critical and Historical Dictionary.

Among these I have placed the new American "Century Dictionary," just completed in six quarto volumes, as being the best of its kind, and undoubtedly it is so, though its rival may appear when Dr. Murray's Oxford Dictionary is published. However, another one, the "Imperial Dictionary," is of such excellence as to answer all the requirements of the general public, besides being much cheaper and less bulky. Both the "Century" and the "Imperial" have superior illustrations, and illustrations are indispensable for giving a tangible signification of the meanings of certain description of words, such as architectural features. After Chambers's I would prefer the English Cyclopædia for general reference, though neither of these approaches in bulk to the "Britannica" or the "Metropolitana." It is Cooley's Cyclopædia—a work containing all known receipts—which I am sure would obviate the greatest number of queries from amongst your readers who so often ask for receipts; it is, however, dear in price, but a small book partly of the ~~same kind~~ is Beasley's "Druggist's Receipt Book." Dr. Smith's admirable dictionaries of antiquity are obviously "Bowdlerised" productions, and hence I have introduced those of Voltaire and of Bayle (last edition, Paris, 1820) for such as are anxious to pry into the *nuda veritas* of antiquity. The reports of Parliamentary debates in past years will be found in Hansard's "Debates" for the particular year or session. Those wishing to read accounts of remarkable events or trials occurring within the last half-century or so will find such narratives contained in a series of volumes called the "Annual Register," one volume being issued for each year; while those desirous of a short biography of the eminent men of the present day should consult "Men of the Time" or "Men and Women of the Time," or else the French "Vapereau." In the above list I have made no mention of the small books best suited for elementary instruction, and though that would be an important matter in itself, yet it would be really difficult to decide. Great libraries possess not only numerous volumes of periodical literature, but also of ephemeral literature. The only daily newspaper which has got a reference index is the London *Times*, for which Palmer's "Index to the *Times*," in half-yearly parts at 10s. each, serves as a divining-rod to the reader. **Vehmgericht.**

BRAIN WORRY.

[33066.]—IN the last letter of your correspondent "F.R.A.S.," which is vastly interesting (as his letters generally are unless someone has fluttered the red rag of some flagrant abuse before his gaze), he states that when under the influence of brain worry he constantly found himself reversing figures, such as putting down 6s. 8d. for 8s. 6d., &c. It is interesting to me to find that this reversal is a recognised form of error, perhaps caused by the fatigue of the calculating molecules of the brain. It happened many years ago, that in balancing the extensive accounts of a company, several perplexing errors of this sort turned up, possibly from some clerk engaged in the interminable calling over of figures, getting the cart before the horse, and while listening to, say 6s. 4d., putting down 4s. 6d. After a few experiences in correcting these errors, a method occurred to me of always ascertaining if the discrepancy were of this reversing character. The error is always a multiple of 11d., and is as many times 11d. as the difference between the original number of shillings and of pence. Thus, writing 6s. 8d. for 8s. 6d., the difference is 11d. × 2 (1s. 10d.); and between 9s. 4d. and 4s. 9d., the difference is 11d. × 5 (4s. 7d.); between 1s. 9d. and 9s. 1d., the difference is 11d. × 8 (7s. 4d.), and so on for every reversal of shillings and pence. Knowing, then, that the Dr. and Cr. sides of the (double entry) books do not balance by any of these multiples of 11d., there is a strong presumption that the error is one of this nature, and it becomes comparatively easy to re-examine all entries where the difference between shillings and pence is the same as the number of times that 11d. is contained in the amount of the discrepancy. If pounds and pence are reversed, the difference is always a multiple of 239 pence or 19s. 11d. Thus, £2 6s. 3d. instead of £3 6s. 2d., gives an error of 19s. 11d., while £6 5s. 4d. instead of £4 5s. 6d., gives an error of £1 19s. 10d., or twice 19s. 11d. Perhaps this rule may be of service to some of your readers.

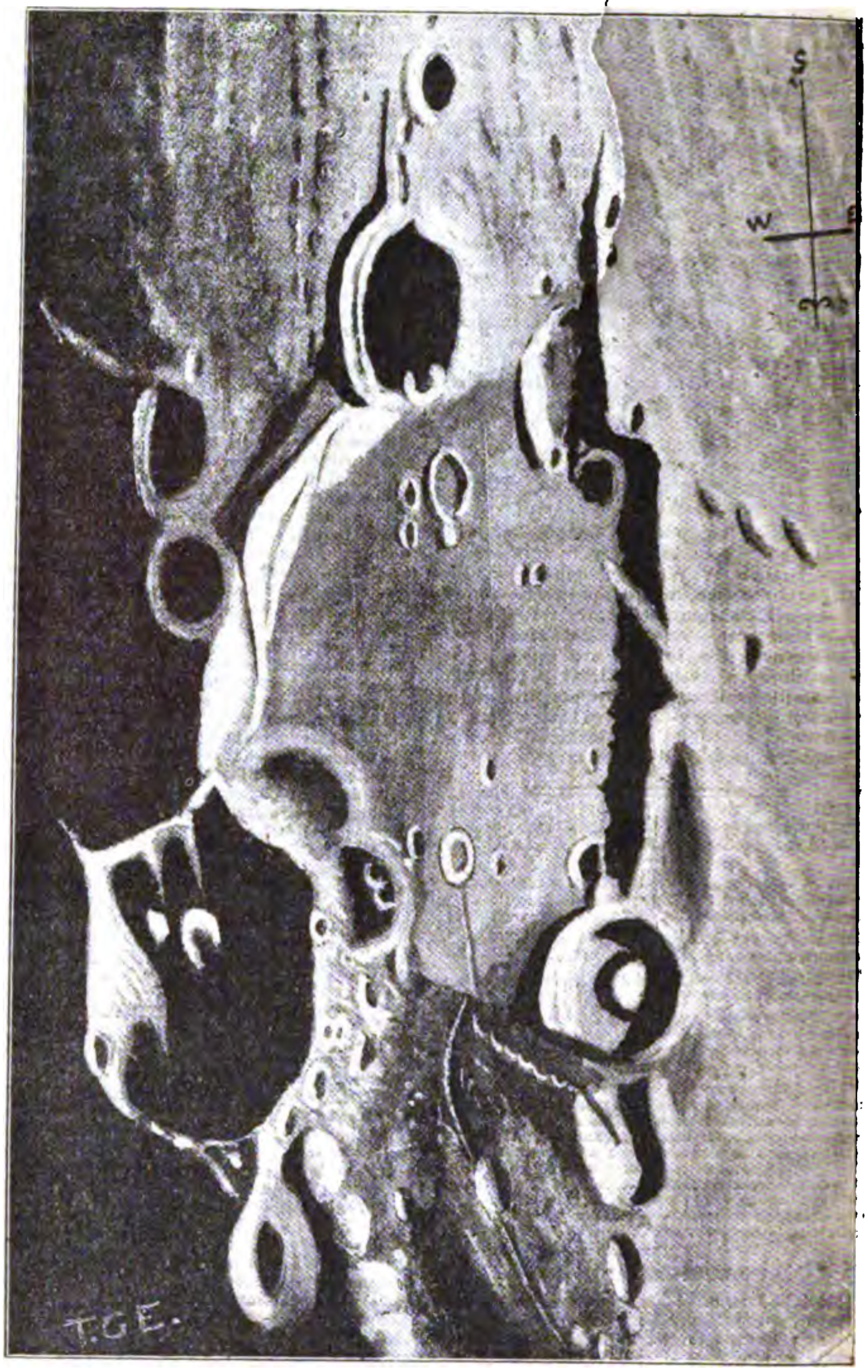
Richard Inwards.

OVERTAXED BRAIN.

[33067.]—As Lancastrian " asks me a question I reply by putting him another. Put the adult population of Great Britain of between 20 to 40 years of age inclusive at 10,000,000. Out of these, how many can feel the pulse, describe its average condition in health, appreciate the distinction as to the pulse between, say, synochem and ataxic, &c., fevers? Well, homœopathy not only teaches them all the above, but also how to treat and to cure many disordered conditions in which that information, and the remedies indicated thereby, would alone be sufficient guides. Two of my sisters were shut up in Paris by the German Army. During the year intervening between their escape from Paris and the marriage of the elder with one Henri Rodrigue, Captain 9th French Hussars, she was urged but in vain to occupy it by acquiring a fairly practical elementary knowledge of homœopathy by study of its literature and by clinical experiences in the Paris hospitals. Four years after marriage, pleurisy on its seventh day proved fatal to her husband, under the army surgeon's treatment of the disease, by *bleedings* and purgatives. Had she, on the first appearance of the *malaise*, given him aconite and bryonia in rapid succession, the man would have been well *in a few hours*, and thus saved as a protector for my poor sister and her children. This is one only of the many reasons for the reminding the ever-recurring fresh stratum of "Ours" what lies within their own reach—i.e., life-saving, self-to-be-acquired medical knowledge.

The Lydney Dispenser.

SELENOGRAPHICAL: VENDELINUS.



[33068.]—THE accompanying drawing of this very irregular walled-plain, made between 9h. and 10h. on December 17th, exhibits it at a phase peculiarly suitable for showing many of its most interesting features to the best advantage. Though the foreshortening due to its proximity to the W. limb greatly exaggerates the disproportion between its extension from north to south and its breadth, in whatever position it was placed its unsymmetrical form would remove it from the normal type of these inclosures. Apart, however, from this singularity, it is remarkable for many curious details, which will repay close attention. The plateau at the northern end, bordered on the west by the large complex formation shown in the sketch as nearly filled with shadow, is especially noteworthy. On the night of the 17th inst. the definition was at frequent intervals superb. With a power of 350 on my 8½in. reflector the mottled-grey eastern slope of this ring was seen to be literally riddled with craterlets. Of these, I have only drawn five or six of the larger ones, which can be easily identified, as it would be futile to attempt to show a tithe of the minute black circular pits which, now and again, appeared to flash into momentary distinctness. The inner slope of the great rhomboidal inclosure, Walter, is the only other locality I can recall where they are so closely packed.

On the plateau, which is only slightly raised above the level of the northern end of the floor, and which exhibited, under the low evening sun a very hummocky, rough surface, the cleft discovered by Schmidt in 1851 was an easy object; as was also a crater-rill running nearly parallel to the southern edge of the plateau, and ultimately extending on to the floor of the depression marked *e* in Neison's map. The cleft running to the foot of the plateau from the bright little ring D in the interior was also seen, but less distinctly. The large ring-plain B on the south is very prominently terraced, as are also the two smaller depressions on the terminator beyond the S.W. wall. From the more northerly of these to the N.W. wall of B a dark marking was noted which exhibited an expansion about midway. Dr. Sheldon, of Macclesfield, and other observers have seen longitudinal ridges on the floor of Vendelinus; but of these there were no traces, though it was manifestly uneven. The plain on the south is covered with rows of little isolated hills, all apparently radiating from the neighbouring Petavius. I have attempted to portray them, but, I fear, with indifferent success.

The positions of objects on the floor were fixed by alignments with salient points on the border. Among the former, perhaps the most remarkable are the two dusky semicircular rings which abut on S.E. slope of the large depression already noticed. The more northerly of these is deeper than its companion, and contains two craters.

As Vendelinus is one of the objects selected for special study by the Lunar section of the British Astronomical Association, much attention has of late been directed to it, with the result that many hitherto unrecorded details have already been detected.

Bedford, Dec. 31, 1891. **T. Gwyn Elger.**

AMATEUR GLASS-BLOWING.—II.

[33069.]—VACUUM TUBES.—THE second terminal will be made exactly like the first, the wire, when coated, being bent as required, in order to bring the aluminium plate into its proper position. Warm the tube carefully, and make the small hole for its reception as already described, and then let it cool in cotton-wool. When cold, the terminal is placed in position and secured by bending the wire into a neat loop. Now draw out the end of the tube as before by roughly welding to it a waste piece of glass, to serve as a handle, using the large flame for the operation. Let the sides of the tube fall together by their own weight, as, if it is pulled out too quickly, the glass will be very thin. Its appearance is shown in Fig. 2 *a*, the reduced portion being from 2in. to 3in. long, and ¼in. in diameter. Now apply the flame to the end of the narrow neck, soften it all round, and quickly pull the end right off, thus leaving a long, conical end of very thin glass, which can be safely broken off with a small pliers, the rough ends being then softened and rounded into shape. The narrow constriction shown in Fig. 2 *c*, required for sealing up after exhaustion, can either be made now or when the tube is finished; but without waiting for glass to cool, proceed immediately to seal in the terminal in the same way as the first, taking care to warm up the whole neighbourhood of the terminal very carefully before bringing the flame upon the terminal itself. This might have been done before the end was drawn out, but then there is greater risk of cracking. It is always dangerous to apply heat anywhere near a sealed terminal, and by the above plan this is avoided.

The particular method of construction here adopted can be varied in many ways. For instance, the end of the tube may be pulled off close, as shown in Fig. 3, *a*, and a smaller tube joined to it. The tube can then be softened in the large flame, and blown out into a neat shape, as in Fig. 3, *b*. If it is desired to put the terminal in the position shown in this figure, it will be necessary to drop the completed terminal into the tube, draw out and join on the small tube, pierce the small hole, and wrap up to cool, without allowing the terminal to slip down into the hot part of the glass. The only objection to this plan is that, owing to the position of terminal, it may be a little awkward to get it to fall into its place for sealing, unless it be made of such a shape and size that it may be introduced and withdrawn through the narrow tube.

Perhaps the neatest arrangement is that shown in Fig. 3, *c*. To make this, begin by stopping up one end of the tube with the perforated cork, and attach to it a mouth tube, the use of which has been explained in former letters. This consists of a small indiarubber tube about 2ft. long, having at one end a glass mouthpiece. The small glass tube for attachment must be ready for use, with one end temporarily closed.

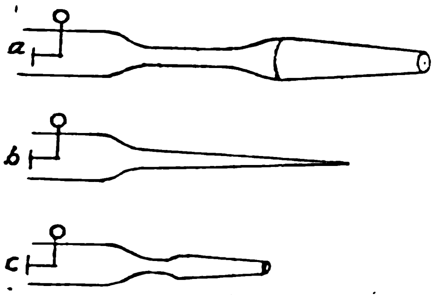


Fig. 2.

Now close up the end of large tube, bring a very small pointed flame to bear on the spot to which the small tube is to be joined, and when soft blow through the mouth-tube until the glass bursts, leaving a neat round hole of the same diameter as the tube to be welded to it. Soften the walls of the hole and the end of the small tube and press them together; then work all round the joint, bit by bit, softening the glass at each point, and blowing gently into shape. The small tube can then be bent in a neat curve, either in the blowpipe or in an ordinary gas-flame. The hole for terminal is then pierced, and the whole allowed to cool in cotton-wool, and the terminal afterwards sealed in as usual.

The second terminal is dropped into the tube, the other end of it closed up and blown out into slightly globular shape, and the small hole pierced, care being taken as before that the terminal does not get near the flame. This method has the advantage that there is not the slightest difficulty in getting the second terminal to slip into its place.

The character of the connecting joint to the pump will depend upon the degree to which it is desired to carry the exhaustion. The simplest way is to join them by means of a short piece of pure indiarubber tube, bound down to the glass with thin iron wire (not copper). Such a joint will answer very well indeed for many purposes, and is quite sufficient to show all phenomena connected with the stratified discharge, though a slight gradual leakage will always occur. There are methods of surrounding the joint with a jacket of mercury or glycerine, to prevent all access of air; but I do not recommend them, as the additional security is not worth the extra trouble.

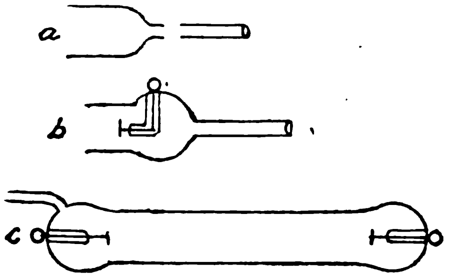


Fig. 3.

In all cases where a really high vacuum is required, all mechanical joints are out of the question, and the best plan is to weld the tube directly on to the pump, and this can be done as easily and quickly as any other connection. A description of a hand blowpipe for this purpose has already been given, and the operation explained, all that is needed being a small portable blowpipe connected to gas and air supplies by light indiarubber tubes of sufficient length to secure perfect freedom of movement. The vacuum tube is supported on a firm stand with its extremity in contact with that of the pump, the junction is then heated all round and gently pushed together, if necessary using a pointed iron rod to close up small openings, and in this way a rough joint can speedily be made which will be perfectly airtight, and quite strong enough for its temporary use.

We will suppose that the tube has been attached to the pump, and that the exhaustion is proceeding. For some time the tube will be found to be quite impervious to the induction coil discharge; but when the pressure has fallen to something like ¼in. of mercury, the first traces of luminosity may be looked for, which will be first noticed as a faint glow at the terminals. To this will speedily be added a number of thin distinct luminous lines extending from one terminal to the other, and in incessant shifting and undulatory motion. These threads of light tend to adhere more or less to the walls of the tube, availing themselves of any particles of conducting matter that may be in their path, and they are also very sensitive to the presence of the finger or other conductor outside the tube. See Fig. 4 *a*.

The negative terminal is partially covered with a layer of blue light, which will gradually extend over its surface as the exhaustion increases. Soon the discharge widens, becomes more regular, and is no longer attracted out of its direct course by conducting particles. A distinct gap near the negative terminal soon becomes apparent, which is sometimes erroneously confounded with what is known as the "dark space," and the main body of the tube from this gap right up to the positive terminal is filled with a luminous, amorphous cloud. Fig. 4 *b* represents this stage. This long column then begins to split up transversely into numerous thin segments, separated by narrow, comparatively dark intervals, as in Fig. 4 *c*. At the same time, the luminous envelope surrounding the negative terminal begins distinctly to separate slightly from its surface, leaving a dark layer between it and the metal, this interval being the true "dark space," or mean free path, of the molecules. The striæ become larger and further apart, and the gap between them and the negative glow continually increases, the striæ being, as it were, driven back upon the positive terminal. The dark space enlarges round the negative terminal, still keeping its sharpness of outline, and following the shape of the terminal until it extend from a ¼in. to ½in. from its surface, being bounded on every side by a luminous margin of light; but, on further extending, this luminous margin gradually decreases in brilliancy until the borders of the dark space can no longer be perceived.

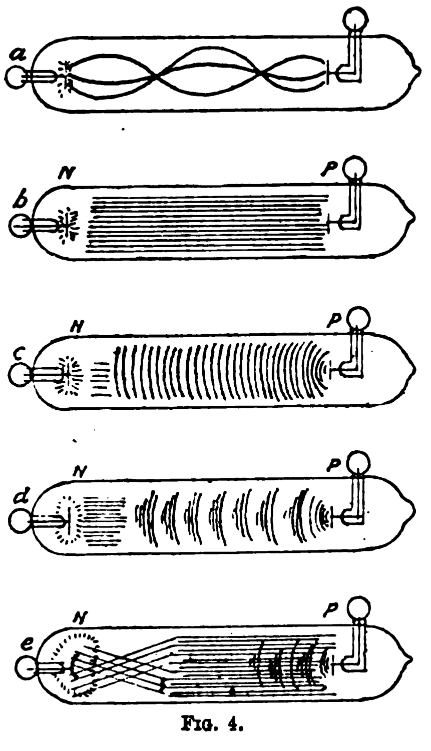


Fig. 4.

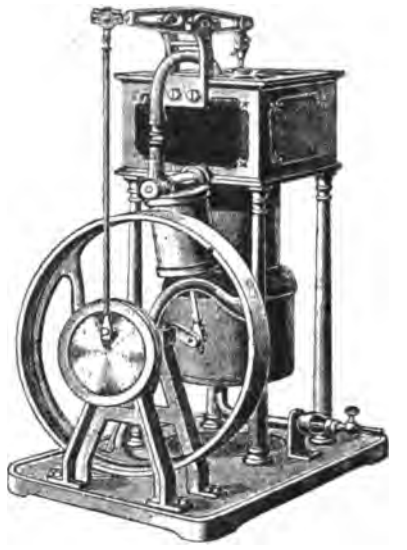
These effects are slightly varied by the dimensions of the tube, the shape and appearance of the striæ being particularly changeable; but the main features are the same in all cases.

The increase in size of the darker spaces goes on as described until only one or two striæ are faintly visible near the positive terminal. Soon these also disappear, the tube having now lost its former brilliancy, and being comparatively dark all along its length; but if the exhaustion is still continued, a new effect speedily appears. While the interior of the tube still continues dark, its walls begin in places to shine with a strong phosphorescent light, and we have then to deal with a totally new order of phenomena.

Leicester. E. E. B.

HOT-AIR ENGINE.

[33070.]—I enclose illustration of hot-air engine which is heated by gas, but, if required, can be heated by a paraffin-lamp or other means.



E. R. Dale, A.I.E.E.

VIOLIN MATTERS.

[33071.] — Erratum.—In my last (32995) on "Jointed Fiddle Backs," I wrote "The old masters gave *us* jointed backs." The printer had it "gave *no* jointed backs."

Mr. Monk (letter 32996) asks why so many of the Italian makers narrowed their ribs in the direction of the neck, and also gives his solution of the matter—i.e., it was with a view to control the air-space, which is doubtless reasonable. But if this were so, would it not mean that the instruments were strung up and tried "in the white," before being varnished? With most of the Italian varnish that I have met with it would be next to impossible to reduce the sides after the varnish was on without leaving traces of chippings which would have to be covered, and I do not remember to have seen any such traces. Again, if cut down after being finished, should we not expect to see that the operation had removed a portion of the side-linings; or is it Mr. M.'s opinion that the side-linings were removed bodily before the cutting, and subsequently replaced on the reduced ribs? The great copyist, Vuillaume, seems to have paid very little attention to this point, although he was a wonderful imitator generally. Lupot, on the contrary, made the reduction, and so did one or two of the old Dutch makers; but there has been no trace of it in some instruments I have had of the Testore class, whereas it appears in others. I am inclined to think the old makers made the reduction purposely, and before gluing up, and the books on violin construction that I have seen give instructions for the ribs to be reduced to begin with.

I think I must side with Mr. Calver (32997) that the old makers were intelligent craftsmen, as against Mr. Wenham that they worked on scientific principles.

Mr. Wenham's interesting kaleidophone experiment I have not previously heard of, and I intend to take the first opportunity of trying it.

Mr. Schucht (32998) also gives some useful facts and reminiscences. The circumstance of the tone of his friend's violin being considerably influenced by the changing of one chin-rest for another is interesting to me, as it seems to bear out my remarks on the necessity for a proper balance of equilibrium. Who can tell that a series of experiments with chin-rests may not lead to the discovery of a simple means of transforming a poor-toned fiddle into a good one? Mr. Schucht's subsequent letter (33037) and diagram are well worth study. Tending to confirm his theory is the well-known fact relating to the substance of the neck. I have found instruments having a poor tone greatly improved by the insertion of a stouter neck. On one occasion a Gagliano violin, apparently good and sound in every way, had a vile tone. It had also an unusually small neck, perhaps purposely reduced to meet a whim of the owner. I put in a stouter neck, and the instrument "went" beautifully. Again, some years ago a Gaspar da Salo was offered me with a notoriously bad character, and which the owner had in vain tried to have improved. I bought it with all its faults, being convinced that a heavier neck would be beneficial, and the result was precisely as anticipated. There was evidently in both cases not sufficient resistance in the necks. No other alteration was made in either violin.

"Orderic Vital" (letter 32999) asks how to clamp and vibrate a plate so as to correctly determine its fundamental note. My slight experience in this particular has not had any satisfactory issue. Whether in plates of wood, or in actual bellies from fiddles of well-known makers, clamped between two pieces of cork in a vice, or held in the hand, I have found that a different note was produced on the same plate or belly whenever the place of impact with the bow was changed. On one occasion I tried the belly of a Guadagnini, a Carlo Bergonzi, and two other fiddles of lesser renown, and found that when the bow operated across the edge at different points in the outline, a different note was produced; and, moreover, there appeared to be no sort of uniformity as between either of the instruments. This may easily be tried without the trouble of clamping in a vice, but simply by holding the wood between the fingers and thumb—say on the bass bar. It by no means requires a firm grip, but by sawing the bow at different points round the outline it will be found that the note varies at each point. Prof. Savart, and, before him, Dr. Chladni, made a series of important experiments, of which, if it is desired, and the Editor will give the space, I will give a condensed account from a narrative written in 1821 by a gentleman who "interviewed" Prof. Savart at the time, and whom he found to be "a man of talent, deep reflection, and unassuming modesty, eager to give every possible assistance and information."

"Vio" (letter 33036) is very complimentary, and I may here thank him, "Orderic Vital," Mr. Wenham, Mr. Schucht, and other correspondents for their temperate criticisms and useful hints and information. It is pleasing to me that my papers have evoked so much sensible comment. "Vio's" suggestion as to reproduction in book-form may probably be carried out. And it is additionally gratifying to learn that several amateurs are at work at violins on the lines I have suggested.

From "Vio" to "Scio" is simply a step from the sublime to ——, and I decline to have anything to say to the latter unless he accepts Mr. Wenham's challenge to come out under his real name. He has been so tremendously snubbed by both our editor and by correspondents, that I will spare him. He gives us nothing but growls and conceit. He reminds me of the refrain of one of Albert Chevalier's songs:

"It ain't exactly wot 'e sez,
It's the nasty way 'e sez it."

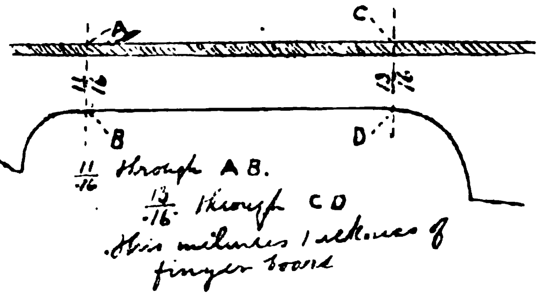
Carlo Bergonzi (query 76154).—The sizing you desire may be made with a solution of gamboge in spirit of wine or naphtha, and the depth of colour required by adding a very small bit of dragon's blood.

"E. E. M." (query 76267).—The normal position of the bridge is between the two little notches in the *f*-holes. It give an ugly appearance if otherwise. Try this yourself, and hold at arm's length. As you say, the recognised position of the soundpost is about ¼in. behind the right foot of bridge. In thickly wooded instruments I have sometimes (simply for experiment) moved the post to the front of the bridge without the slightest detriment to the tone. I have never heard of Trapani as a maker.

G. H. (query 76229.)—If you ask at the wholesale warehouses for Swiss pine, you will doubtless get the correct article. It is beautifully white, clean, and soft-looking, and the bate very fine—not coarse and strong like the red pine.

W. Pickering.

[33072.]—If J. Sutcliffe will again refer to my letter, he will see that I did not assert that the *f* sound-holes are of "little importance." I merely suggested that they are the right things in the wrong place, and I propose to try the effect of these sound-holes cut as apertures in the opposite sharp bends of the ribs at the waist. I should begin by making these holes about ½in. in diameter, and enlarge them as found necessary. Not much can be done in enlarging the *f* holes to any extent without positive disfigurement. I think it is about twenty years ago that I sent a communication to this journal on improving or perfecting the tone of a violin by giving more or less thickness to the belly and back, so that they should vibrate in unison. The idea of tuning pieces of wood called forth some ridicule at the time, but the principle now appears to meet with recognition. I have the ENGLISH MECHANIC for the last twenty-five years, but as yet have not been able to search for my article. The experiment I tried was this: Having an old violin that was weak and poor in tone on account of the back being abnormally thin, I glued a strip of pitch-pine about ⅛in. thick outside beneath the length of the back. I then pared away the thickness of wood till, by repeated trials, I had fetched up the tone. In a rough way this proved my position, but as the subject is now revived again, I shall probably have some experiments tried more carefully in all ways in the construction of a more perfect violin, and will record the results in this journal. **F. H. Wenham.**



VIOLIN MATTERS.

[33073.]—To "Assoc.M.Inst.C.E." (letter 33039) I would say that the muffled tone is certainly an imperfection, and may probably be the result of the bass-bar being too short or imperfectly fitted.

You may reduce your neck to suit your own hand: it will not affect the tone of the instrument in any way. Too thin a neck, however, is not desirable. I have given dimensions of a Guarnerius in the above sketch, which I trust may serve as a guide.

Matthias Griesser was a maker of lutes and fiddles, as his label indicates, but was not considered amongst the best of the German school. His label was—

Matthias Griesser,
Lauten und Geigenmacher,
Insprugg, Ann. 1727.

Glasgow. **Scio.**

[33074.]—WOULD it be too much to hope that Mr. Pickering will supplement his very instructive articles by giving us some hints as to the manner of adjusting the tone of a violin? There are no doubt many of the violinist readers of the "E. M." who, for want of time and convenience, could not undertake to make a violin; but have instruments that might be improved, if someone would show us how.

I will give two cases, and ask his advice: A violin has had the belly thinned down at the lower end; it is high-breasted, bass bar about ¼in. deep, and full-length; fingerboard gives about 1¼in. bridge. The back has not been thinned, as there are traces of the original varnish, which is nearly all removed; soundpost ⅜in. behind centre of right-hand foot of bridge, strings slightly less than full size. The tone of this instrument is sweet and penetrating on first and second strings, but decidedly "tubby" on third and fourth. The last-mentioned comes up a little in tone if the soundpost is moved towards the centre (⅜in. back). In the case of a new "Grandini," which is fairly even on all strings, and has been played upon for last six years, the tone is full, but rather hard, and lacks that penetrating quality which is generally noticed in good instruments; it seems to be of a fairly full thickness, and is quite intact. Could these be improved in any way?

I should like to ask a few more questions from an "amateur violin repairer's" point of view, but am sure that if Mr. Pickering should be taking the matter in hand, he would treat it in the same concise manner as before. **J.**

[33075.]—FOR years I have always regulated my violins myself: by "regulation," I mean finding proper height, and thickness of bridge, and the best position for the soundpost. I would gladly pay a dealer to do it for me, but invariably find that, after I have paid the dealer, I have to do the work again *de novo*. These men are very skilful up to a certain point; but they are not players, and, in order to ascertain if a correct result has been obtained, it is necessary to try the violin in various keys, on all the strings, and in high positions, as well as low ones. It is a long, exhausting, and anxious business, and it is no use persisting in the experiments when the ear is jaded. Joachim, I have heard, when anything goes wrong with his violin, sets off at once to one particular man in some German town. Strauss, I believe, regulates the violin himself. All admit this regulation is a matter of the extremest difficulty. Not one violin in a dozen is correctly regulated; not even those in actual use, and belonging to professionals. Few people possess the requisite attributes of tireless assiduity, patience, and intense development of critical and discriminating faculty, and to those who do possess these last, it is more of a curse than a blessing, though useful.

There is no rule for finding the correct position of the soundpost. It varies in every violin. Every violin has a strong and separate individuality. The variation may be not more than $\frac{1}{32}$nd of an inch, and yet this may make all the difference in the world. Generally speaking, a high-built instrument likes a sound-post nearer to the foot of the bridge, and ¼in. will not be too near in some instruments; in low, flat fiddles the anterior edge of the S.P. may be ⅜in. from the posterior edge of the bridge foot.

If the 3rd and 4th strings are strong and full-toned, but 2nd and 1st weak, the post wants pulling a little to the treble side. The great thing is to get all the strings even. If the fiddle sounds well in low positions, but dull and weak in the upper, move the post a bit further back, and *vice versâ*.

The post should fit the belly with the utmost exactness. This is best ascertained by careful examination of the underside of the belly with a laryngoscopic mirror. By this means the post can be fitted as exactly as if it were an external operation, the slightest want of apposition being instantly detected. The fit of the post to the back is not a matter of as much importance, and it is difficult to get an exact fit of both post ends, but the belly end *must* fit.

Before making the experiment, the violin must be well strung with good, properly proportioned strings, one string false or disproportionately thick will alter the tone of every string on the fiddle, and I might almost say every note. Mind nothing touches the fiddle so as to jar; tighten up the holder, and see that no string-ends touch the belly under the tail-piece; mind, also, and have a fairly new fourth on, as the wire gets loose in many old trings, and jars: otherwise you will be apt to alter the soundpost for defects not due to it, and may land in a hopeless muddle.

What I write now has cost me years of study and experiment, and may be of use to some of less experience than myself; but there are some amongst your readers who could add to and improve upon what I have written, though I am aware of no published matter containing as much on this subject as I have sent you.

My best thanks to Mr. Pickering for his splendid articles on violin-making. His is the most able and honest effort to teach the art that I have ever come across. **Lancastrian.**

THE HAWTHORN LOCOMOTIVE.

[33076.]—As it may interest some of the readers of the "E. M.," I herewith inclose a drawing and description of the above engine, which was exhibited at the great Exhibition of 1851, and is, I think, a fair specimen of the English locomotive at that period. The dimensions of this engine were as follows:—Wheels, diameter of driving, 6ft. 6in.; ditto, leading and trailing, 9in. diameter; cylinders, stroke 22in., diameter 16in.; heating surface: firebox, 98·6sq.ft.; ditto tubes, 865·4sq.ft.; total, 963·0sq.ft. There were 158 brass tubes, outside diameter 2in.; total area of firebox, 110sq.ft. The firebox had a bridge, with water space across the centre. The maximum speed of the engine, with an average express train, was equal to 80 miles per hour on a good line of railway. The improvements in the engine consisted of compensating beams and springs, instead of the six ordinary springs (one to each axle bearing), thus causing a direct and simultaneous action communicated to all the axle-bearings, so that a uniform weight was constantly maintained on all the wheels and axle-bearings, thus causing a constant amount of weight on the driving-wheels. It will be seen from the sketch that all the axle-bearings on the "Hawthorn" were outside the framing, the trailing axle being immediately behind the firebox. Patent slide-valves were placed vertically between the cylinders in one steam-chest in the usual manner. The link motion was also introduced into this engine for the first time by Messrs. Hawthorn and Co. The engine had no steam dome, the prevention of "priming" being caused in a manner similar to that now adopted in the G.N.R. locomotives, a steam-pipe fixed into the tube-plate of the smoke-box, and extending nearly the whole length of the boiler (near to the top), and perforated with a number of small apertures, so proportioned as to admit the steam into the pipe directly above where it was generated, instead of having to rush from all parts of the boiler to one or two orifices, so that steam was carried into the cylinders more pure. It is well known, I think, that Messrs. Hawthorn were the first to apply the "four fast eccentrics" to the locomotive engine, "immerse them in a fairly strong boiling hot water," which is contrary to general opinion; but he may be right and general opinion wrong. On this point of hot or cold I should like further information. Finding by painful experience that articles of wool do shrink much, I tried to learn what is done by the manufacturer. My knowledge is imperfect; but I learn that after the articles are made, wooden boards are placed inside them of such size as to stretch them out larger, and sometimes much larger. With these boards remaining inside they are heavily pressed, and this pressure causes them to retain the increased size. In this state they are sent out into the world, and the first washing shrinks them back to their original size. The manufacturer will say that the object of this stretching and pressing is merely to smooth the face of the goods, but it is also done to make them appear larger than they really are, and this is really the most deceitful part of the business, causing most of the after inconvenience. Now for my mode of remedying this. I cut some wooden boards to put inside the articles and to stretch them out to what I considered requisite. After the articles are washed and dried, I place these boards inside, well wet the articles, and hang them up to dry on these stretchers. When quite dry they are taken off and remain stretched out, fit for wearing; but the next time of wetting or washing they will shrink back to their original size, and have to go through this treatment after each time of washing, so that this method of enlarging is not permanent; but I think that after it has been done a number of times the enlarging may become permanent—I hope it will. Should anyone try my method, there is one thing to be remembered: the stretching must not be carried out all over the ribbed portions at the ends; leave 2in. or 3in. not stretched, for if the stretching is carried quite to the ends, these ends will curl up, and thus destroy the object of the ribbing. **Simonides.**

[75903.] — **Incandescent Gas-Burner.** — In answer to "S. G. R.," I may state the products of the incomplete combustion of a Bunsen burner are by no means so deleterious as those from a luminous (ordinary) burner. Leaving out such gases as nitrogen, carbon dioxide, &c., analysis has shown for the two kinds:

	(*a*) Luminous	(*b*) Bunsen.
Carbon Monoxide..	1·189	·006
Acetylene	·036	Nil.

parts per 100 of gases analysed. As is well known, these two gases are very poisonous, whereas hydrogen, marsh-gas, &c., may be styled innocuous in comparison. In any style of incandescent lighting danger is to be feared from "checked combustion," where most certainly unburnt gases find their way into the air of our rooms, and render it unfit for respiration. **Iota Dash.**

[75908.]—**Incandescent Gas-Light.**—I also, as "Z. Y. X.," wish to know of the power and capabilities of this light. I want a small-power engine (½H.P.) for an amateur to drive lathes, circular and band saws, or even a general joiner, and have made a lot of inquiries, but, so far, have found nothing really satisfactory. Gas machines are either a failure or fearfully expensive, and this incandescent light no one knows anything about. Petroleum engines seem also to be either humbug or so dear there is no touching them. I should like to light and heat my shop by gas of some sort; but it must be guaranteed free from danger in any form. The benzoline used in the incandescent machine is highly inflammable, and therefore, I take it, exceedingly dangerous. Of course, it is understood I am out of the reach of ordinary coal-gas, and that I want something to take its place.

James Cooper.

[75903.]—**Incandescent Gas-Burners.—Injurious Combustion Products.**—In answer to "S. G. R." (p. 447), the products of combustion in all forms of Bunsen burners are certainly more injurious than those of ordinary illuminating burners. Not only is acetylene (which causes most of the bad smells) liable to be formed, but carbon monoxide, an odourless and extremely poisonous gas, is always given off, especially when the flame is applied to a solid surface colder than itself, such as an incandescent mantle, a fire-clay lump, asbestos fibres, or wire gauze. This I mentioned a few weeks ago in a reply respecting the "fire-globe" (p. 266 of this vol.) I know a science professor who was very nearly done to death by a small asbestos gas-fire in his bath-room, the register-valve in the flue of which had been closed without his observing it. He found his mind wandering and strength failing, and was just able to throw open the window and escape through the door; but he did not recover from the effects for several days. I have been in several churches warmed and poisoned by stoves with non-illuminating burners, and my devotions have been always mingled with (1) pity for my fellow-sufferers, (2) admiration at their heroic but unintelligent endurance Sunday after Sunday, (3) disgust at the ignorance and stupidity of the officials and gasfitters who provided such a welcome for those who came prepared to join in a bright service and appreciate a good discourse. I fear that it is of little use to repeat that no stove with non-illuminating burners should ever be used without a thoroughly efficient flue, of such a kind as to make a down-draught or a stoppage impossible. A wretched 2in. pipe, poked horizontally through a wall or window is not enough. If a brick flue is not available, a 3in. or 4in. pipe, rising vertically for some distance and kept from chilling by a wrapping of slag-wool, should be used. **A. X.**

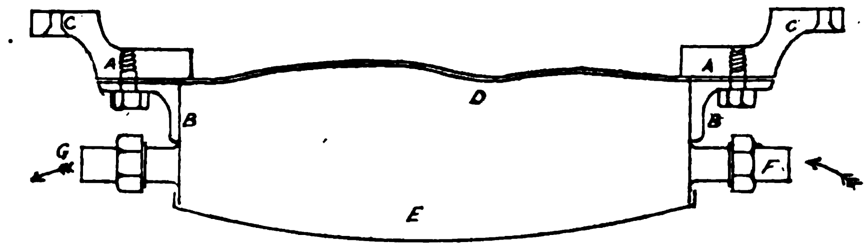
[75924.]—**Strain of Engine Belt (U.Q.)**—This is not an easy problem to solve, and the following is only approximate:—The pulley on the engine being 5ft. diameter, the circumference of the pulley is 15·7075ft., which at 80 rev. per minute gives 1256·6ft. per minute as the belt speed. Then if S be the strain on the belt in pounds, and 80 the I.H.P.

$$S = \frac{33{,}000 \times 80}{1256{\cdot}6}(1 + K).$$

K being a co-efficient dependent upon the portion of the driven pulley embraced by the belt. If this is 0·4 of the circumference of the driven pulley, then K is 1·10; if 0·5, then K is ·77; if 0·6, then K is ·62. To solve the problem accurately, many other considerations have to be taken into account, such as adherence, centrifugal force, &c., and it would probably take an hour or more to work it out with logarithms. A link-belt merchant's list will give you the proper width to transmit the 80H.P., and these belts, as I know from long experience, grip extremely well, although not always at first, I believe because a vacuum cannot form under them. I should, however, use a wider link-belt or ordinary belt than 12in. to transmit 80H.P. at this belt-speed; in fact, for doing your work with a belt ¾in. thick, 21in. would, I believe, be nearer the width, and ¾in. is more like four-fold belting than double belting. **Mistral.**

[75930.]—**Gas-Engine.**—I send herewith sketch explaining method of making tin-plate gas-bag (?). As only the back is flexible, it must be made considerably larger in dia. than the old rubber bags. The only way you can tell if the bag is full is by putting your hand behind and feeling, unless you rig up some sort of indicator, which is not, in my opinion, worth while. A A, iron or brass ring with three or four lugs, C C, cast on it; B B, ring made from angle brass, to which the tin-plate body E is soldered; D, rubber diaphragm (which must not be stretched tight); F, inlet; G, outlet.

Brighton. **T. C. Smith.**



[75964.]—**Coating Iron with Brass (U.Q.)**—As to which is the cheapest, I cannot say; but should think it cheaper to make them out of sheet brass at once. However, it is possible to electroplate with brass. To deposit copper or brass, &c., on iron or any other metal affected by sulphate of copper, the solution must be strongly alkaline. Weil gives the following method:—Dissolve 150 parts of Rochelle salt in 1,000 of water, and add 80 parts of soda lime, containing 50 or 60 parts of caustic soda, then 35 parts of copper sulphate. As the metal is deposited bags of oxide of copper hung in the solution keep up its strength. With this solution other metals, brass, &c., may be laid on if their salts are substituted for the sulphate of copper. I succeeded in depositing brass on iron many years back, but have not the exact formula of the solution at present by me. It is a troublesome operation, and requires a strong current. The thickness of the deposit of course depends on the length of the operation, and for thin sheet articles, after all the labour necessary, it would seem to point more to a loss than a profit. **Mistral.**

[75969.] — **Hydrochloric Acid (U.Q.).**— No chemical work that I know of justifies the formula you propose of H_2ClO, on the contrary. Besides, HCl in combining forms chlorides, not chlorates, which may be compared with sulphides and sulphates. The heat given out in the combination of this acid with the bases does not seem to verify your supposition, and many substances, such as protosulphide of tin, metastannic acid, &c., are soluble in concentrated HCl, but insoluble in water. **Mistral.**

[75997.] — **Leclanche.**—M. Leclanché was a Frenchman, who improved the binoxide of manganese battery cell by amalgamating the zinc, and by the use of salammoniac instead of the usual acid solution. Probably the fullest description of his cell and his invention will be found in Niaudet's work, but, as the querist has found, very little is stated of the man himself. He was, I believe, a telegraph engineer or operator, on the Eastern Railway of France. **Nun. Dor.**

[75979.] — **Rarefaction of Air by Fan Motion.**—If air can reach the fan there will not be a vacuum produced, as the air will naturally flow in as fast as it is withdrawn or forced out by the fan blades. **T. L.**

[75984.]—**Cylinder Rings.**—Spring the rings out a bit until they have to be squeezed to get the piston into the cylinder. Is the cylinder true? Perhaps that may be the source of the defect.

M. M.

[76018.] — **Mechanical Telephone.**—If this telephone with the broken diaphragm is one of the ordinary type, a new ferrotype plate is probably all that is required; but it may be one with a bladder diaphragm, and then all that will be necessary is to get a piece of bladder, stretch it while wet, varnish when dry, and then it will be as good as ever. If it is metal, it is no doubt ferrotype plate, as that is what is generally used. **M. P.**

[76141.]—**Deafness.**—I would certainly endorse "The Lydney Dispenser's" remarks on the danger of syringing an ear till the fluid passes out through the nose. The tympanum—or drum—entirely shuts off the nose from the outside ear-tube in ordinary folk. In cases where accident or disease has ruptured the drum, it can be done with benefit; but in cases where the drum is intact, it might rupture it, and thus break down one of Nature's barriers, whose function is to keep the outside air from the inside cavity (amongst other things), and the rupture of which, perhaps, has caused that very deafness which the syringing in question now relieves, by carrying away external causes of inflammation that have got into the inner ear, through that ruptured drum. Be thankful if fluid cannot pass from the outside ear to the nose.

Shanklin, I.W. **H. G. Dixon.**

[76153.]—**Distilled Water for Domestic Use.**—The Salutaris Company supply several sorts of the above, still or aërated. Write to them, Brompton-road, S.W. If you wish to distil for your own use, you must apply to the Inland Revenue for liberty, under stringent laws.

B. F.

[76180.] — **Accumulators.** — Brunswick black would be a good thing to apply, especially if the nuts, &c., were warmed previous to its application.

A. E. B.

[76182.]—**Small Steam Boiler.**—I presume your boiler is a welded one. You can work it with perfect safety up to 100lb. pressure. There is not sufficient water space for useful work.

Draughtsman, Patent Light Co.

[76184.] — **Boring and Turning Engine Cylinders.**—I should be glad if J. T. Blacket would, with the Editor's permission, send sketch of boring bar, &c., for "Ours." I think an article on the use of boring bars would be very acceptable to many amateur mechanics, showing the different methods of fixing the castings, &c.

Titmouse.

[76185.]—**Proportions of Cylinders.**—A very good rule, and one that is much used in practice for the thickness of cylinder flanges, is:—To the thickness of body of cylinder + ·25; cover = thickness of body + ·1; thickness of bod
meter of
cylinder × ·06 + ·2.

Draughtsma
o.

[76193.]—**Safety Bicycl**
class
machines the chain-wheel o
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tachable, and can therefore
ittle
expense. In the cheaper m
ften
of malleable iron in one
; in
which case the wheel wi
n to
pieces and a new hub put i

[76194.]—**Safety Bicycl**
wheel of a rear-driving saf
or screwed and soldered on
can get it off and send it to
or machine, they will send
putting on; but if the ball

much, he had better have a new hub put in by a cycle repairer. J. L. M.

[76197.]—**Electric Light.**—Many thanks to Mr. Bottone for his reply to this query. Would he kindly tell me in making inquiries as to dynamos in each case, how I should describe my requirement? I suppose it would be "a dynamo of so many volts and so many amperes." BORDERER.

[76198.]—**Bunsen v. Daniell.**—Allow me to thank Messrs. Smith and Bonney for their answers to this query. I am well acquainted with the Bunsen; but looking through some old numbers the Daniell is so often recommended as being superior to it, that I wished to know the advantages of the Daniell and the proper form, as so many modifications are given. However, from Mr. Bonney's answer, I fail to see the gain in substituting a Daniell for Bunsen—in small work, at all events, which mine is at present. My battery, which is sufficient, being an ordinary Leclanché bell battery converted into a Bunsen. BORDERER.

[76198.]—**Bunsen v. Daniell Batteries.**—In my opinion, the Daniell is the best: my reason being because of its constancy and reliability, and also because it gives off no objectionable fumes. A Bunsen weakens (1) by the weakening of the exciting acid; (2) by the gradual impoverishing of the nitric acid; (3) by the accumulation of zinc sulphate. No. 3 is the only one which applies to the Daniell, for sufficiently obvious reasons. The proper form of the Daniell is (1) a copper pot; (2) a porous pot, with a zinc cylinder inside. Charge the porous pot with water, and the surrounding copper pot with a saturated solution (blue vitriol), and have some spare crystals in a muslin bag, suspended in this, so as to keep the solution in a state of saturation. A stoneware pot, with a lining of sheet copper, such as is used for stencil plates, will do, instead of the copper pot. Remove the porous pot and zinc after use, or your zinc will be blackened by the osmosing of the copper solution.

A. E. B.

[76199.]—**Battery Cells.**—Put the pot into a slow oven for the night, so as to expel moisture, of which all apparently dry, earthy matter contains a great deal, and brush over in the morning with brunswick black. If you use paste in the composition of a paper cell it will soften in the water whatever you apply to the outer surface. I should think some kind of thick varnish or gold size might well be used for the purpose. A. E. B.

[76202.]—**Teeth and Smoking.**—The deposit should be removed with dental scaling instruments in the same way as tartar. When this was last done for writer, dentist advised that as much care should be given to use of tooth-brush behind the teeth as in front, and deposit would not form. Twelve months' experience has proved the correctness of the advice. The only dentifrice used has been soap and occasionally a little precipitated chalk.

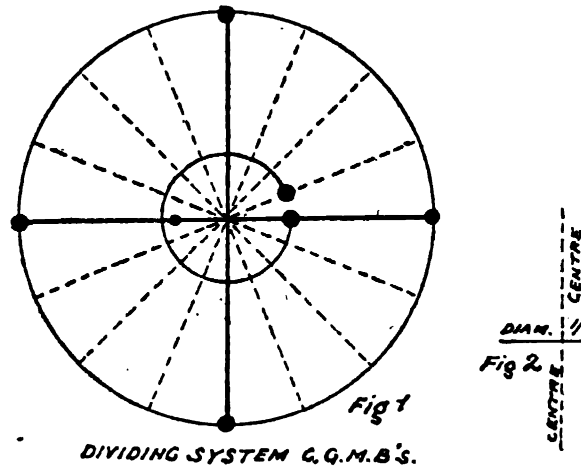
A. W. B.

[76204.]—**Electric Light for Safety Bicycle.**—Your query, like a good many other things, shows what pretty and ingenious fancies can be discovered (in the mind), but unfortunately, have no counterpart in nature. To produce such a light as you mention would require your whole strength, even granting that you possess more than the average amount. To keep this going, and also your bicycle, you will need the strength of a horse, but must not have its weight. My advice is keep to colza and paraffin. A. E. B.

[76211.]—**Devil Insect.**—This diabolical designation is too indefinite for identification; their name is legion. Linnæus, when collecting insects, was badly stung by an "infernal fury," so it is described in an old book on Natural History I possessed. Many years ago I sent an account to this magazine of a terrible flying creature frequenting the virgin forests of the Upper Brahmapootra river, and an illustration of the deep and lasting scar produced by his ejected poison; so formidable an antagonist to a man's eyesight that no pecuniary reward would tempt a half-starved savage to capture a specimen, and I do not think there is one in any collection. He is locally known as the "great bug." The following from South Africa will be interesting:—"Mr. W. H. Reddel, sen., who returned from Bloemfontein last week, informs the *Somerset West Budget* that the train in which he came down was about 12 hours late at Cookhouse, having been delayed by the locusts on the line. At one place near Middelburg Road they spent six hours in getting up a small rise, having to take the train into three pieces before they could do so. The locusts lay some 6in. to 10in. thick on the rails, clogging the wheels, and rendering the rails so greasy that the train slipped constantly back."

Eos.

[76212.]—**Wheel-Cutting.**—This system, which I send to the "E.M.," I am almost sure you will find good and easy to work out. I discovered this method very quickly after reading your query, and I fail to see how you can get at the point any other way unless you guess at it. Proceed as follows:



DIVIDING SYSTEM C.G.M.B.'S.

Draw a circle any size you like on your drawing-paper, then divide your circle into four equal parts (any line drawn from the centre of a circle to the circumference is called a radius, and all straight lines drawn from a certain point within the circle to the circumference are equal to one another—Euclid, def. 17, 19), as shown by the lines not dotted in Fig. 1. In your query, you want your wheels to have 12, 18, 24 teeth, ⅛in. pitch. I will take a wheel, for an example, to have eight teeth, such to be ⅛in. wide, and let you work out your wheels yourself with my method. I draw a circle any size, and divide it into four equal parts (as stated above), and each part I again divide up into four more equal parts, making dots for the division; then I draw a straight line from the centre to each dot on the circumference, thus dividing my wheel into 16 equal parts, exactly twice the number of divisions I require. Each tooth is to be ⅛in. wide, so I take my compass and open it ⅛in. With the help of my compass I then guide it between one of the spaces until it fits between the two dotted lines I chose, equally; I then make a dot on each line, as shown in Fig 1, and from the centre draw a circle, using the space between the centre and the dots as a radius; you then know that the tops of the divisions within the circle are ⅛in. broad. If you want your cogs ⅛in. high, you again measure with your compass, but this time along the diameter and dot as shown in my sketch; then take the size of circle we have just made, and draw your cogwheel (I explained how to draw a cogwheel in a back number of the "E. M.") You will find on looking at my sketch that I have 16 divisions, but only 8 cogs as required. You will do well if you remember this rule, the only one in my method—viz., double the number of cogs you want to draw, and divide your wheel into as many spaces as the addition comes to. For example: Required to draw a cogwheel having 8 cogs, each to be ⅛in. wide. For this example you must divide your circle into 16 parts, as I have done in my figure. Fig. 2 shows diameter of wheel with 8 cogs, which is a little over ⅛in. Of course the greater width of cog, the larger the wheel. I have proved this method by drawing very large wheels, and find (that is to say if the drawing is correct) that the measurement is just the same as a small wheel. "Tredagh" must divide his wheels as follows:—First wheel, 24 spaces; second wheel, 36 spaces; third wheel, 48 spaces. If he does not understand this system, I will send him his wheels already marked. I hope this system will help a good many draughtsmen in their drawings of cog-wheels. By studying the illustration in the ENGLISH MECHANIC for half an hour, they will soon be acquainted with this method.

C. G. M. BENNETT.

[76212.]—**Wheel-Cutting.**—To find the diameter of cog-wheels the pitch must be multiplied by the number of teeth (which will give length of pitch-circle), the result divided by 3·1416 (for diameter of same)—and a fraction of the pitch—usually about ⅘ added for actual diameter. However, various makers differ as to the exact proportions of teeth. Thus:

$$\frac{\cdot125\text{in.} \times 12\text{in.}}{3\cdot1416} + \cdot125 \times \cdot8 = \frac{1500}{3141\cdot6} + \cdot1$$

∴ 31416) 150000 (·477 + ·1 = ·475in.
125664 Diam. of wheel
——— of 12 teeth.
243360
219912
———
·234480
219912

The other sizes are 1½ and 2 to the above.

T. S. B.

[76212.]—**Wheel-Cutting.**—Multiply the pitch by the required number of teeth and divide the product by 3·1416, this gives the pitch-line diameter. Then add to the diameter at pitch-line $\frac{11}{15}$ of the pitch of cog, and this gives the diameter at the top of teeth. Then subtract from pitch-line $\frac{13}{15}$ of the pitch of cog, and this will give the diameter at bottom of teeth. Example: A wheel is to be made with 12 teeth ⅛ pitch, then ⅛ pitch is equal to ·125, then—

·125
12
———
3·1416)1·50000(·477 pitch-line
125664
———
243360
219912
———
234480
219912
———
14568

Then get $\frac{11}{15}$ of pitch thus—

·125
11
———
15)1·375(·091 = $\frac{11}{15}$ of pitch of cog
135
———
25
15
—
10

Add this to pitch-line diameter, and the answer will be the diameter at top of teeth, thus—

·477
·091
———
·568 diameter at top of teeth.

Then get $\frac{13}{15}$ of pitch thus—

·125
13
———
375
125
———
15)1·625(·108 = $\frac{13}{15}$ of pitch of cog
15
—
125
120
—
5

Then subtract this from the pitch-line diameter, and the answer will be the diameter at bottom of teeth—

·477
·108
———
·369 = diameter at bottom of teeth.

Then a wheel with 12 teeth ⅛in pitch will be—

·477in. diameter at pitch line
·568 „ „ top of teeth
·369 „ „ bottom of teeth

A wheel 18 teeth ⅛ pitch—

·716
·807
·608

A wheel 24 teeth—

·954
1·045
·846 F. TAYLOR.

[76215.]—**Gas-Engine.**—So far as economising the force generated by the explosion is concerned, it is of great advantage to fire the gas by the electric spark. In the oldest form of gas-engine, the gas was fired, I believe, at what might be termed a touch-hole, and hence the same waste accrued as in the old flint-lock musket, by the force of the explosion partly expending itself through the vent; this the closed percussion cap removed, and so did the electric spark, in the case of the gas-engine. I believe now the same end is attained by means of a small iron tube, kept red hot, and closed at the end in the flame; but, at the other end, opening into the explosion cylinder. A. E. B.

[76216.]—**Winding Motor for Boat.**—To MR. BOTTONE.—The whole specification for this motor and battery, to drive a 15ft. boat, is faulty, and would give no good results. To begin with the battery. Four chromic-acid cells will give 2 volts per cell = 8 volts; and the largest current you could take from them, without running them down in less than half-an-hour, would be 2 ampères. Hence 2 × 8 = 16 watts = $\frac{1}{46}$ of H.P., certainly not enough to drive your boat. You will want at least 12 cells. Then a Siemens armature 3in. diameter should be at least 9in. long, and have a channel 1¾in. wide and 1in. deep, the web being ¾in. wide. This could be worked with 1¼lb. No. 18, and the fields, which should be as long as the armature, but standing only about 6in. high, including the polepieces, should be wound with 7lb. No. 16, connected in series. This would give ⅛ to ¼H.P.

S. BOTTONE.

[76217.]—**Laminated H-Armature.**—To MR. BOTTONE.—Cast laminations not nearly so good as punchings from the sheet. Bosses which allow the plates to touch, undo the good that lamination is supposed to effect, since each lamination is supposed to be magnetically and electrically insulated from its fellow, to prevent the occurrence of the Foucault or cross-eddy currents. In my 3in. armature the laminations are $\frac{1}{32}$in. thick, and the air space between about the same. S. BOTTONE.

[76218.]—**Bristol Steamships.**—The *Great Western*, being 2,000 tons and 500H.P., was built at Bristol in 1837, a paddle-wheel Atlantic steamer, commanded by Capt. James Hosken. The *Great Britain*, being 322ft. long, 1,000H.P., iron screw ship, was built at Bristol 1843. Gates and masonwork had to be removed to get her out of dock. Capt. James Hosken had command, and in September, 1844, through a revolving-light being omitted in the chart, the ship in a storm got stranded in Dundrum Bay. My sister, Admiral Hosken's widow, 9, Apsley-terrace, Ilfracombe, has a small autobiographical sketch printed, which gives some very interesting information, if "M. W. G." will write. WM. HOSKEN.

[76218.]—**Bristol Steamships.**—The *Great Western* was launched on July 19, 1837, was commanded on the New York trade by Capt. James Hosken (afterwards Admiral Hosken, R.N.), under whom she made sixty-four trips across the Atlantic, 1838—1843; was sold in 1847 to the West India S.P. Co., and was broken up at Vauxhall in 1857. It was this steamer and the *Sirius* steamer, belonging to the St. George Steam Packet Co., that made the first entire and boná-fide steam voyages across the Atlantic. The *Sirius* left London (as previously advertised) for New York, calling at Cork Harbour to "coal-up" on March 28, 1838, arriving at New York at 9 p.m., April 22. The *Great Western* left Bristol on April 8, 1838, arriving at New York on the 23rd at 3 p.m., the *Sirius* therefore gaining the priority by 18 hours in this historic voyage. The *Great Britain* was floated out of the building dock on July 19, 1843, but did not leave Bristol until January 23, 1845, having been detained, in order to increase the width of the gate locks at Cumberland Basin. She made two double voyages to New York under Capt. Hosken, but on her third voyage ran on shore in Dundrum Bay, County Down (not, as "M. W. G." stated, in Bantry Bay!), owing to a light having recently been put up, but not on their chart, and so was mistaken for that on the Isle of Man. She had, in fact, also overrun her distance. This occurred on September 23, 1846. She was floated off on August 27, 1847, and sold afterwards to Messrs. Gibbs, Bright, and Co., who refitted her with auxiliary engines; but she was afterwards converted into a sailing vessel, and then into a hulk. There was another large iron steamer built in Bristol whose name I cannot recollect. In taking her down the Avon, she got across the narrows on a falling tide, and broke her back.

ROBT. J. LECKY.

[76219.]—**Oil-Stove Cookery.**—The fault which you mention appears to be inherent in the construction of your oil stove. The same defect—top-heating (which is against all true principles)—is also incidental, as you truly remark, in the modern kitchen range. What should we think of a hot-water engineer who placed the boiler at the top of the building? And yet a similar absurdity is tolerated every day in thousands of houses. The cook, however, rising to the occasion, sets in action, by means of abundance of coal and pulled-out dampers (?), a veritable furnace. I do not know what Lancashire ranges are like; but those I have seen in Sunderland appear to answer to "Derby Castle's" description, their chief feature being the elevation of the oven, so that the bottom of it is level with the fire. The principle of such an arrangement is unimpeachable. But the best oven I have ever seen is the Norfolk oven. This is generally set in a recess, with a kind of copper flue underneath, the direct action of the fire upon the bottom of the oven being moderated and diffused by a ¼in. iron plate extending all over the bottom. This in working is splendid. A. E. B.

[76220.]—**Electro-Motor.**—If you can tell me how many ampères of current you propose passing through your motor I can help you; without this I cannot, because the gauge of wire to be used depends on the amount of current it is called upon to carry. S. BOTTONE.

[76221.]—**Spritsail versus Gaff and Boom.**—There is a lifting quality about all lugsails and gaff-sails not possessed by spritsails, which latter press on a boat. I do not like them, and gave up their use long since. WM. HOSKEN.

[76221.]—**Spritsail versus Gaff and Boom.**—The best rig for a sailing boat is the "sliding gunter rig"—viz., a topmast rigged abaft the lower mast, with a ready down haul—a "shoulder-of-mutton" sail, ending in a point, and a boom—a single foresail with the tack to the top of the stem. Spritsails are handy for smooth water and light wind, but dangerous otherwise. B. F.

[76221.]—**Spritsail versus Gaff and Boom.**—A spritsail is much the more handy to use; but it looses some in running before the wind, although it is good for beating on a wind. The danger of a boom, especially to such a sail, when running is that it stretches out so far to leeward, and a roll or a puff may bring the boom into the water just at the critical moment when you wish the boat to come up to the wind, which is, of course, thereby prevented, and a capsize takes place. A sprit without this is free from the great danger that, to my mind, goes with long, low booms, put out to windward. Could you carry a big lug to run with as well?

Shanklin, I.W. H. G. DIXON.

[76224.]—**Gearing.**—I have in my possession an old book (1836), "The Principle of Mechanics," by William Emerson, with an appendix by G. A. Smeaton. This book contains 83 copper-plates, many of which are devoted to gearing. As the book is so ancient, I doubt if it would be of any service to you beyond its interest as a curiosity. It was published by Orlando Hodgson at 12s.

A. D. SOUTHAM.

[76225.]—**Crucible.**—The separation of gold, silver, and lead is by no means a simple matter without proper appliances, and unless the quantity to be dealt with is large, it will be much the cheapest method to send it to the refiners.

THOS. FLETCHER.

[76226.]—**"Induction' Coils: How Made and Used,"** by Dyer, is a handy book, price 1s. S.

[76226.]—**Induction Coil.**—"T. B." will find particulars of a coil giving 8in. spark in Vol. XXX., p. 611, and Vol. XXXI., pp. 45, 310, 410. This coil is still extant.

Belfast. J. BROWN.

[76226.]—**Induction Coil.**—If "T. B." will ask Mr. G. E. Bonney for the information through the columns of "Ours," I have no doubt he will get the very answer he requires. Mr. Bonney has lately been engaged in writing a splendid book on coils (I am not quite sure whether it is already out of the publisher's hands), which promises to be the most complete work on the subject in the English language. The Pyke-Barnett pattern seems superior to many forms in point of perfection of insulation. Some that I have seen, however, seem to take a good deal of battery power to drive them.

S. BOTTONE.

[76228.]—**Cataract.**—Induce your friend to consult an eye physician at once, and not be deceived (the disease will not be deceived) by the pretensions of homœopathy, which, as you say, would be a waste of time, trouble, and expense; or, if living in, or near, London, to attend the Ophthalmic Hospital, near Broad-street Station.

A. E. B.

[76230.]—**Round Haystack.**—Divide circumference in feet by 3·14 = diameter; diameter squared and divided by ·7854 = square feet in base of stack; square feet multiplied by height from ground to eaves gives cubic feet in that portion of stack. Apply the same process to that portion above and divide by 2. Add the two results together and divide by 27, and you have the cubic yards in stack. W. B.

[76230.]—**Round Haystack.**—The area of the base by the perpendicular height will give you the solid content. To obtain the area of the base, multiply the square of the circumference by ·07958. Your rick accordingly would contain 35·09478 cubic yards. Any round hayrick would, I imagine, be measured in this way, with the exception of the height, which is usually taken from the sparring just above the eaves. The weight of a rick after the measurement is known is a matter of judgment, the allowance per cubic yard varying from 1 to 2cwt. Round hayricks are unknown in this county (North Hants), but other shapes are usually sold at so much per rick, outsides and everything. How can you have a centre point in the circumference of a circle? You say "three yards high on the outside in the centre."

WALTER HERBERT.

[76233.]—**Defective Voss Machine.**—To MR. BOTTONE.—Clean carefully from all adhering dust. Revarnish both plates and supports of conductors and brushes with good shellac varnish; dry in a warm, dry room, so that the varnish should not chill, but dry glossy. See that the brushes touch the bosses. S. BOTTONE.

[76234.]—**Thermopile.**—The cause of your failure to obtain more than ½ an ampère on the short circuit may depend on many factors. The two most likely are, first, the insufficient heat of the top of the Duplex lamp chimney as compared to the actual flame of the spirit lamp; secondly, some difference in the composition of the German silver wire, which, in your case, might contain more copper than in mine. S. BOTTONE.

[76235.]—**Breaking-Weight of Spar.**—Should read "length of spar, 40ft.," not "4ft."

SAILOR.

[76236.]—**Neighbours' Pianos.**—As your neighbour is so unneighbourly, try the effect of an occasional grind on the loudest and most out-of-tune old street-organ you can borrow, and place against the wall where his piano is. One good turn deserves another. G. WASHINGTON MOON.

[76236.]—**Neighbours' Pianos.**—I am afraid the mode you propose will not greatly relieve you, since the scantlings nailed to the wall will certainly conduct some of the sound. The following whimsical mode may eventuate in causing your neighbour to move the piano to the opposite side of the room. Procure a cheap barrel-organ (pipe) on hire, as loud and as discordant as you can cheaply get it. Place it against the wall near which the piano of "notre ami l'ennemi" is situated. When the piano is played, you begin to grind away at your organ. No human being can possibly play the piano with any satisfaction to himself, or others, under such circumstances, and he will perforce move the piano to some other spot.

S. BOTTONE.

[76236.]—**Neighbours' Pianos.**—I do not think you would find much relief from the false wall which you propose to erect, for the nails driven into the wall will be quite sufficient to transmit the sound vibrations to your thin boards, sawdust and felt notwithstanding. Whatever is rigidly fixed to the wall is liable to convey the sound to any available sounding surface; so that, even if you silenced the wall, the very floor-boards would cry out. The only course I can think of is to treat the disease on the time-honoured principle of "similia similibus curantur." Purchase a drum, cornet, trombone, or any other Nebuchadnezzar-like instrument, and, when the piano starts, accompany it with the dulcet strains of "My Lodging is on the cold, cold ground," "Oh, where is my boy to-night?" or any other air you may consider applicable at the time being. A. E. B.

[76237.]—**Carbon.**—I do not think carbon can be deposited from any liquid by electrolysis; a protracted disruptive discharge, I believe, throws it down from carbonic acid, and the filaments of incandescent lamps are thickened by rendering them incandescent in carbonaceous vapours and gases; but this could not exactly be called electrolysis. A. E. B.

[76238.]—**Re-charging Dry Cells.**—Connect them with the positive terminal (the carbon) to the positive pole of any battery or dynamo having a higher voltage than they; that is to say, allow, at least, 2 volts for every cell to be charged. The current must not be too large, 3 or 4 ampères, at most, for the usual sizes. One hour's charging will generally be sufficient. S. BOTTONE.

[76240.]—**Electrical.**—1. Although the published price of the book is 7s. 6d., it is sold for 5s. 8d. nett, thus allowing 3d. in the shilling discount. If "Alex." resides in the country, he may only get 2d. in the shilling, if that; but he can obtain the book for 5s. 8d. at Lambey's (stationers), Exhibition-road, South Kensington, or any bookseller will order it for you. 2. Theoretically, there is no difference between a dynamo and a motor. Supply a current to the former and it becomes a motor. Revolve the armature of a motor, and it will give out a current—i.e., it becomes a dynamo. In practice, the "lead" of the brushes would have to be altered—forward for a dynamo, and back for a motor. A shunt dynamo is often used as a motor to start a gas-engine; this is effected by discharging the accumulators through the armature. Briefly, a dynamo is a machine for converting mechanical energy into electrical energy, and a motor converts electrical into mechanical energy. 3. "Practical Electricity" does not give instructions for making dynamos, &c. "The Dynamo" and "Electro-Motors: How Made, &c.," by S. Bottone, are probably more suited to your requirements.

A. D. SOUTHAM.

[76244.]—**Clitheroe Castle.**—If you will refer to the *Oil and Colourman's Journal* for the present month you will find what you want. H.

[76245.]—**Smelting Iron.**—The use of coal-gas for this on a commercial scale is out of all question, on account of the cost. Dowson or producer gas can be used with a regenerator; but the initial temperature obtained by the combustion of these gases is too low to be of any use without a regenerator. The subject is altogether too large to be discussed by correspondence, and information may be obtained from numerous works on the subject. THOS. FLETCHER.

[76246.]—**Spontaneous Combustion.**—You do run risk; any combustible powder diffused in the air, especially if in such quantity as to approach the chemical equivalent, is liable to explode. Flour-mills, from the lightness and exceeding fineness of their products, are particularly liable to such accidents. Of course the danger is greatest at night time, when the gas (or lamps) is lighted, for a flame is necessary to start the explosion. You will not be offended at my drawing your attention to the correct use of the term, "spontaneous combustion," which indicates ignition without the start of a flame or exterior agent from which, under the circumstances you describe, there would be no danger whatever. A. E. B.

[76247.]—**Charging Dry Cells.**—To MR. BOTTONE.—See reply 76238. S. BOTTONE.

[76248.]—**Sulphur in Coal-Gas.**—Procure a piece of sensitised paper from the photographers; breathe on it to damp it slightly. Now turn on the gas, do not light it, but hold the sensitised side of the paper against the issuing jet. If it contains sulphur the paper will be darkened, and show iridescent colours. S. BOTTONE.

[76248.]—**Sulphur in Coal-Gas** may be determined by allowing a jet of the gas to play upon a strip of paper which has been moistened in a solution of acetate of lead or nitrate of silver. If the quantity of sulphur be small, the stain produced on the paper will be a faint brown; or, if large, a brownish black. W. B.

[76248.]—**Sulphur in Coal-Gas.**—This determination is performed daily at about twenty stations in London by order of Metropolitan Gas Referees under various Acts of Parliament; 10ft. of gas are burnt at the rate of half a cubic foot per hour under a suitable condenser, the burner being surrounded by about 2oz. of carbonate of ammonia. The liquid products of combustion are collected and precipitated with chloride of barium. The precipitate is collected and weighed secundum artem. The weight in grains of this precipitate multiplied by 1·375 gives the number of grains of sulphur in 100 cubic feet of gas. Temperature and height of barometer should be noted so that results may be reduced to usual standard, which is 30in. and 60° F.

CHRYSOMELA.

[76250.]—**Coil: Dimensions for 2in. Spark.**—To MR. BOTTONE.—Core 1in. diameter, 12in. long, No. 16 soft iron wire; primary, 2 layers No. 16 silk-covered wire, thin ebonite tube over this; secondary, 2½lb. No. 36 silk-covered copper wire, in three sections, separated by ⅛in. vulcanite discs, each layer of secondary to be carefully insulated from its subjacent neighbour by a turn of good paraffined demy paper, and each layer basted with hot melted paraffin-wax, the excess being melted away by holding a warm soldering iron while it is being rotated in the winder. Cotton-covered wire may be used for primary, as you have it, but will not do for secondary. Condenser, 200 sheets of tinfoil, 7in. by 9in., interleaved with paraffined paper. S. BOTTONE.

[76258.]—**Comets.**—Can give no information as to comet of 1873; but if "Am. Astro." will refer to *Observatory* for current month he will there see what comets are due in 1892. G.

[76261.]—**Drum Armature.**—To MR. BOTTONE.—You will require to get about 5oz. No. 22 on your armature to obtain the desired results. Unless you bore the tunnel of your armature out somewhat, you will find it difficult to make so small a drum armature. S. BOTTONE.

[76262.]—**Serpentine Marble Turning and Polishing.**—The Cornish serpentine turners polish their softer stones with emery cloth, finishing with rouge or putty powder on chamois leather slightly anointing the article with grease or oil before applying the latter. For the harder kinds they use sheet lead, such as is got from the chests, fed with sharp sand from the seashore and plenty of water, or emery powder and water. Flat surfaces are rubbed on a lead block fed with emery and water, and finished on a board covered with leather and rouge or putty powder. Their cement is composed of resin and oil, with as much plaster of Paris as can be stirred in without clogging it enough to prevent running. It is run out in thin sheets on a slate well dusted with plaster. Both lead chuck and stone are made too hot to handle with the bare hand when cementing to the chuck. The stone dust is not dangerous to bearings; but sharp sand, water, and emery flying about are things to dread, and the fine stone dust settles everywhere. CAPT. JACK.

[76263.]—**Silver Casting.**—You have probably failed with the plaster and sand moulds from want of thorough drying. Mix your plaster and sand in equal parts dry, add water, and stir rapidly until you get a plaster, which you pour and shake into your models; remove when set, and dry it slowly and carefully. If not perfectly dry, steam will form, and the casting will be faulty.

THOS. FLETCHER.

[76268.]—**Minimum Thermometer.**—There are several important reasons why alcohol is used in preference to mercury in the construction of minimum thermometers. 1. Simplicity and consequent cheapness of production, for a minimum thermometer of mercury would have to be constructed on Six's principle, which shows maximum as well as minimum temperatures, and is of rather a complicated, and, I think, not over-correct, construction. 2. Mercury solidifies at 39° Fahr., and becomes irregular in its contraction before that point is reached, and minimum thermometers are required for lower temperatures than that. With regard to the second part of your query, the "surface tension" of the alcohol draws the index down—that is to say, the little surface of the alcohol would have to become broken by being dragged past the end of the index when the alcohol retracts, but this it resists for reasons which many experiments demonstrate; but this force is not interfered with when the thermometer again rises. You will, perhaps, say that mercury would act by its surface tension in the same manner, and so it would with an index of some heavier metal (for a steel index would float upon the mercury). But how would you see it through the mercury as you can through the transparent alcohol? Read up the phenomenon of surface tension and you will cease to be puzzled.

A. E. B.

USEFUL AND SCIENTIFIC NOTES.

OX-HOOFS and leather are soaked in French nut-oil, and are then burnt, pulverised, and mixed with sea-salt and potash. The following proportions are used: 30 per cent. of hoofs, 30 per cent. of leather, 30 per cent. of sea-salt, 10 per cent. of potash. This product is said to harden iron all through.

Dry-Plate Exposures.—The firm of Marion and Co., of Soho-square, having convinced themselves of the reliability of the Hurter and Driffield method, have adopted it entirely for the determination of the speed of their dry-plates, and on each box they stamp the number denoting rapidity; they also send gratis, in reply to any application, a little pamphlet which explains the system.

The Square Drilling Machine and its Uses.—At an ordinary meeting of the Civil and Mechanical Engineers' Society, a paper on the above subject was read by Mr. Reginald Bolton, A.M.I.C.E. The author dealt with certain criticisms that have been applied to the invention, and more particularly with a statement, which he characterised as short-sighted and ignorant, that there exists no demand for such work as the tool accomplishes, and showed diagrams of applications of angular orifices and very clearly demonstrated a number of uses which call for mechanically-formed and correctly-shaped holes. It was further urged that a number of stereotyped devices in mechanical construction are no longer rendered imperative now that it is possible to accomplish by this machine attachments of machinery in a perfectly simple and labour-saving manner. The operation of the tool stands superior to that of hand work by at least a ratio of 36 to 1, and in many cases it will produce results utterly impracticable by present methods at any reasonable cost. A curious point in the invention is that it drills round holes with equal facility to any ordinary boring machine, and is really superior in this respect also, as various sizes may be drilled with the same tool, a perfect adjustment of diameter being provided in the machine. It would seem an almost incredible result, but it is nevertheless a fact, that a taper hole of any shape can be drilled either larger or smaller at the bottom than at the entrance, a capability most important to manufacturers of dies. The square drill thus becomes a tool of almost universal application, and would appear to be a necessary adjunct to any constructive establishment, for it operates equally well in wood, brass, and stone. The operation of the machine may be described as that of a rotating drill spindle mounted in a ball joint and vibrated during its rotation against a "firmer" or template giving the desired shape. This template is made adjustable and removable, so that it is a very simple matter to change the work of the tool from a square to flat-sided outlines of many forms. The cutting tool is a one-sided drill bit, containing really one-half of the cutting edge of an ordinary drill.

UNANSWERED QUERIES.

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The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

Since our last "Mistral" has replied to 75694, 75699, 75924, 75964, 75969; "A. E. B.," 75779.

75730. Electric Organ, p. 250.
75738. Testing Rennet, 250.
75739. Fan, 250.
75756. Self-acting Railway Carriage Coupling, 251.
75759. Question in Arithmetic, 251.
75760. Law, 251.
75767. Dry Plate Developer, 251.
75768. Hysteresis—To "Sigma," 251.
75779. Atomic and Molecular Volumes, 251.
75781. Horological History, 251.
75785. Sun Transits, 251.
75799. Repoussé Work, 251.

75976. Explosion, p. 338.
75988. Phosphor Bronze, 339.
75996. Triangle, 339.
76003. Aluminium, 339.
76004. Blower for Organ, 339.
76006. Small Hooks, 339.
76009. Deviation of Compass, 339.
76010. Wire Spinning for Pianofortes, 339.
76016. Silvering Specula, 339.
76017. Generator for Gas Furnace, 339.
76021. Spiral Steel Springs, 339.
76030. Dwelling Houses, 339.
76033. Steel Tube and Casting, 340.
76035. Telephone Construction, 340.

QUERIES.

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[76269.]—**Gas.**—Through what substance—as benzoline, ether, or gasoline—must I pass a stream of air to obtain (1) a gas of great illuminating power, (2) a gas of great heating power? What precautions must be observed to avoid risk, if any, of explosion?—MUDVILLE.

[76270.]—**Camera.**—Will someone kindly tell me what ¼-camera folds into thinnest space, so as to be conveniently carried in the pocket—slides in another pocket? Must have fair extension; no loose parts. Please give dimensions when closed.—MUDVILLE.

[76271.]—**Moulding Cork Dust.**—Can any reader oblige me with information as to what is the best composition for casting or moulding cork dust into squares? I find it difficult to get anything to make the cork dust bind together. I have tried indiarubber solution, but that fails to answer my purpose.—G. KING.

[76272.]—**Statuary.**—Can anyone inform me how to make the gelatinous mixture used by Italians in moulding statuary, &c.? The object to be moulded appears to be covered with the liquid, and upon the composition setting, it only requires slitting up one side to release the original. Upon being released, the mould springs closely together again at the cut part, and is then ready for use, thus dispensing with the somewhat tedious process of "piece-moulding"—i.e., moulding in plaster with a number of small separate pieces, accordingly as the object to be moulded is more or less undercut. I should also be glad to learn if there is any good process for hardening plaster moulds, as I find them very apt to snip and break after using a short time. I have tried mixing the plaster with alum-water, but with no better effect. Also, what is the composition used by image vendors to produce the wax-like glaze on their wares?—E. J. W.

[76273.]—**Pianoforte Tuning.**—In the "E. M." for May 15, 1891, Mr. Bottone (74385) gives a most practical lesson on tuning a piano, for which I thank him, and if it is not troubling him too much, may I ask him two more questions? 1. Where am I to put the stick to stop the right-hand wire of a bichord? A trichord, I suppose it is stuck between two of the strings, leaving one open. I have tried putting it between the hammers; but then the hammer will not work. Perhaps it is done by shifting the action with the soft pedal. Trust you will understand what I mean. 2. What is the difference between a check-action piano and any other? as it seems it is not a new invention. I came across one last week with a check action over forty years of age, by A. Charles Cadby.—C. G.

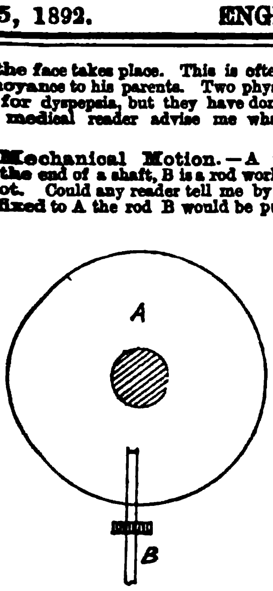
[76274.]—**Rendering Iron Hot by Electricity.**—I wish to heat a piece of iron, 2in. long, 1in. square, by electricity to very near red hot. Could any of "ours" give me the size of a battery for doing same? I want the battery as small as it possibly could be, not to keep hot, but to make red hot in an instant, and then cool down again. Please give size in inches, and price for same.—R. M.

[76275.]—**Fresh Water from Sea Water.**—I am under the impression that the only way of obtaining fresh water for drinking purposes from sea water is by boiling the sea water and condensing its steam—i.e., by distillation; but a friend tells me he thinks it is also obtained without boiling by adding a little Condy's fluid, or a very small quantity of sulphuric acid, or other means. Will anyone who knows kindly set us right?—XMAS SCIENCE.

[76276.]—**Mathematical Instruments.**—I am under the impression that the only way to construct the spiral known as the Ionic volute is that usually given in textbooks on practical geometry—viz., by the method of making quarter circles from various centres, taken in order, set off in a square contained in a circle called the eye of the volute; but my friend thinks he has seen a kind of instrument that will construct the Ionic volute from a single centre. Will anyone who has such an instrument kindly say if it does so?—XMAS SCIENCE.

[76277.]—**Blushing.**—My son, since he was 11 years of age, has had a peculiar habit of blushing. Not only in company, but when there is no occasion for it, a rush of blood to the face takes place. This is often the cause of great annoyance to his parents. Two physicians have treated him for dyspepsia, but they have done no good. Could any medical reader advise me what to do?—NEMOS.

[76278.]—**Mechanical Motion.**—A is a wheel attached to the end of a shaft, B is a rod working up and down in a slot. Could any reader tell me by what shape of eccentric fixed to A the rod B would be pushed down about 3in. for a quarter revolution, remain in that position for another quarter, rise about 3in. during the third quarter, and remain so for the last quarter revolution, or if an eccentric is not admissible, any other mechanism that will accomplish the purpose required?—NEMOS.



[76279.]—**The Ether.**—Will correspondents oblige by stating what is the most generally accepted theory of the ether? Although recently the subject of an interesting correspondence in "Ours," this part of the matter received little attention, the principal effect of the discussion being the demolition of more or less fanciful theories. I believe many readers who, like myself, carefully followed the discussion, would be grateful for information on this point.—A. W. B.

[76280.]—**Taunton Dynamo.**—To MR. BOTTONE.—I wish to make a small dynamo of the above type to light two 10c.p. lamps, or one 16c.p. lamp. You might say if the following dimensions will suit: Cores 3in. high, 1in. square; poles 3in. high, 2in. square, with tunnel for armature 2¼in. diameter, 2in. long. The base of the machine serves as the yoke, so that the armature is above the magnets. Please give amount and gauge of wire for magnets, and say what is the best kind of armature, and the amount and gauge of wire for it, and how connected and output? If I make the cores of soft wrought iron, and the poles and base of ordinary cast iron annealed, would it do, or must I get cast malleable iron for the whole machine? You might give diameter of commutator and length.—R. T., Paisley.

[76281.]—**Running Dynamo with Light Load.**—Will Mr. Bottone or some other correspondent tell me the best way to run a dynamo (95 volts) with two or three lights without undue sparking? At present I cannot run less than 20; full load 45.—WORTH.

[76282.]—**Electro-plating.**—Will some reader kindly give me the best source of information as to solutions, voltage, &c., and say if I can do anything with a 95-volt dynamo by running the same slowly to get the voltage required; only small work required?—WORTH.

[76283.]—**Sea Error of Chronometer.**—It has lately occurred to me that a source of error in marine chronometers must be sought for in the variation of the force of gravity, consequent upon a change of latitude. It is well known that a pendulum beating seconds in the latitude of London will not beat seconds if taken to the Equator, as the force of gravity is then less. Therefore, from the same cause, the balance of a chronometer will lose in weight as the instrument approaches the Equator, while the force of the spring remains the same. I should be glad to hear what some of your correspondents have to say on this matter, and should also like to know what difference of variation has been observed in some of the best chronometers, after a voyage across the Equator.—HOROLOGIST.

[76284.]—**Skates.**—Will any practical mechanic oblige by letting me know the best and proper way to grind skate steels by hand—if emery-wheel or grit stone are preferred, and if to hold steels lengthways or across the stone to grind both plain and hollow edges? An early answer will oblige.—W. H.

[76285.]—**Lantern Tank.**—I have made some small tanks for chemical experiments with the lantern. The glass sides are let into grooved pieces of wood, which form the bottom and ends. What kind of covering will make the wood water and acid proof, and withstand the heat of the lantern? Will shellac or marine glue be of any use?—OPTICS.

[76286.]—**Engraving Tools.**—Will some reader tell me the way to use engraving tools for engraving brass and copper?—P. B. S.

[76287.]—**Bronzing.**—Will any reader inform me as to the method of obtaining the dark green bronze so often met with on brass and gunmetal optical and other instruments?—FERRUM.

[76288.]—**Enlarging Photographs.**—Could any one give me a few hints as to the construction of dishes suitable for developing large prints in, porcelain dishes being too expensive? Also, I wish to know are the diaphragms used in the lens when enlarging from a negative?—A. B.

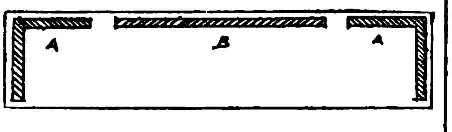
[76289.]—**Telephone.**—Would Mr. Bottone or one of our readers kindly tell me whether I can improve my telephone, which is composed of two "Bell" receivers, by putting a small battery in the circuit? The distance between the receivers is very short, and yet the voices are very low, although distinct. And whether the microphone described in Mr. Bottone's book can be used as a transmitter instead of another "Bell" receiver.—E. C. LESTER.

[76290.]—**Galvanometer Multiplier.**—I am making a galvanometer multiplier. Will Mr. Bottone kindly advise as to the coil? I have some very good silk-covered No. 20 wire. The frame on which this is to be wound is 2in. wide, inside measurement, and 3in. long. This frame will require 40 turns of the wire. To fill it from side to side, how many layers ought I to put on this frame to form the coil? I intend to use the instrument, when completed, chiefly for experiments with the thermopile, where I believe a great length of wire is not required. Will four layers giving 160 turns of wire be enough? My chief difficulty will, I fear, be in the making the astatic needles. Some writers speak as if it is absolutely necessary that the needles should be of exactly equal moment; others seem to imply that this is not attainable or absolutely necessary; still, I wish to make them as nearly so as possible. Shall I succeed in doing so by the following method?—If I take a fine steel wire knitting-needle, and cut off a portion the length of both intended needles, then file a notch in the centre, after which, if I magnetise the entire length by an electro-magnet, and then break the piece of wire in two at the notch, will not each half have exactly the same magnetic moment; or is there any better method?—NO SIG.

[76291.]—**Onyx.**—Can any reader give me a process for etching on onyx stone with acid, or what kind of acid should I use for cutting or eating a design on an onyx slab? I fully understand the process of engraving on glass or metals, but don't know how to proceed on onyx.—ONYX ENGRAVER.

[76292.]—**Electrical Brazing.**—Would any reader kindly answer the following?—I have a lot of plates of iron (wrought), size 4ft. by 8in. by 14 gauge, requiring to have brazed to one of the surfaces a sheet of brass, same dimensions, except that the brass is only about half the thickness of the iron. I have thought that by thoroughly cleaning the surfaces to be brazed together, well sprinkling the iron with hard solder, and placing the brass plate in position, that the heat required to fuse could be furnished by electricity. Can this be done, and if so, how?—PUZZLED.

[76293.]—**Wheatstone Bridge.**—To MR. BOTTONE.—I am about to make a Wheatstone bridge as described in your "Electrical Instrument Making"; but instead of a 2ft. scale, I wish to have it 1 mètre long. Would you kindly tell me the length of the arms of A A and length of strip B? Also how broad ought they to be, and what thickness? Would you also tell me what B.W.G. the German-silver wire must be, and where I could get it already cut to the right length, and about what it would cost?—BRIDGE.



[76294.]—**Daniell's Gravity Battery for Electric Clock.**—Accept my thanks, Mr. Bottone, for answer to electric clock. Should like to know now, please, if I am correct in the way I made a small one (not a two-gallon size), as follows: The jar is 6½in. by 6½in.; have put a round piece of copper at bottom, 5in. diameter, and piled up with sulphate of copper about 2in. I then filled loosely round with coarse sawdust till near top of jar. I then put on top of this the round piece of zinc (insulated wires attached to both metals), then covered all round with sawdust, and, lastly, saturated the sawdust with water, which took three quart bottles. In twelve hours or more it only shifted the galvanometer hand to 20 (Blakey, Emmott, and Co., Halifax, maker of the galvo.) Could you let me know if I am correct in making the gravity battery?—ELECTRIC CLOCK.

[76295.]—**Cork Frames.**—Kindly inform me how to make cork picture frames in various designs?—JOHN WATT.

[76296.]—**Prolapsus Ani.**—Will "Eos." or other qualified correspondent kindly suggest treatment of above complaint, and say if there is any mechanical support that would be of use? The querist is otherwise healthy, though not of a very robust constitution, and has consulted medical men at home and abroad without deriving any permanent benefit.—EDINA.

[76297.]—**Cementing Glass and Metal.**—Can any reader who has used it, and found it effective, give the composition or name of any cement, and the manner of using it, that will attach glass and metal firmly together, as the parts of a gazogene?—O. R.

[76298.]—**Bisulphite of Lime.**—Would any reader inform me if the above is a good antiseptic for food, and how it may be prepared in small quantities?—H. D.

[76299.]—**Dynamo.**—I want to make a dynamo for an engine 2in. by 3in. stroke. I can put on any size of driving-wheel that I like. I want it to light two five-candle lamps in parallel. I want it to be a drum armature, and as small and as light as possible. What size of armature, magnets, pole-pieces, yoke, size, and length of wire on each magnet; size, length, and number of sections of armature? Will forged iron do for the magnets and punchings for armature? What ampères and voltage will I be able to get?—B. B. C. A.

[76300.]—**Fern Case.**—In my house I have a fern case, and have had it a considerable time. In it there are two lengths of ivy, one 11ft. and the other 12ft. long; also a few ferns. During this last three months the leaves of the former have been dropping, until now there is about 3ft. in all, and not a single leaf. The ferns likewise have showed marked signs of decay by their drooping and dying away. I thought possibly there might be grubs on the plants; but on examining them, I failed to discover any; then the mould was turned up, but there were none there. Perhaps some of our readers will be kind enough to supply me with the information that may lead to the r[illegible]y case.—EXMO.

[76301.]—[illegible]y.—Would some reader kindly give the names, prices, and publishers of some of the more recent works on the above subject?—EXMO.

[76302.]—**Electrical.**—I should be glad to know the width and length of a piece of selenium required to connect two electric wires, so as to allow the current to pass in the light, but not in the dark.—R.

[76303.]—**Electrical.**—Will someone please give sizes and quantities of wires for field, armature, and gramme ring, and diameter of core for ring for 50-volt shunt lighting dynamo?—ENTHUSIAST.

[76304.]—**Carbonaceous Cement.**—Will Mr. Bottone kindly give receipt of carbonaceous cement mentioned by him in answer to query 76116?—OLD SUBSCRIBER.

[76305.]—**Dynamo.**—Have made a Manchester type dynamo with Gramme ring 4½in. dia. and 2in. wide, cogged and solid, with twelve sections wound with about 36 yards of No. 20; field-magnets 1¾in. dia. by 3¾in. (all W.I.), wound with 50 yards No. 18. Series wound: Have also wound on F.M. 2lb. No. 24, connected to brushes. Have tried shifting brushes and reversing engine, but no effect; speed 3,000; except about 40 candles. Will Mr. Bottone or others advise?—J. B.

[76306.]—**Natural Phenomena.**—The other morning, in travelling by rail between Hull and Selby, I noticed a small ball of soot settle on the side of a large raindrop, which stood on the glass outside the carriage window, and I also observed it to immediately commence to circle round the drop—up one side and down the other, about half-way between the centre and the circumference of the drop. As the train slackened speed it moved more slowly, and when the train stopped at the station it finally ceased to revolve; but on the train moving from the station it again commenced to revolve as before, increasing its velocity as the train increased in its speed, until a gust of wind removed it. The train was running nearly E. and W., and the ball of soot revolved with the sun. Would the rotary motion be confined to the ball of soot sliding round the exterior of the raindrop, or would it be due to an exterior portion of the liquid drop revolving on its axis, and so carrying round the ball of soot on its side? Why should the direct motion of the train cause the raindrop or the soot-ball to revolve?—PUZZLED.

[76307.]—**Guitar.**—Will some kind reader of the "E. M." give me the necessary instruction on guitar-making, what kind of wood to use, length of head, &c.?—AMATEUR.

[76308.]—**Type-Writer Ribbons.**—How are type-writing ribbons dyed?—TYPER.

[76309.]—**Medical Coil.**—I have made a coil 4¾in. between the discs; core ¾in. diameter, wound with three layers No. 16 for primary (silk-covered wire), ½lb. No. 34 for secondary, well insulated with bank post paper and paraffined; built in every way according to Mr. Bottone's instructions in a back volume of the "E.M." I cannot get any current from the primary. The current in the secondary is very powerful when the tube is drawn out about half-way. Would a condenser improve the primary current? The breaker is very massive. Any information will be thankfully received.—J. R.

[76310.]—**Accumulator.**—To MR. BOTTONE.—I have the E.C.C. Ld. + W. type, 31 plates, 51 in series. They have been in regular work for 21 months, and lately I find they become fully charged before I can get on the last step of the resistance. Is this as it should be, or is there something wrong with them? There is a small amount of sediment at the bottom, and I find on two or three of the zinc plates there are a few scales. Please reply, and oblige—ELECTRIC.

[76311.]—**Cast-iron Gas-bag.**—Should be glad if anyone who is using one could give particulars of Messrs. Crossley's new cast-iron gas-bags for their gas-engines, especially as to how the gas is drawn out when cock is shut between bag and engine.—SHUNT.

[76312.]—**Steam-Pump.**—I have three double-acting steam-pumps forcing water all to the same height, about 90ft. (vertical), each with separate columns of delivery pipes. The size of water pistons are two 6in. and one 4½in. 1. Will one column of large pipes answer the purpose of the three at present in use? 2. What diameter should column be? 3. Would there be less friction in one than three? Would it require a back-pressure valve for each delivery into main? Any further suggestions will be welcomed by—WATER.

[76313.]—**Octave Coupler.**—I am thinking of having an octave coupler to my harmonium, having plenty of spare time. Should like to make and fix it myself, if some correspondent would kindly put me in the way of it. A sketch would help me a great deal. The harmonium is not a large one, and has two false stops.—MECHANIC.

[76314.]—**Compounding Machines.**—To MR. BOTTONE.—Will you kindly say why machines are compounded? Also their efficiency as compared with shunt machines, whether they are used for arc or incandescent lighting, or both, and the proportional resistances of both coils? A sketch would oblige.—ZAMPA.

[76315.]—**Clock.**—Will the writer of the excellent articles upon the construction of a chiming clock kindly give instructions for setting out a recoil escapement, the wheel having 38 teeth?—A. F.

[76316.]—**Fine-Art Casting.**—Will some friend give me a few wrinkles on moulding and casting fine-art work in gold and silver? I was shown a few days ago by a jeweller, some very delicate castings, such as leaves, &c., with the veins showing, and also a copy of a medal which was a perfect *fac-simile* of the original. He assured me that they had been cast, and not made, by electrotype; but he would not tell me how they were done, saying it was a trade secret. I have gone through eight vols. of back numbers, but cannot find anything relating to this class of castings. I hope some of our friends will oblige by giving a few hints to one who would like to succeed. I think that I can melt any metal that will be required, as I am the happy owner of a Fletcher's injector gas-furnace. I may say that I have tried to cast them in cuttle fish; but my work was not to compare with the castings shown to me by the above jeweller.—A WOULD-BE ART CASTER.

[76317.]—**Ring Armature.**—To MR BOTTONE.—I understand, from some of your letters, that the running resistance in a ring armature of a two-pole motor is a quarter of the total resistance of wire used in winding the armature; then in a four-pole motor, where the commutator strips are joined to the opposite strips, and the brushes set at right angles, is the resistance then one-eighth of the total of wire used?—MULTIPOLAR.

[76318.]—**House-Warming.**—What is the best and most economical method of warming ten-roomed house, which has a good cellar?—DENISON.

[76319.]—**Electric Bells.**—To MR. BOTTONE.—I have a building six stories, and I have a small lift which conveys small goods from one floor to the other—that is six floors—and I wish to fix an electric bell and push on each floor, so that it can be rung by a code 1, 2, 3, 4, 5, and 6, so that they will know where the lift is going to at each floor. I want all bells to ring at once except bell on floor where rung from. I have one of your books on "Practical Electric Bell Fitting," but cannot see anything of the above in same. A sketch would greatly oblige.—W. TAYLOR.

[76320.]—**Turbine or Windmill for Electric Light.**—Is there any perfectioned turbine or windmill at regular velocity? What are the dimensions to be given in order to have a pretty good efficiency? Can they be used for a small electric light installation? Is there any book referring to them?—ENGINEER.

[76321.]—**Incandescent Gas-Lights.**—"M.H.'s" reply (No. 75908) is very interesting, especially the reference to water-gas; but is it possible so to scent the gas that an escape could be detected by the smell alone, as in the case of coal-gas? If not, the risk incurred appears to me to outweigh the economy its introduction would insure. Is water-gas more deadly than coal-gas, volume for volume?—YESALLAW.

[76322.]—**Testing Internal Resistance of Battery.**—One method given in the textbooks is to join two cells in opposition, so that they give no current. How is this done? I join the two zincs together, but find that there is still a current; also if I join zincs to carbon of both cells, so as to complete the circuit.—W. H.

[76323.]—**Regulators—Weights.**—Will any reader favour me by stating what is the usual weight of driving weight of pendulum bob, and diameter of driving barrel of regulators, with trains, as described in Brittain's Handbook?—G. C. S. H.

[76324.]—**Magnifying Power of Microscopes.**—Will "F.R.A.S." kindly give the formula for finding the magnifying power of microscopes, and also mention if the length of the tube materially affects the power? An example in figures would be esteemed.—LUCIDA.

[76325.]—**Sodium Amalgam. — Potassium. — Calendula.**—What is the proportion of Na_3Hg in this amalgam? Is it influenced by the atmosphere? To what use in the arts and sciences has it been applied? How is it that while potassic sulphide or sulphate are poisonous (more or less), and that potassic cyanide is a deadly poison, yet that potassic sulpho-cyanide is perfectly inert as to poisonous, and therefore, medicinal, action on animal life? Is there a potassium hydrargyrum amalgam? Possibly the recent admirable articles on botany from the pen of Dr. Aveling, may have led to (more or less) study by some of "ours," as to the uses, properties, &c., of British plants and flowers, especially their actions, medicinal or toxic, on mankind and on animal life, herbivorous and carnivorous. Can any one give information concerning the genus or species of which Calendula is one of, and their actions medicinal in olden and modern times?—PHOTOS, DE PLUS EN PLUS PHOTOS.

[76326.]—**To Mr. Bottone.**—I have a battery of 52 180 ampère hour accumulator cells. My trouble with them is this: I cannot get the s.g. of the acid any higher than about 1175 to 1180, instead of 1,200 as I should wish. In the second place, they will not show the 2 volts each. The s.g. of the acid when first put in was 1,150, and I charged them until they bubbled up nicely before putting on any lights; but although they bubbled up so nicely, the s.g. was no higher than above stated, and then they would not show 2 volts each. I may say they had something like 36 hours' charging before being used to light the lamps. I may say that in first charging them I unfortunately charged them the wrong way; that is, put the + pole of the dynamo to the − pole of accumulator for about an hour, but altered it as soon as I noticed it. Would this account for them not working properly? Would it be of any advantage to put some strong acid in the cells when they are bubbling to bring up the s.g.? I should like to know how many lamps a battery of this size should light, and for how long? Until now I flattered myself on knowing a good deal about accumulators; but I am thoroughly beaten this time.—ENGINE DRIVER.

[76327.]—**Electrical.**—I am looking after a small electrical plant. I have an alternator giving 1,000 volts high tension, which is transformed to low tension of 50 volts. I have one particular transformer which is rather overloaded, and I wish to connect up another transformer to it; but before I do so, I wish to know if both of the transformers are wound the same way, for if I should connect the two together, and the coils of one of them be wound in a right-hand direction, and the other in a left-hand direction, one or the other, or both of them would be burnt up. Now I want to know how I am to find this out, and after I have got them connected together rightly, I want to test the voltage of them separately whilst working by means of a Cardew's voltmeter, without interfering with the lights. I have plenty of switches, &c. N.B.—Both transformers are of 1,000 volts high tension, and 50 volts low tension. A rough sketch will very much oblige. I also want to put ammeter in circuit. Secondly, will you kindly let me know how many ampères a certain gauge fuse wire will take from No. 16 to No. 36, and what is the difference between the lead and tin fuse wire?—E. J. H. H.

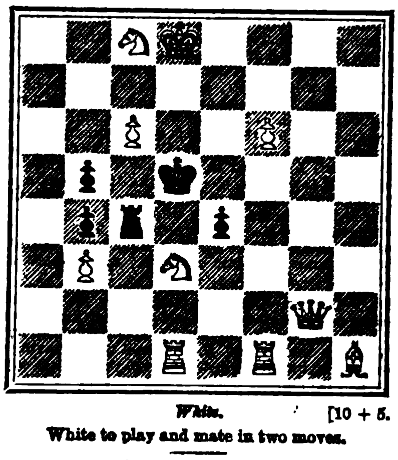
AN ocean pier, 4,000ft. long, is being constructed at Puerto Columbia, in South America. It will be entirely of iron and steel, and from six to ten vessels can be accommodated at once.

CHESS.

All communications for this column to be sent to the CHESS EDITOR, at the office, 332, Strand.

PROBLEM MCCLXXXIX.—By A. G. FELLOWS.

Black.



White. [10 + 5.

White to play and mate in two moves.

SOLUTION TO 1287.

White.	*Black.*
1. Kt-Kt 4.	1. Anything.
2. Q, B, or Kt mates.	

NOTICES TO CORRESPONDENTS.

CORRECT solutions to 1287 by T. Guest, F. H. Guest, A. C. Hurley, W. T. Hurley, A. G. Fellows (many squares doubly guarded, but problem is good), and F. Slade; to 1286 by W. T. Hurley (two duals; rather difficult; an apparent solution 1. Q-Q 8 is finely met by B-B 8), R. W. Houghton (two duals; a good problem; the mates with the Kt are very pretty), F. H. Guest (two duals), T. Guest (two duals—not three), and J. Kistruck (two duals).

SMETHWICK, W. T. PIERCE, AND W. T. HURLEY.—Problems received with thanks.

F. H. GUEST.—The dual continuations are enough to give in three-movers.

A. C. HURLEY AND A. G. FELLOWS.—Your attempt at 1286 will not do.

A. G. FELLOWS.—Thanks for problems. $\frac{\text{W-K}}{\text{K 8}}$, $\frac{\text{B-K}}{\text{K 4}}$ is too easy, though neat.

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ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the EDITOR of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, January 13, and unacknowledged elsewhere:—

CAMELBOD.—W. H. S. Monck.—Armature.—A. O. R.—F. E. K.—F. S. A.—Z. Y. X.—A. Gedd.—P. Perrun.—Jas. T. Gowing.—Student.—E. R. Dale.—R. J. W. E.—M.I.C.E., Bath.—A Fellow of the Royal Astronomical Society.—Villa.—Paulistano.—J. H.—J. S. Brown, jun.—Dr. Aveling.

EXPERIMENTS IN ELECTROSTATICS.—G. J. B. (Please send another drawing of Fig. 1 for the first letter.)—TIN TACK. (If you have no agreement, and your master has taken out the patent, we fear he has you pretty much at his mercy. You had better see a lawyer versed in patent matters without delay, and place all the facts in his hands.)—BOB. (We are afraid they are swindlers. They have changed their style and address repeatedly lately, and each time we have had complaints about them.)—FR. C. (The telephone for mine working should be fitted up by those who understand it and will be responsible for it; but you will find details in back volumes. He would be able to couple the telephones on the line wires by means of binding screws.)—NON-MUSICAL. (Answered last week. To do vamping effectively, learn the chords. No book on such a subject, except the regular textbooks on Harmony.)—A READER AND STUDENT. (Not that we are aware of.)—AQUA. (See Hints above. Any dealer in such goods can supply the coil required.)—J. HERBERT CLARK. (We gave all the information we had. The address, if wanted, must be advertised for in the usual way. It is doubtful if there are any "agents.")—H. B. T. S. (See previous answer. We gave all the information available.)—TELESCOPE. (Get Proctor's "Half-Hours with the Telescope," and Webb's "Celestial Objects for Common Telescopes." Any bookseller can procure them. There are many other useful books, which you will find mentioned in back volumes.)—ONE IN A FIX. (They are two different things. The methods of making have been described several times, even in recent numbers.)—F. S. Sc. (Impossible to say. It may be an air-pump valve for a steam-engine.)—R. J. T. (We do not know. See "Hints" above.)—CHAS. R. HOWATSON. (We do not know them; but suppose they are made of paper, impregnated with chloride of cobalt.)—ENGINEER. (The questions should have been repeated. So far as we remember, the answer to one is that the ice is "fresh," or fresh comparatively speaking: it leaves the salts when it congeals.)—C. G. B. (A design can be registered at the Patent Office; but for purposes of copyright register at Stationers' Hall, Ludgate-hill, E.C.; cost 5s.)—E. C. (Most ironmongers keep the blowpipe lamps, and they have been illustrated in back volumes. Inquire amongst those who use them.)—ELECTRON. (It is a patent, and a full description will be found in the back volumes. See p. 257, May 21, 1886.)—J. A. K. ("Provisional protection," as it is called, protects for nine months; but it does not carry the "right" to letters patent, which, however, are never refused to anything not against good manners or morals. It is always advisable to employ an agent.)—LIGHT. (What sort of lenses? There is much information in back volumes—even in recent numbers.)—NEW READER. (Any of our advertisers who deal in such articles would advise; but there are many hints in back numbers.)

Nervousness in Men is seriously on the increase. Check it at once by wearing one of Harness' Electropathic Belts. They are a perfect boon to all sufferers from nervous, muscular, or organic weakness. Thousands of unsolicited testimonials. Pamphlet and consultation free on application to the Medical Battery Company, Limited, 52, Oxford-street, London, W. Address letters to Mr. C. B. Harness, President.

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The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, JANUARY 22, 1892.

LATHEWORK FOR AMATEURS.*—XI.

(*Continued from page* 363.)

Threading Wooden Screws.

OF all the tools which furnish the amateur's laboratory the screw-box for wood is, without doubt, the one which produces the most positive effect. When the screw-box is well made the most inexpert beginner can, at his first trial, cut a screw and its nut equally as well as the most accomplished workman.

Authors who have written on this subject have surrounded the employment of this tool with difficulties. They have prescribed rules for the method of using it; they have required that guide-plates should be glued on to insure the travel of the box, these guide-plates to be unglued afterwards. Cylinders had to be turned, twin V's were to be used, the boxes were to be split in two parts, hollow tops were to be used, &c. All this apparatus has vanished before the simplicity of the new method of construction, and all difficulties have disappeared. They arose in great part from a radical fault in the construction of the tool. Workmen who made it—slaves to routine—followed their old methods, and when an improvement was known, instead of adopting it freely, they exhausted their efforts in trying to combine the new idea with the old practice, which they could not abandon.

These few words on the use of the screw-box for wood will suffice. When you wish to make a nut, bore a hole: with a centre-bit, which has previously been mentioned (see Fig. 101, p. 188) if the wood is plankways, and with a spoon-bit (see Fig. 102, p. 188) if the wood is end grain. Be careful that the diameter of the hole is the same as that of the body of the tap, measured at the bottom of the spaces between the threads. Then introduce the tap by turning it in this hole, and when it has passed through the plank the nut is made.

To make the screw. By means of the drawing-knife (see Fig. 10, p. 128, Vol. LIII.) roughly shape a piece of tough wood, such as service-tree, apple, or pear; pass it through the screw-box, and the screw is made. That is all. If a head is wanted turned and ornamented with mouldings, doubtless it must be turned on the lathe; but these details are foreign to the making of the screw proper. All the art, therefore, lies in the construction of the screw-box; and it is to this point that attention is called.

Old-Fashioned Taps.

The old methods will be recalled in a few words, to make the advantage of the new more clearly understood. The taps were made in different ways; the oldest were of boxwood. When a wooden screw had been procured with eight or ten threads, a notch was cut in its circumference, and the wood cut away was replaced by nails, the heads of these being filed to the shape of a thread. Care being taken that the first projects but slightly, the second a little more, and the third and fourth finishing the thread begun and enlarged by the first and second.

This method had the serious drawback that when once the sharp edges of the irons became worn, the tap would no longer cut, but would scrape and abrade the wood. Then as it was impossible to advance the cutters after their projecting parts had been diminished by refiling, the tap became useless. Vain attempts were made to arrange holes behind the cutters, so that these might be driven out with a punch when they required refiling. This could not be done, because these cutters, thus displaced, slid too easily in the wood, and receded rather than tapped the nut. Attempts were also made to put the nails on four sides of the wooden screw; but this method was quickly abandoned, because these nails or cutters acting from each side prevented the thread on the wood from acting as a guide. Then the nut became untrue and got oblong, or took some other form deviating from the circular. And, further, the nuts were conical, being enlarged at the entrance through the irregularity of the first threads.

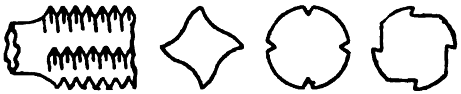
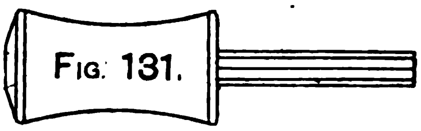
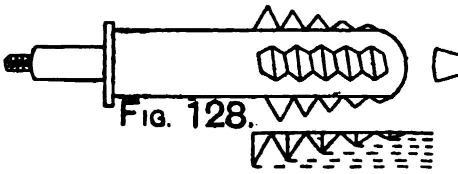


FIG. 127.





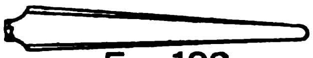


FIG. 132.

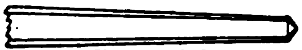
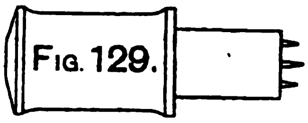


FIG. 133.



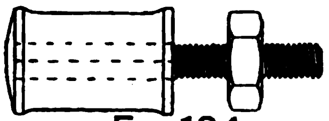
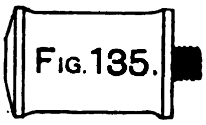
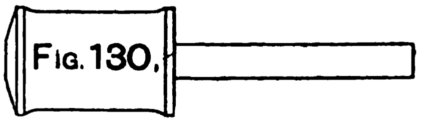


FIG. 134.





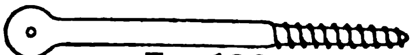


FIG. 136

Iron Taps for Threading Wood.

For the reasons given, it was necessary to come to an iron tap, which seemed at first to remedy all the defects of the wooden tap. At first its sectional form could not be determined; some made it square, others made the angles of the square sharper by means of a semicircular groove (see Fig. 127). Bergeron published his Treatise for Turners, and brought together all the improvements experience had made in these things. He had an idea of perfection, but he could not attain it. However, he made an advance in the subject in determining the triangular sectional form to give freedom to the tap. The inclined tooth which he prescribed was a decided advantage. The hollow tap was a great allurement to all amateurs, as it should have been; but in practice it did not fulfil its fancied promises. It was, therefore, abandoned, and all the more readily from its being difficult and costly to make, and the tap with inclined teeth was made to serve.

However, as this tap worked laboriously, and as the nut was not cut clean and sharp, amateurs sought to improve its imperfections, and so attain this double object. To do this, a piece of iron was turned, on which was left a projecting band intended to form the threads. The thread desired to be made was set out on this band, and shaped by filing, so as to form a truncated cone, the inclination of which at each turn of the spiral thread was one-fifth of the height of the thread. This resulted in the top of the thread at the smaller end being only one-fifth larger in diameter than the bottom of the thread five turns higher up (see Fig. 128). Next four longitudinal channels were made in this tap, the width of each an eighth, or even more, of the circumference; each groove undercutting the thread on both sides, and in this way the escape of the chips was easy and assured; see Fig. 128, which shows several views of this tap.

To make a nut with this tap, a hole is made about $\frac{1}{16}$in. smaller than the point of the thread, and by turning the tap in this hole the nut is made perfectly. It is easy to understand the reason of this: the first thread cuts slightly as it enters, the following threads penetrating deeper in the sides of the hole as the tap is turned, and when the last thread has passed through, the groove is as deep as it should be. During the use of the conical tap, the wood is continuously cut, both in ascending and in descending, and it is never compressed, as is the case when the tap is cylindrical. It is therefore much easier to rotate, and is positive in its action.

The Screw-box for Wood.

The screw-box, more complicated and more difficult to make, has passed through modifications as well as the tap. After having tapped the guiding thread, the V to cut the material was put in place. When after endless trials the correct position was finally found, that is, a little below the second thread, it was still necessary to spend considerable time to correctly adjust the amount of projection, so that the point formed by the meeting of the two cutting edges should enter the wood neither too much nor too little. When these difficulties were overcome, the V was fixed by means of nails, pieces of wire, &c., and the plate, in which is the entrance hole, also served to fix it. When the iron ceased to cut and it was necessary to resharpen it, the whole structure had to be taken apart, and the same trouble had to be gone through in reconstructing it.

Ere long the screw-bolt with a hook and nut was used, which passing through the screw-box and was clamped from below by means of a nut imbedded in the wood. This method was an improvement, but there always remained a great defect to overcome. The resharpened V became shortened, and in an operation which required so much precision this shortening of the iron caused great derangement to the screw-box. Small pieces of sheet-iron or tin had to be put under the heel of the V to advance the cutting edge the same amount as had been taken off in resharpening; and sometimes it happened that half a day's work was not enough for this readjustment. I cannot perceive how afterwards the author already referred to (Bergeron) meddled with placing two V's when a single one already gave so much trouble to adjust. This fact should, however, have impressed itself on his mind—viz., that whatever degree of accuracy he may have flattered himself to have made in the tool, only one of the V's actually cut, the other only added difficulty to the construction. And even admitting a fortuitous result, how can the proportions be maintained when the sharpening is done on a stone?

---

* "Lathework for Amateurs" is mainly adapted from "L'Art du Tourneur," by Desormeaux; but deletions and additions are numerous and extensive. The illustrations are new, and the treatise entirely remodelled.

This method had to be abandoned, as well as that of having the screw-boxes in two parts, because the thickness of the saw kerf necessarily took away the correct proportions of a circle. Other modes were, therefore, adopted, and nowadays perfectly good screw-boxes can be purchased at the tool-shops.

Of Mouldings.

Mouldings are the gratifying ornaments of work turned on the lathe. The turners' art consists less in the perfection which should be bestowed on their execution, according to the style of work, than in the taste which should govern their use, and in the manner of distributing them without profuseness, and yet, at the same time, without scantiness. He should avoid abrupt discordances, which result from the proximity of a massive member to a slender one; and that monotony which results from repetitions of the same forms within short distances. In the employment of mouldings, it is the closest imitation of nature, the best architectural models, and particularly the knowledge and good taste of the amateur which should guide him.

Mouldings are not treated upon except to give the names by which they are known, and these are not repeated here because there are several which cannot be made known by their technical names because they consist of several members in combination. All these mouldings are absolutely arbitrary in their proportions. As they may be applied to work of all sizes, no dimensions have been given to which they should be limited. Considering mouldings, when they are quite true and sharp, and without faults and breaks, to be a most essential feature in the attainment of perfection in the art of turning, some details of this subject are expounded.

Turning Mouldings.

When the piece put on the lathe has been properly roughed out, either cylindrically or to a shape required for the purpose intended, the amateur should determine in his own mind as to the nature and form of the mouldings with which he wishes to ornament it. Their width and the space to be allowed between them should be fixed, and it is as well to indicate these on the wood at first by means of a pencil. Next the principal lines will be marked with the upper angle of the chisel, and this double marking will become indispensable when several similar pieces have to be turned. Taking gouges of different sizes, with the smaller hollow the grooves in the mouldings themselves, and with the larger the spaces between. Proceed in such a way that when this preliminary operation is finished the form of the work and of the ornamentation which should embellish it will be foreshadowed.

Next taking chisels also of different sizes, use the smallest to shape the small fillets, turning them with the bevel sometimes on one side, sometimes on the other. In the same way they are used to hollow the grooves where the grain of the wood meets. A similar, but slightly wider, chisel is taken to smooth with its middle part [the wider parts turned with the larger gouge, striving to master the tool sufficiently not to show any angular mark on these surfaces, which should be rounded, neither leaving any mark of the tool where re-applied, nor of false strokes. Finally, a still wider chisel is taken so as to smooth the longer parts, which should be turned cylindrically on the work, or made pear-shaped, either in the middle of the work or at its extremity.

If the execution of these difficult processes has been successful, the work will be perfect and will require but little polish. But if there are little faults which are not enough to cause the work to be cast aside, then recourse is had to the polishes which have been mentioned in speaking of needle-cases, and which will be spoken of at greater length hereafter.

In giving the preceding explanations as to the manner of forming the mouldings on objects fashioned on the dead-centre lathe, it has been assumed that only native woods were employed; or, at the most, foreign woods capable of being cut with the gouge and chisel. But if woods are used which are capable of withstanding the action of these tools, or such materials as ivory, shell, bone, or horn, then round-nose tools, point-tools, single-bevel chisels, and parting tools should be substituted.

Chucks for the Dead-Centre Lathe.

In many cases it is required to turn on the dead-centre lathe various pieces of wood which, by their form and from the necessity of economising material, do not allow the turner to make upon the work itself a reel to take the cord. He should, therefore, acquaint himself with the methods of dispensing with so doing, and this naturally leads to the consideration of chucks.

Chuck with Pin Claws.

When the dead-centre lathe is to be used for making a hollow circle, such as a wheel, a frame, or other works of this nature, a claw-chuck is to be used (see Fig. 129). It is furnished with three or five pointed pins, and it is advisable to have these chucks in different sizes. To make a strong chuck of this kind, a piece of firm wood about 4in. long, and as nearly as may be the diameter of the intended work, is turned with a gouge, so as to make a reel of about 2in. long, and from 1¼in. to 1½in. in diameter. At the left end an enlarged part, called a flange, is left projecting beyond the body of the reel, so as to prevent the cord slipping off. At the opposite end the wood will be turned its full diameter for a length of about 1in. or 1¼in. The flange at the left should be coned on the end, so that it will not be liable to break when struck with a mallet, as will be explained later on. The opposite end will be turned off flat, and perfectly true.

With a pointed hook side tool trace a circle on the face of the large end at a short distance from its circumference. The work is taken off the lathe, and on this circle four points are marked at equal distances apart by means of the compass. Take five pieces of steel wire, each ¾in. to 1in. long, and cut off squarely on the ends. One piece is driven into the hole made by the cone point of the poppet, and the four others into the points marked on the circle. Each of these five projecting pins are pointed with a bastard file, so that the central one projects at least ⅜in., and the four others not more than ¼in.

When it is wished to put a piece of wood, such as a disc, on this chuck so as to turn it, it must be previously rounded and made flat. First, the central point is marked with the compasses, next, opening the compasses as required, draw a circle corresponding to that of the four pins projecting from the chuck; finally, draw a circle the diameter of the large end of the chuck. This done, place the piece to be turned flat upon the bench and rest the chuck upon it, taking care that the pin projecting from the middle of the chuck enters the centre of the piece, and the four others enter the corresponding circle. By striking with a mallet on the conical end of the chuck, the pins will be driven into the piece till the two surfaces join exactly.

Replacing the whole on the lathe, care is taken not to fix the right-hand poppet till after being quite assured that the cone point has exactly found the centre of the piece resting on the chuck, and that this turns quite true. It is needless to remark that the diameter indicated, both for the reel and for the large flange of the chuck are only relative, and if it is deemed advisable to make smaller chucks, the dimensions should be subordinated to the size of the pieces to be turned and to the force of the rotating motion they will have to convey.

Wood Arbor Chucks.

The arbor chuck, made of wood, Fig. 130, can be used in the same cases as the preceding, but for pieces or circles of smaller diameter. It may be 6in. or 8in. long, or even more; its diameter is determined according to the use to be made of it, or to speak more plainly, different sizes should be used. One portion of its length, intended to receive the driving cord, is shaped as a reel with flanges, the ends being coned. The wood that is left adjoining the reel is turned cylindrical, and to smaller diameter, tapering slightly and gradually towards the end so as to jam the piece put upon it. This chuck, turned entirely on the dead-centre lathe, receives at the centres of its ends the imprints of the two cone points of the poppets. This affords facility in taking it out of the lathe, and replacing it at will without disturbing its truth. It is a very convenient chuck for rounding rings and ferrules of all materials, both on the edge and on the sides.

To mount upon this chuck a piece of wood either plankways or endways of the grain, the piece is placed in the vice, or under the holdfast, and a hole is bored through the centre by means of a brace fitted with a centre-bit. The piece is put upon the cylindrical arbor part of the chuck, forcing this in sufficiently, so that the work will withstand the action of the turning tool without slipping on the chuck. If it is requisite to turn the piece on both its sides, the position of the chuck may be reversed on the lathe. As, by the effect of changing the position, the reel will be found on the right of the turner, another reel of common wood will be fitted temporarily upon the small end of the arbor, and on this the cord will be placed to finish the piece. In order that this reel may hold properly on the arbor of the chuck, the hole should not be made very smooth, and, for further security, rub the cylinder with chalk. It will be seen that in order to work on both sides of the piece, this must not be driven on the arbor far enough to allow the flange of the reel to interfere with the application of the tool, nor must the reel temporarily fitted upon the arbor be too near the work. On both sides sufficient space must be left to allow the tool to be applied quite close to the arbor.

Metal Arbor Chuck.

The chuck with a metal arbor, Fig. 131, has a much more general use than the two preceding ones, because it is indispensable for turning, on the dead centre lathe, pulleys and works of a like kind which have a hole bored through the centre. All sizes should be provided, from the very smallest used on the clockmakers' lathe upwards.

A chuck of this kind, for the largest size, should be made of tough wood; for example, a piece of quartered walnut. This is placed upon the lathe and shaped with the gouge and chisel to form a reel 3in. long. At the ends rounded shoulders are made to hold the cord, and one end is conical, and the other flat. This piece is placed in the vice, and first bored though from end to end, as straight as possible with a drill. Next a cone or taper bit (Fig. 132) used with a brace, is inserted from the conical end of the reel. For the arbor use a piece of soft steel 6in. to 8in. long, file it nicely square in section, with sharp angles, thinning it by a third of its diameter from one end to the other, so that if one end of the arbor is ⅝in. square, at the other it should be only ¼in. square. When assured by means of a steel straightedge that this arbor is perfectly square, and that it tapers regularly, the four angles of the square are filed down so as to make the arbor octagonal. For the length of the reel, at the larger end these four angles are only slightly reduced, a necessary precaution to prevent the arbor turning in the reel. The remainder of the length will present a regular tapering octagon.

When this is completed, make at each end of the arbor a hole exactly in the centre; first with a properly tempered centre-punch, and next with a bow drill, making these 1/16in. deep, and coned at the mouth so that the cone points of the poppets can enter them. The steel arbor will then be forced into the reel, its small end entering from the coned end of the reel, and it will be driven in forcibly with a mallet until its larger end is flush with the end of the reel. It may have happened, either in boring the reel or in driving in the arbor, that the former has become slightly askew, and is no longer precisely true. In this case a temporary reel is to be fitted, in the manner indicated when speaking of the wood arbor chuck, on the end of the steel arbor, and placing it upon the cone point of the left-hand poppet, put the cord on it, and turn the reel of the chuck true. The dimensions will be reduced somewhat by this process, for which allowance should have been made originally.

This kind of chuck being in general use, as has been stated, it is advisable to have not only a variety of sizes for larger work, but also some very small ones for turning by hand on the clockmaker's lathe. For these, the arbor, instead of being octagonal, will be made square, so as to be less liable to turn in the reel, and in the work which is turned on these small chucks. The small arbor will be drilled up at its larger end only—that is to say, at its reel end; the other smaller end will have a conical point, so that it may rest in a hole made in the small steel cylinder of the left poppet. As it will be put in motion by the bow, the reel will be shorter than in the other chucks, as it will have to hold only a thin gut cord. For greater substantialness the reel must be made of a hard substance, such as boxwood, stag-horn, goat-horn, &c. When the work has to be turned on its two sides, a temporary reel will be put upon the arbor of the chuck, as explained previously.

Small discs and pulleys turned upon the arbor chucks will naturally be round. It will be very easy to obliterate the flats left in the hole through the work through the pressure of the angles of the arbor. To do this, take a six-sided broach (Fig. 133) of suitable size, and rotate this in the hole until all trace of the impression is entirely effaced. For this purpose this tool is preferable to any other, and even to the drill, which might cut unequally, and render the work untrue. The broach, so to speak, only smoothing the wood instead of cutting it, does not render the work liable to bind when turning on its axle later on.

Screw Arbor Chucks.

There is another kind of chuck much used on the dead-centre lathe; it is made with screws, and in two different ways. First, by turning a piece of iron between the points, reserving a square to take the reel (see Fig. 134). The round part is threaded with good dies passed over it several times, so that the iron is not twisted and the thread is cut deep. Next, a nut is made of boxwood, or of some other hard wood not liable to split, and it is screwed tightly upon the iron. When it is wished to turn a foot for a candlestick, a vase, or any other flat thing, which is to be fixed by screwing, tightly screw the plank on the chuck until it butts against the shoulder of the reel. Then fix it with the nut just spoken of, screwed against the other side. In this way a small picture-frame may be turned upon its two sides, as may also any similar object.

The other method (Fig. 135) differs little from this, except that it is useless to make the screwed part so long. Three or four threads are enough, and no nut is used. When it is wished to turn a column or a table leg, saw off very squarely one end of the piece of wood intended for this purpose. Then, having found the centre with the compasses, bore a hole in it the size of the thread of the chuck, which is screwed into this hole till the shoulder of the reel touches all around its circumference against squarely drawn end of the piece to be turned.

Chucks Used with the Universal Wheel.

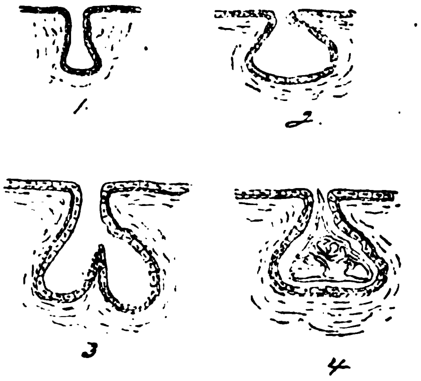
To use all these chucks by means of the universal wheel, it is sufficient to make a hole radially into each reel, and to insert in this hole a screw as shown by Fig. 136. The tail of this screw is caught by the driving chuck marked F in Fig. 84 on p. 100, Vol. LIV.

(*To be continued.*)

PRACTICAL MICROSCOPY FOR STUDENTS.—XVI.

By FREDERICK DAVIS, B.Sc., Associate of the Pharmaceutical Society, &c.

IN treating the various glands, we have before us a task which will involve nearly every organ of the body; the organs, however, which have been previously dwelt upon, will not be again described, excepting so far as will be necessary for the purpose of explaining the secretory or excretory functions of the glands, which enter into their formations. The largest gland in the human body is undoubtedly the liver; but we have in addition an immense number of simple glands, the liver, of course, being considered one of the most complex. In our examination of the skin we had occasion to speak of the sudoriparous or sweat glands, finding them to be merely tubular depressions, the inner ends being coiled up. We have, however, other tubular glands existing in the body: for instance, the gastric follicles present in the coats of the stomach; Lieberkühn's glands of the intestines; the Meibomian follicles of the eyelids, the secretion from which lubricates the surface of the eye, and the sebaceous glands which, as we saw in connection with the hair, exist and pour out their secretion for nourishing the hair follicle.

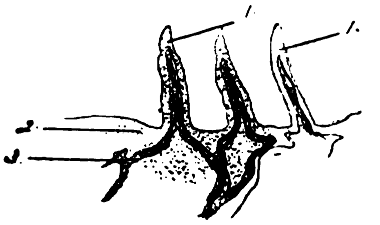


Various Forms of Glands.

1, Tubular gland; 2, Saccular gland; 3, Bisaccular gland; 4, Saccular gland with coiled tube.

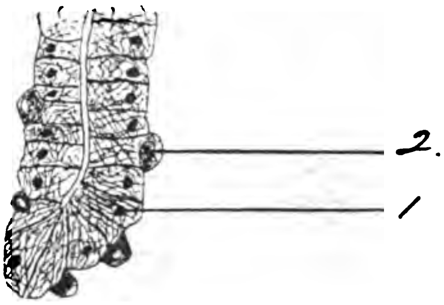
The two latter varieties are known as sacculated, that is, they are tubular glands with little sacs upon their internal surface. If the inner portion of a tubular gland is, after being sacculated further, divided into a number of smaller sacs, branching in various directions, it is termed racemose; the lachrymal gland of the eye, which produces tears, is of this variety; so also are the salivary glands, such as the parotid, maxillary, and sublingual: the secretion from these are rich in a ferment called ptyalin, which materially affects the digestion of amylaceous foods. The student should remember that the little tube by which the secretion is carried away from a gland is called its duct.

In speaking of ducts, it may be well to mention there are a number of glands in the body which are altogether ductless: these are termed vascular glands. We have a good example in the spleen, the thymus gland, which is situated at the base of the heart (it is a notable fact this gland is much larger in infants than in the adult); the thyroid gland, at the base of the larynx or voice-box; and the supra-renal glands, which, as the name denotes, are situated above each kidney. Now, although the whole of the foregoing ductless bodies are termed glands, yet it may be of interest to the student to state that the function of each is unknown, and, therefore, whether glands or not remains to be proven. The spleen is situated in the abdominal cavity, to the left of the stomach, of a dark red colour, and served with blood by the splenic artery, which is carried away to the vena portæ by the splenic vein. If we examine a thin section of the spleen microscopically, we shall observe upon its surface a number of little bodies, termed splenic corpuscles, composed of cells inclosed in a mass of capillaries, or little blood-vessels, each corpuscle being connected with a branch of the splenic artery. It is generally considered the function of the spleen may be that of secreting the white corpuscles of the blood. This is most probably the case, because we find that the blood supplied by the splenic artery, although rich in red corpuscles when entering this organ, is possessed of comparatively few red corpuscles when leaving the splenic vein, but has become rich in white or colourless corpuscles. We have spoken of white corpuscles: it may be expedient, therefore,



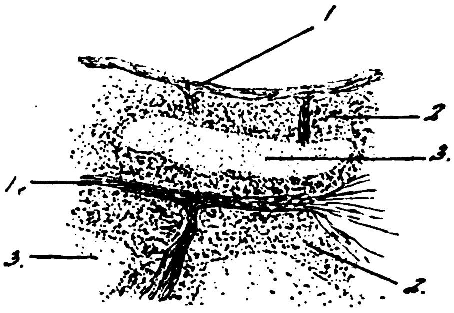
Section through Peyer's Glands.

1, Villi, showing chyle-tube in centre; 2, Lymph follicle; 3, Lymphatics surrounding lymph follicle.



Portion of Highly-Magnified Peptic Gland.

1, Important cells; 2, Parietal cells.



Section through the Thymus Gland of a Fœtus.

1, Fibrous tissue; 2, Cortical portion of the follicles; 3, Medullary portion.

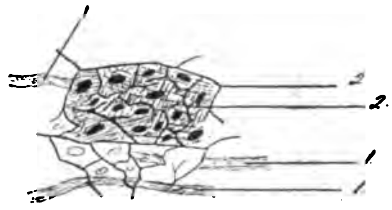
to examine the arrangement known as the lymphatic system, which is supposed to influence the quantity of the white corpuscles found in the blood to no small extent. The lymphatics appear to commence in every part of the body where blood capillaries are found, and exists as a network of vessels. The vessels are composed of elastic tissue and muscular fibres, and are exceedingly thin. They differ from veins in the fact of uniformity in size, and being possessed of bodies termed lymphatic glands, and from blood capillaries by being only in connection with vessels carrying fluid from them.

Like veins, they are possessed of valves arranged in pairs. The microscopist will, therefore be able to account for the swollen appearance which these vessels present at intervals.

The lymph or fluid which this system contains is alkaline in character, and possessed of nucleated corpuscles in every way similar to the white corpuscles of the blood; in fact, it would appear the plasma of the blood, having exuded through the walls of the capillaries, is absorbed by the lymphatics. The fluid or lymph carried by the lymphatic system is eventually poured into a duct running through the vertebral column—that is, up the inside—termed the thoracic duct, which, in its turn, pours its contents into the venous system, where the left jugular meets the left subclavian.

The thoracic duct is guarded at this point by a valve, which prevents blood from these veins finding its way into it. Each lymphatic gland is composed of an immense number of vessels, very much divided, and forming a meshwork with the blood capillaries, with which, however, they do not actually communicate. The liver, which, as we stated, is the largest gland in the body, is also one of the most important in structure—to the microscopist one of the most beautiful, and to the student of physiology of paramount importance.

We will enter into its physiology as far as may be necessary for the purposes of microscopy. The liver in the adult should weigh about 60oz. It is situated immediately beneath the diaphragm, in the abdominal cavity, supported by the stomach, intestines, and right kidney, and held in position by three ligaments, known as the broad and lateral ligaments, which are extensions of the peritoneum, by which it is invested. The liver is divided into a number of lobes.



Section through the Liver.

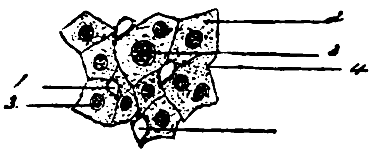
1, Small blood-vessels, called capillaries; 2, Bile capillaries between hepatic cells.

If we examine a thin section of a lobe which has been hardened and stained in the manner previously described, we shall find a larger number of lobules, or little lobes, about $\frac{1}{20}$in. in diameter. These are sometimes called sacs, or acini.

Each lobule is seen to consist of a mass of cells, which are nucleated, and called hepatic cells, between which we may find the ramifications of an immense number of capillaries. The liver is supplied with its vital, or life, blood by the hepatic artery, which is a direct prolongation of the aorta, and its digestive blood from the intestines by the portal vein. After the important constituents have been separated from the blood served by the portal vein, the whole of the remaining portion, that is, the blood from the hepatic artery and the portal vein, leaves by way of the hepatic vein, and is poured into the vena cava inferior. The hepatic artery, hepatic vein, and portal vein accompany one another through the whole of their ramifications through the lobules; it will also be noticed the hepatic artery enters each cell of the lobules by capillaries, which ramify each individual cell. These capillaries eventually unite into one vein, termed the intra-lobular vein, which in its turn opens into the branches of the hepatic vein. The portal vein takes the same course, side by side with the branches of the artery. The function of the liver is to secrete bile, an alkaline fluid, which is conveyed to the intestine, that is, the duodenum, by a tube called the hepatic duct.

Whilst the process of digestion is quiescent, the hepatic duct is closed, and the secretion of the liver (the bile) is conveyed to the gall bladder; the gall bladder is connected with the hepatic duct by the cystic duct.

The secretion of the liver is of very little interest to the student of microscopy. It will therefore suffice to say that it is chiefly composed of glycocholate of soda, taurocholate of soda, cholestrin, and colouring matter termed bilirubin, composed of biliverdin and bilifulvin.



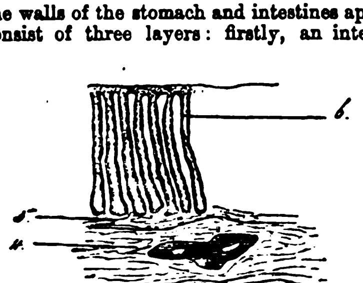
Section of Liver, highly Magnified.

1, Capillaries, cut across; 2, Cells of the liver; 3, Showing nuclei; 4, Bile capillaries between the cells.

The student will find by carefully staining a section of the liver with carmine solution, and clearing with turpentine in the ordinary manner, a very beautiful object will result.

We will now proceed to examine a few glands which enter into the phenomena known as digestion. For this purpose we must briefly review the whole operation. Food, then, having been masticated in the mouth, and consequently mixed with the alkaline fluid termed ptyaline, secreted by the parotid, submaxillary, and sublingual glands, is seized by the fauces and pushed down the œsophagus until its arrival in the stomach. Here the proteids are acted upon by the "peptic glands," which are continually secreting an acid and a substance known as pepsin. This converts the proteids into peptones; from this position the massed food is hurried on into the intestines. Now the intestines are divided into two parts termed respectively the smaller and larger intestines: the smaller intestine is divided into three parts, the part immediately succeeding the stomach being called the duodenum, the remaining portion the jejeunum, and ileum. Here the starchy foods are further acted upon by the various alkaline secretions, and as they become sufficiently and suitably converted into a soluble form, are absorbed by the villi, &c., and pass into the blood as nourishment; any portion not so absorbed being passed on by the peristaltic action of the bowels, and eventually expelled as fæces. Now there are several forms of glands situated in the stomach and intestines, and it becomes our duty to examine them.

The walls of the stomach and intestines appear to consist of three layers: firstly, an internal layer called the mucous; secondly, the middle layer termed the muscular; and thirdly, the peritoneal or serous layer. The principal glands imbedded in the mucous layer of the stomach are those previously described as peptic glands or gastric glands; but in addition to these we have a large number near the pylorus, columnar in form, termed mucous glands, because they appear to secrete mucus only. The gastric glands proper, however, are only partially lined with columnal epithelium, and secrete the so-called gastric juice, which, as we found, is merely pepsine in acid.



Section through the Wall of the Stomach.

1, Outer or serous coat; 2 and 3, Muscular fibres, arranged transversely and longitudinally; 4, Submucous layer; 5, Muscular layer of mucous membrane; 6, Peptic glands.

There are also little bodies called lenticular follicles scattered upon the surface of the stomach. The student should obtain a portion of the stomach of a pig, and having hardened its substance by immersion in bichromate of potash solution, cut and mount in the authentic manner. With regard to the glands of the intestines, we have three varieties: Lieberkühn's, Peyer's, and Brünner's. Lieberkühn's may be found over the whole surface, and are tubular in shape; Peyer's' are only found in the small intestine, arranged in patches, and are saccate; Brünner's exist in the duodenum only, and are lobular in shape. All of these glands are well supplied with blood-vessels. It may be well to mention that a gland similar in appearance to Peyer's gland is found in the large intestine, to which the term lenticular gland is applied.

Mention was made in a previous paragraph of absorption by "villi," and it is necessary we understand what is meant by this name. "Villi" are little thread-like processes found upon the surface of the mucous membrane of the small intestine. Each villus has an outer layer of columnal epithelium, and internally a vast number of blood capillaries, in the centre of which we find the portion termed the lacteal vessel. It would appear to be the function of these lacteal vessels to absorb the fatty substances with which they come in contact; but how they accomplish this is not yet known. One thing is known, however—namely, the epithelium first absorbs the fat, and then passes it on to the lacteal vessel; but how the fat passes through the network of blood capillaries is a matter for further study and investigation.

GEOLOGY FOR STUDENTS.

By EDWARD AVELING, D.Sc. Lond., Fellow of University College, London.

Chapter XXII.—The Upper Silurian Formation.

THE third and uppermost division of the Silurian system will now be considered.

A. DERIVATION. The name explains itself.

B. WHAT. (1) *Structure.*—Two distinct types of rock are grouped together under the name of Upper Silurian. First, there are the sandy mudstones and shales, flat, soft, unaltered, with here and there bands of limestone, all lying unconformably upon the Lower Silurian strata, and all occurring in the country of the Silures between the Severn and the Towy. Second, there are in North Wales, in North England, in Scotland, and in Ireland, hard massive grits and shales and limestones.

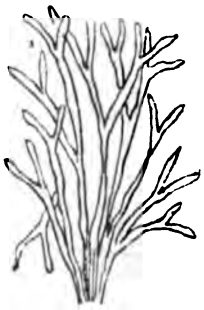


FIG. 131.

(2) *Composition.*—Here, as usual, a table of the groups is given.

TABLE XIV.

Upper Silurian Formation.

Upper Silurian	Ludlow group.
	Wenlock group.
	Upper Llandovery group.

The Upper Llandovery, named after Llandovery in Caermarthen (p. 435), are of conglomerate below, and sandstones containing iron oxides, and in many cases shells, above. Thickness, about 1,500ft.

The Wenlock group is named from Wenlock Edge, a range of hills in Shropshire north-east of Bishop's Castle, and ending at Much Wenlock, 12 miles south-east of Shrewsbury. Shales and limestones, 1,600ft.

The Ludlow group, of soft shales and sandy mudstones and of limestone, takes name from Ludlow, on the borders of Shropshire and Herefordshire. 1,950ft.

C. WHERE.—1. Europe. *a.* British Isles.

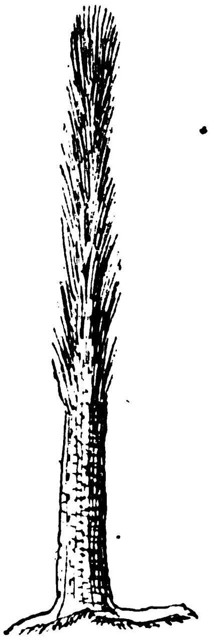


FIG. 132.

i. England. In the counties of Hereford, Worcester, and Shropshire. The most south-easterly point is Woolhope, seven miles south-east of Hereford. Then May Hill, between Hereford and Gloucestershire, and between Mitcheldean and Newent. In the Malvern and Abberley Hills—the latter are near Stourport, in West Worcestershire. At Aymestry, 5½ miles north-west of Leominster, Ludlow, and Wenlock, and in Staffordshire at Dudley and Walsall. In the northern parts the Upper Silurian group appears in the Isle of Man and in the southern part of the Lake District, notably on Kirkby Moor, 4½ miles north-west of Ulverstone, and generally between Shap and the mouth of the river Duddon, with especial developments at Stockdale, lying between Shap and Windermere, and at Coniston.

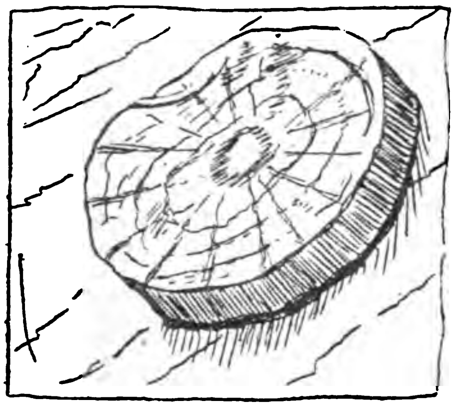


FIG. 133.

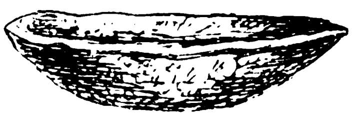


FIG. 134.

ii. Wales. Usk in Brecknock, Llandovery in Caermarthen, Old Radnor and Presteign in Radnor, the valley of the river Tarannon in Montgomery, and in Denbighshire.

iii. Scotland. From Port Patrick, on the west coast of Wigtown, to St. Abb's Head, on the east coast of Berwick; and from the Cheviots in the south, to Edinburgh and Glasgow in the north, coming out especially in the Pentland Hills and at Lesmahagow in Lanark.

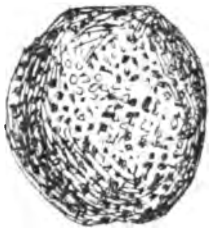


FIG. 135.

iv. Ireland. Along the west coast from Brandon Bay in Kerry, to Donegal Bay in Donegal; and especially between Lough Mask, in Mayo, and Killary, on the Galway coast.

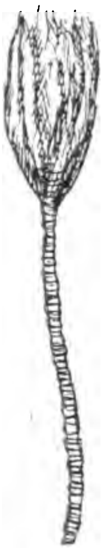


FIG. 136.

b. The Continent. In all the regions where the Lower Silurian rocks appear (p. 435), and also in Sardinia, Galicia, in the north-east corner of Austria, and Podolia, its next-door neighbour, in the south-west corner of Russia. In these last three regions, thus far, only Upper Silurian rocks have been found.

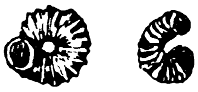


FIG. 137.

2 and 3. Asia and Africa. The distribution of the Upper Silurian rocks in these two continents is the same as that of the Lower Silurians (p. 435).

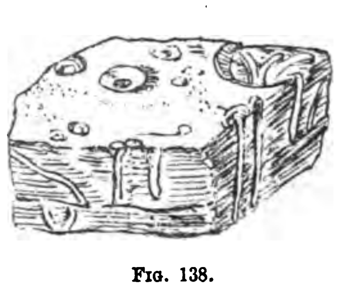


FIG. 138.

4 *a* and 4 *b*. North and South America. The same sentence can be repeated in this connection. The Niagara limestone over which the Falls pass is Upper Silurian.

5. *a.* Australasia. Upper Silurian rocks occur in New South Wales, especially in Bathurst county, and in New Zealand on the Baton river.

D. PALÆONTOLOGY.—(1) *Palæophytology.*—As with the Lower Silurian rocks, but also presenting among the fucoids Chondrites (Fig. 131), allied to a seaweed known as Chondrus; Sigillaria (*sigillum*, a seal), one of the Lycopodiaceæ or club-mosses (Fig. 132); traces of ferns, and portions of a plant known as Nematophyton (Fig. 133), tree-like, with bark and large roots, and yet, apparently, an alga. *νημα* (nema), a thread; *φυτον* (phuton), a plant.

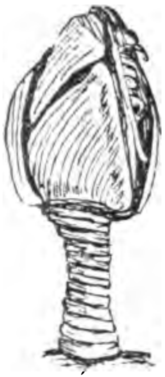


FIG. 139.

(2.) *Palæozoology.*—Rhizopoda (Foraminifera), many species, including Saccammina (Fig. 117, p. 435).

Porifera (Calcispongiæ), Astræospongia (Fig. 134). Astræa was goddess of justice, and is the sign of the Zodiac known as the Virgin.

Hydrozoa, Graptolites. Actinozoa, many corals, such as Halysites again, Fig. 121, Cyathophyllum (Fig. 122), and Favosites, the honeycomb coral (Fig. 135). *κυαθος* (kuathos), a cup; *φυλλον* (phullon), a leaf; *favus*, a honey comb.

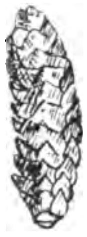


FIG. 140.

FIG. 141.

Of the Echinoza, very many forms, such as Palæechinus (ancient sea urchin), of the Echinoidea; Palæasterina again, Fig. 106, of the Asteroidea; Protaster (first star) of the Ophiuroidea; Periechocrinus (Fig. 136), of the Crinoidea; and Echinosphærites again, Fig. 123, of the Cistoidea. *περιεχω* (periecho), I embrace.

The Annelida are of the tubicolar (p. 365) form, and of the form represented by our earthworms and sand-worms. Of the former Spirorbis, whose carved tube-shell is shown in Fig. 137, is a good example. *Spirus*, a spire; *orbis*, an orb. Of the latter, Arenicolites again, Fig. 107, and Scolithus, Fig. 138, are typical. *σκολιος* (skolios), tortuous; *λιθος* (lithos), a stone. Annelid jaws also occur.

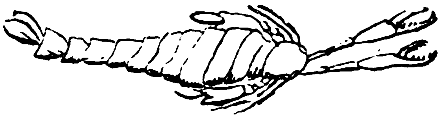


FIG. 142.

Crustacea. The existing barnacle, Fig. 139, is represented by Turrilepas, Fig. 140. *turris*, a tower; *lepas*, a barnacle. The number of trilobites is immense. There are also Leperditia, whose small shell is shown in Fig. 141, and the huge Pterygotus and Eurypterus. Pterygotus, Fig. 142, is named from the size and shape of its mandibles, or jaw-feet. *πτερυξ* (pterux), a wing; *ους, οτος* (ous, otos), an ear. Eurypterus, Fig. 143, is so named because of its broad, swimming feet. ευρος (euros), broad; πτερον (pteron), a wing.

The Arachnida have quite recently been found in Upper Silurian rocks, in the shape of Palæophoneus, Fig. 144, in Gothland, and at Lesmahagow, six miles south-east of Lanark. φονευς (phoneus), a scorpion.

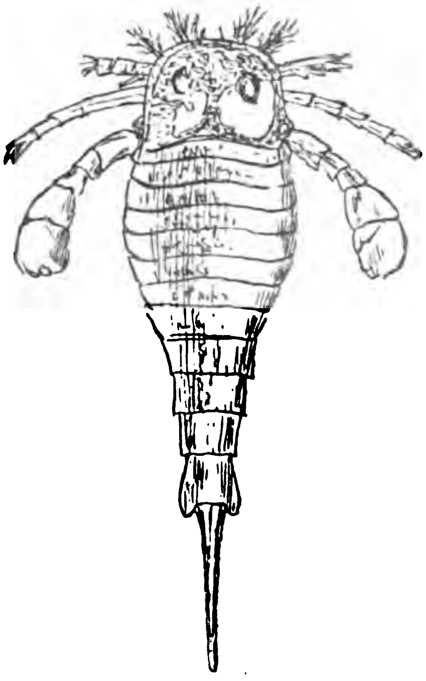


Fig. 143.

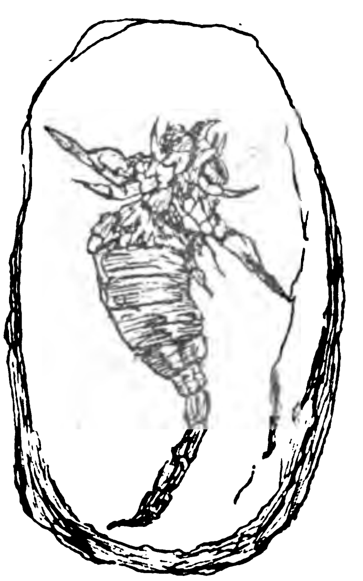


Fig. 144.

The Molluscoida are mostly old friends, such as Fenestella of the Polyzoa, Fig. 111, Pentamerus, Rhynconella, Orthis, Lingula, all of the Brachiopoda (Figs. 127, 93, 125, 126).

This holds also of the Mollusca, speaking generally. The Upper Silurian Lamellibranchiata, Gastropoda, Cephalopoda, are like those of the Lower Silurian. We may add, however, to the Lamellibranchs, Mytilus (the mussel), and Avicula, Fig. 145. *Avicula*, a little bird.

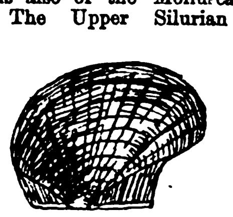


Fig. 145.

In the Upper Silurian strata we meet with the first trace of Vertebrata. As might be expected, the lowest class, Pisces, alone is represented. At Ludlow—i.e., at the top of the Silurian system, there is a bone bed varying in thickness from ¼in. to 4in. Thin as it is, this bone bed covers an area of quite 1,000 square miles, reaching as far south as the mouth of the Severn. In it occur the scales, spines, and teeth of fishes. In Fig. 146 are represented two placoid scales from the Ludlow bed. πλαξ (plax), a plate; ειδος (eidos), resemblance. And in Fig. 147 is represented a spine, called Onchus. ονχος (onchos), bent. More important still are the plates of such fish as Cephalaspis, Fig. 148, and Pteraspis, Fig. 149. κεφαλη (kephale), head; ασπις (aspis), shield.

Fig. 146.

Fig. 147.

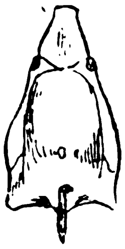


Fig. 148.

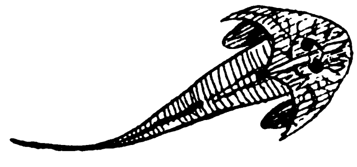


Fig. 149.

E. How.—As was explained above, there was much disturbance and denudation between Lower and Upper Silurian times. The Lower Silurian rocks were slowly submerged in the sea, which crept inland, leaving islands of Lower Silurian, such as the Isle of Man and the island between Builth and Llandegley (p. 435). In this sea, never very deep, and upon its shores, the Upper Silurian rocks were deposited. The Upper Llandovery, e.g., are the remains of sea-beaches. Clays were laid down in the bays, the finely laminated sandstones in tranquil water, the ripple-marked ones where tides came and went.

F. Economical Products.—Not very important. Some sandstones, limestones, slates. From the Upper Silurian of New York State comes gypsum or calcium sulphate.

Table XV. shows the formations of groups of the Silurian system as a whole.

Table XV.

The Silurian System.

System.	Groups.	Formation.	Beds.
Silurian.	Upper Silurian	Ludlow Wenlock Upper Llandovery	
	Lower Silurian	Lower Llandovery Caradoc and Bala Llandeilo Arenig	
	Cambrian	Upper	Tremadoc Slates Lingula Flags
		Lower	Menevian Harlech and Longmynd

FITTING.—XIII.

In a previous article, p. 234, I spoke of the use of templets as alternative to the methods of lining-off upon the table. I propose now to illustrate the typical forms and uses of the more common templets. Of course, as I have said already, these are only used for repetitive standard work.

I cannot see my way to any classification of the thousand-and-one forms that occur in the shops, so must just take at random examples that occur to the mind.

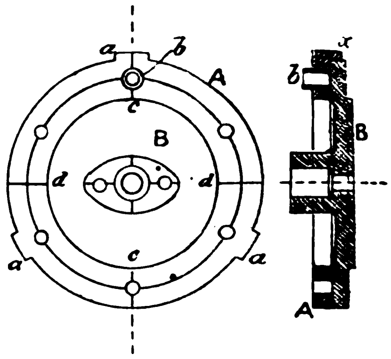


Fig. 70.

Work is either partially or wholly lined-out by means of templets, according to circumstances. Thus, the bolt-holes in a cylinder flange and cover are very commonly marked, or drilled from a single templet, after the flange and covers have been turned; or the hole in a solid bearing can be marked from a templet after the foot has been planed. On the other hand, a cheek or standard, or other similar casting, having a number of shaft-bearing holes in it that must have a definite relation to one another and to the foot, will not as a rule be machined at all anywhere until the templet has been tried on, and the mutual relations of all the parts settled, in order to average approximately the amounts necessary for machining. Then, again, there are templets which are properly gauges, being of the exact forms and dimensions as the work which has to be done by their aid, and their dimensions are simply transferred with calipers and gauges of various forms to the work.

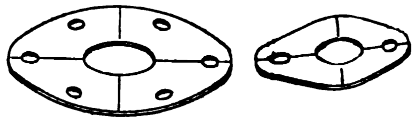


Fig. 71.

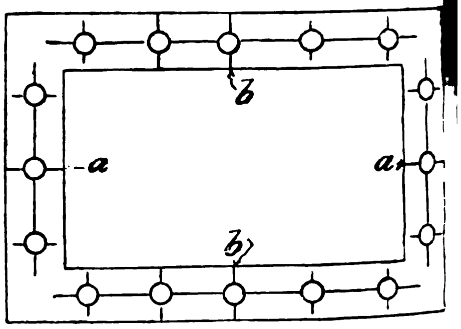


Fig. 72.

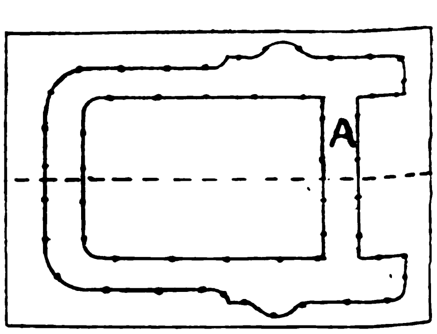


Fig. 73.

Fig. 70 shows a templet, A, used for drilling the holes, either in a cylinder flange, or in a cover, B. The edges of such covers are usually turned for good appearance, and the turned edge affords an excellent guide for the concentric setting of the templet. Three nibs, *a*, are cast upon its edge, and bored to fit closely to the edges of the turned cover, or flange. The bolt holes may be lined off merely from such a templet, or may be drilled directly through it. The latter is the usual practice, and the templet is then made of cast iron of $\frac{3}{4}$in. or 1in. thickness, and if in very constant use, the holes are lined with bushes of hardened steel, *b*; otherwise the holes in the comparatively soft cast iron would soon become worn out of truth by the friction of the drill. If a templet is only used occasionally, and for mere lining out, then for cheapness it may be made of a bit of sheet iron without the nibs, and set upon the flange by the outer turned edge. This is a common practice in the drilling of flanges for steam-pipes, both when they occur on cylinder and condenser castings, and also for the wrought or cast-iron flanges used for screwing upon wrought-iron piping, and also the brazing metal flanges brazed upon copper tubing. Fig. 71 shows two of those thin templets. One is gland-shaped, the other circular. The holes are marked through the templets, which are then removed, the circles and centres centre-popped, and the drilling done.

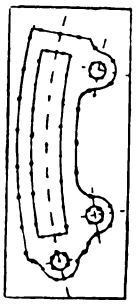


FIG. 74.

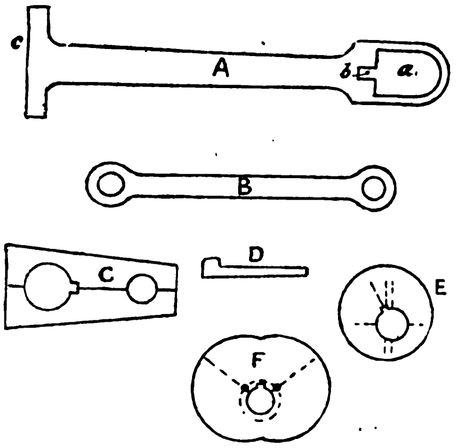


FIG. 75.

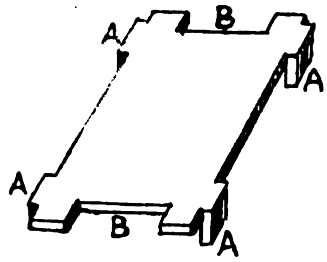


FIG. 76.

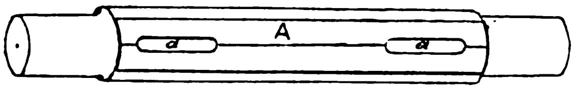


FIG. 79.

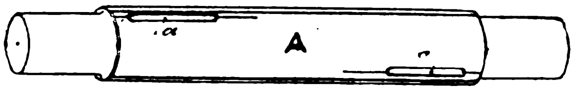


FIG. 80.

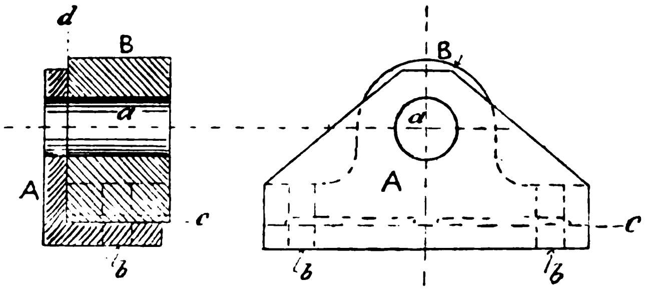


FIG. 82.

When a cast-iron templet like that in Fig. 70 is used, it is clamped upon its cover with two or three of the screw clamps shown in Fig. 19, p. 8. The templet is not necessarily used upon the corresponding cylinder flange. It frequently is, however, being set correctly by means of its centre lines *c* and *d*, so that the cover may stand in its right position. But, as frequently, the practice is, after the cover has been drilled, to set and clamp that upon the cylinder flange, and to drill the holes in the flange through those already drilled in the cover. When bolts are used, this is the better way; if studs are employed—the holes in the flange being small for tapping, and those in the cover being large for clearing—the former is the better method.

Fig. 72 shows a templet used for drilling the holes in the flange and cover of a steam-chest. As the edges of these parts are not usually machined, the templet is set, not by the edges, but by its centre lines *a b*, set upon or against the horizontal and vertical centre lines scribed upon the castings upon the marking-off table. Such a templet as this should be of about the same thickness as that in Fig. 70, say $\frac{3}{4}$in. or $\frac{7}{8}$in., and of cast iron. Or it may be of sheet iron of from about 10 to 14 gauge, like Fig. 71.

The thin sheet-metal templets form a large and important type. A few examples are given in Figs. 73 to 81. They are made of sheet iron, steel, zinc, or brass, varying from, say, $\frac{1}{32}$in. to $\frac{1}{8}$in. thick, according to size and rigidity required.

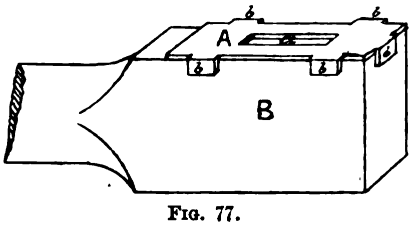


FIG. 77.

Fig. 73 shows a templet used for lining off a strap for a connecting-rod end. This is made of thin sheet-iron, and is prevented from opening out by means of the cross-bar A, either riveted upon it, or cut from the solid sheet, as shown. The figure shows the templet struck out, and its outlines centre-popped upon a sheet of metal in readiness for cutting out. The next figure, 74, also shows a templet of a slot link marked out and popped upon a piece of sheet metal.

Thin templets of this kind are roughed out with hammer and chisel upon a block of iron, and finished by filing in the bench vice. If, however, their thickness is considerable, say, $\frac{1}{8}$in. or over, it is better to drill small holes adjacent to each other, and to the edges that have to be filed, because there is then no risk of distortion occurring, as there is when the chisel is used with considerable force.

Sheet-metal templets are employed for marking out all kinds of outlines and holes. Fig. 75 illustrates a group of them. A, in the figure shows one suitable for marking the recess *a* for the brasses, and *b* for the taper-screw key at the small end of a connecting-rod; and the flat end *c* to receive the marine-pattern brasses used in the example. B shows a templet for a common double-ended lever. Two circular holes for crank-shaft and crank-pin respectively, with the shaft key-way, can be marked from a templet like C. D is a templet for marking off a number of keys precisely alike, E is one for marking off single eccentric sheaves, the circumference, hole, and keyway in correct positions, while F is for double eccentrics.

Templets like F are not much used for lining-out, the turning of these sheaves being usually done upon templet blocks having the requisite amount of eccentricity given to them, and the keyway cut upon a chucking-pin. The only use of the templet, then, is the fixing the position of the hole for boring, and that of the keyway.

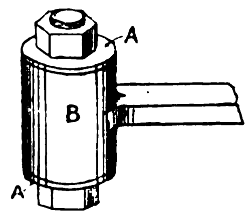


FIG. 78.

Fig. 76 shows a modified form of sheet-metal templet, in which pieces A, turned down at sides or ends, are made to embrace sides of work already faced, and thus become a guide to the marking-off of lines upon a face at right angles therewith. Such a templet as that in the figure is suitable for marking-off an engine crosshead, sliding on guide-bars of rectangular section. The templet being laid against the end of the crosshead, and the nibs A embracing sides already faced, the sliding faces and edges of the crosshead are marked from the recesses B B.

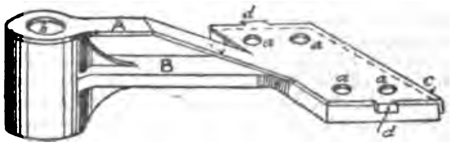


FIG. 81.

Fig. 77 shows a templet by which the cottar way in the stub ends of connecting rods can be marked. The templet A is set on the faced sides and ends by means of the nibs *b* and the hole *a* scribed through.

Fig. 78 is representative of a class of templets not much used in workshops, but serviceable to amateurs and home-workers destitute of mechanism. They are employed either for lining-out or as guides for filing, and their outlines may be varied extensively to suit work in hand. The illustration represents two discs of steel or iron, A A, bolted upon the ends of the boss B, and are used as guides for filing it to shape and size in preference to working to compass lines. Of course, templets of this type can only be used when there are holes existing, into which bolts, or short pins, or studs- can be thrust to preserve the templets accurately in position.

Thin sheet-metal, or cast templets of the general type, shown in Figs. 70 to 77, are of use for a multiplicity of purposes. There is, practically, no limit to their uses, and to the forms imparted to them. Where standard work is being constantly repeated, and centres, distances, and diameters are fixed once for all, the templet is made accordingly, and remains a permanent record of work done, and a guide for future work, and is one of the primary elements in producing interchangeability of parts.

Fig. 79, A, is an example of a templet of another class. It is set to a centre line. This particular one is used for marking the sunk key-ways on a turned shaft. It is a piece of thin sheet-iron, hammered or rolled to the curve of the shaft, and cut to a definite length to correspond with a definite turned length on the shaft. The slots are cut to correspond with the exact positions of the key-ways required. So that on laying the templet upon the shaft, the position of the keyways can be marked, without putting the shaft upon the lining-off table at all. Also, if key-ways are wanted at angles of 90° for cranks or eccentrics, or at any other angle, they can be so cut in the templet A, Fig. 80, saving the trouble of lining off.

Fig. 81, A, illustrates a sheet-metal templet, used for marking off holes in two distinct planes —namely, the bolt holes, *a*, in the foot of the casting B, and the shaft hole *b*. The templet is flanged down at *c* and at *d*, and is thus set in position in relation to the foot. But all these, though in the most common use, are of the simplest possible types. They are essentially templets for use in horizontal planes only. When centres and dimensions have to be marked out upon more than one plane, templets can usually be devised of forms suitable to the requirements of each individual case. Frequently a single templet will suffice for a piece of work, sometimes two or more distinct templets are necessary to complete the lining out.

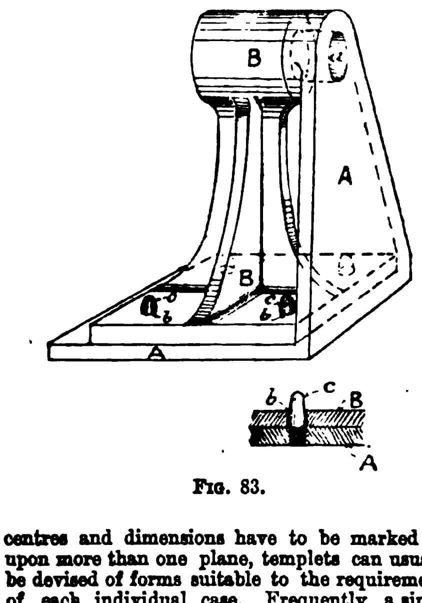


FIG. 83.

Fig. 82 illustrates a simple templet A, used for marking off the bearing hole, *a*, in the dead eye bearing B, and the bolt holes *b* also. Of course, before the templet can be used the foot must be first planed along the line *c*. But a rough lining out of that, so as to insure the proper height of the centre of the hole *a*, with due allowance all round for boring, is quickly done. Perhaps also the face *d* may have to be planed, or a circular facing piece only may be faced over, to save the labour of tooling the whole surface. If so, that must be done also. Then when both foot and face are prepared, the templet is laid on, as seen in the figure, and the holes scribed off or drilled in succession in the castings. In this way many scores or hundred of similar bearings can be turned out all exactly alike.

One more illustration, Fig. 83, must conclude this article. It is that of a templet, A, used for drilling the hole *a* in the bracket casting B. The foot of the bracket has been already planed, and the holes *b* drilled with a plain templet of sheet-metal or of cast iron, and these now are made the guides from which the hole *a* is scribed or drilled direct. There are four pins, *c*, in the planed foot of A, which correspond exactly with and enter the drilled holes *b* in the foot, and so fix the position of the templet. A pin is shown in section below. This is typical of a very extensive and widely varied class of templets used for machining and drilling. In the next I shall conclude all I intend to say on the subject of templets, with some examples of a rather more elaborate character.

J. H.

PRACTICAL HINTS IN BOILER DESIGN.—VIII.—(*Conclusion*).

By W. C. CARTER.

Strength of End Plates.—

Pitch of stays, 17in. S = 289, T = ¾. By formula (xi.)—

$$\frac{187\frac{1}{2} \times 169}{283} = 111\text{lb. W.P.}$$

Combustion Chamber Plates.—

Pitch of stays, 8in. S = 64, $T = \frac{F}{16}$.

$$\frac{100 \times 64}{58} = 110\text{lb. W.P.}$$

Furnaces.—

T = ½in., D = 39in. By formula (iii.)—

$$\frac{8800 \times 1}{2 \times 39} = 113\text{lb. W.P.}$$

Combustion Chamber Girders.—

By formula (xiv.) W = 28in., D = 8in., L = 2⅓ft., P = 8in., C = 750, T = 1¾in., *d* = 6in.

$$\frac{750 \times 36 \times 7 \times 3}{4 \times (28 - 8 =)\, 20 \times 8 \times 7} = 126\text{lb. W.P.}$$

Shell Riveting.—

T = $\frac{13}{16}$in. P = 8in. D = 1in. Percentage of plate by formula (xviii.)—

$$\frac{(8 - 1) \times 100}{8} = 87\tfrac{1}{2} \text{ per cent.}$$

T is omitted, as it occurs in both numerator and denominator. Percentage of rivet by formula (xix.)—

$$\frac{5 \times {\cdot}7854 \times 100 \times 16 \times 23 \times 7}{8 \times 13 \times 28 \times 4} = 86{\cdot}8 \text{ per cent.}$$

Shell Strength.—Allowing 29 tons per square inch on the material, and using a factor of safety of 5·1, as required by Board of Trade rules. Again referring to Art. I., we find that the working pressure varies.

Directly as the Thickness × 2;
,, as the Joint percentage;
,, as the Stress allowed on material;
Inversely as the Diameter;
,, as the Factor of safety.

Or, expressed algebraically—

$$\frac{T \times \text{percentage} \times S}{D \times F} = \text{W.P.}$$

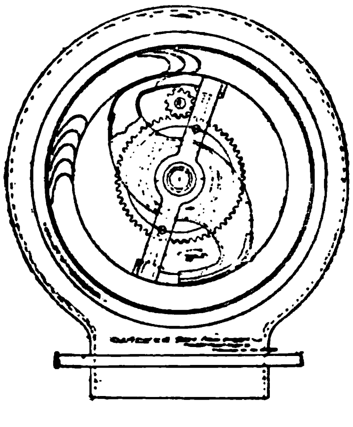
$$\frac{13 \times 86{\cdot}8 \times (29 \times 2{,}240)}{8 \times 1{,}000 \times 162 \times 5{\cdot}1} = 110\text{lb.}$$

We have thus proved the correctness of the dimensions fixed in Article VII., and the leading principles of construction have been, it is hoped, so stated as to enable a mechanic to think out the further details of staying, &c., for himself. Naturally, there is always latitude for the exercise of ingenuity; but if the mechanical principles upon which the problems are to be thought out have been made any clearer by the foregoing articles, their purpose will have been served.

AN IMPROVED WATER-MOTOR.

SOME important improvements have recently been embodied in the construction of the well-known Little Giant water-motor, a simple, serviceable, and powerful machine, of which large numbers are in use. It is built on the principle of the turbine, and therefore gives a high degree of efficiency, and the pinion-gear is extended to the outside to be operated by a lever for the adjustment of the water jets, which are opened and closed at will, the lever being operated by cog gears, as shown in the sectional view. The wheels are made of brass, securely riveted together, the water-chute being of composition, and the shaft of steel, while the motors have only two bearings, babbitted, to run with the least possible friction.

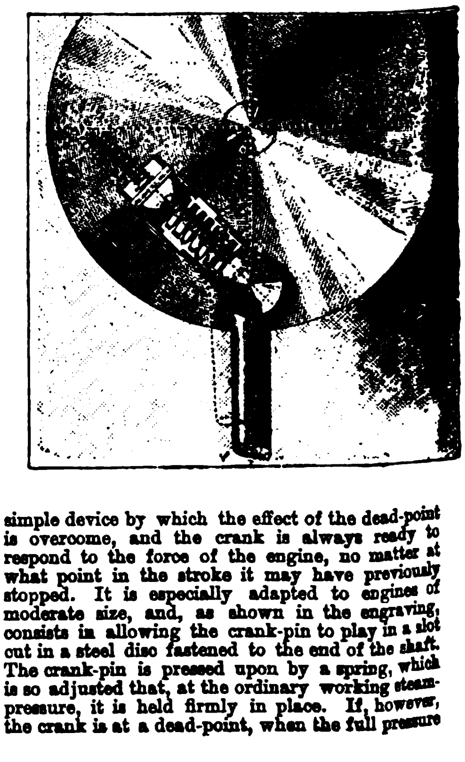
These motors are used in all sections, and for an almost unlimited variety of purposes. In Mobile, Ala., the Craft and Co. roller mill is using one for grinding corn, making 27 bushels of meal per hour with 85lb. of water pressure, and two are in use in the Mobile foundry. In Galveston, Texas, 24 of these motors are in use. At Defiance, Ohio, several large-size machines are in use, and the Franklin, Ohio, waterworks light their pumping-station with a combined motor and dynamo, the high speed of the motors specially adapting them for running dynamos. The Joliet, Ill., and Independence, Iowa, waterworks also use it for lighting stations, for which purpose it is likewise used at Pawtucket, R.I., Boston, Lynn, and many other waterworks stations, a kind of service for which the most efficient machinery is always sought. Many printing offices throughout the country use the motor to run presses, and it is employed for almost every purpose, from running machine shops, elevators, pumps, &c., to the operating of fans, blowers, and church-organs. Further particulars in reference to this efficient motor may be obtained of the Belknap Motor Co., Portland, Me.



A CRANK WITHOUT A DEAD-POINT.

IN reciprocating steam-engines with a single cylinder there are two points, one at the end of each stroke of the piston-rod, where no force is exerted by the engine on the crank; and even if there were, the force would be directly perpendicular to the shaft, and no rotation could take place. If such an engine is accidentally stopped when the piston-rod and crank are at one of these so-called "dead-points," the machinery cannot be started until the crank is pushed past the dead-point, either by hand or by special machinery. Once started, the momentum of the fly-wheel or other machinery suffices to carry it past these points.

A French engineer, M. Michele, has invented a simple device by which the effect of the dead-point is overcome, and the crank is always ready to respond to the force of the engine, no matter at what point in the stroke it may have previously stopped. It is especially adapted to engines of moderate size, and, as shown in the engraving, consists in allowing the crank-pin to play in a slot cut in a steel disc fastened to the end of the shaft. The crank-pin is pressed upon by a spring, which is so adjusted that, at the ordinary working steam-pressure, it is held firmly in place. If, however, the crank is at a dead-point, when the full pressure



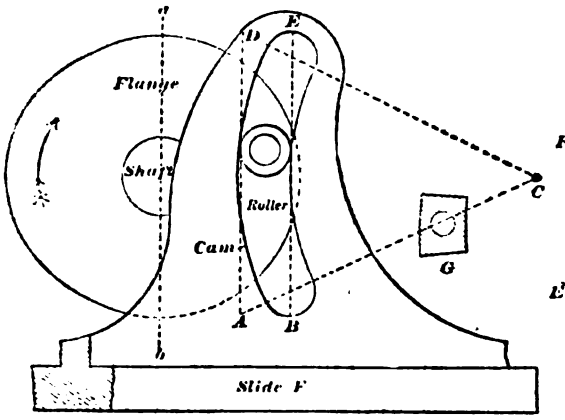


Fig. 1.

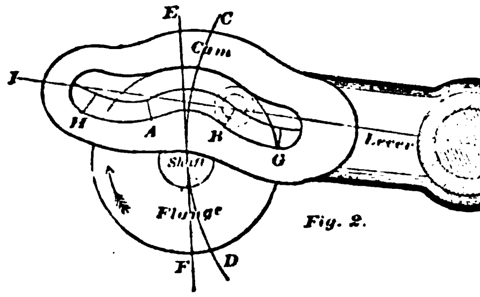


Fig. 2.

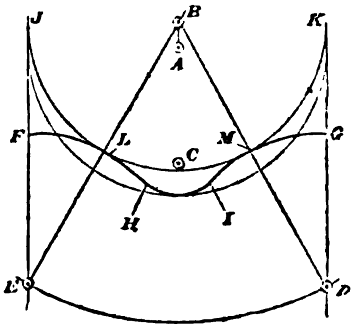


Fig. 4.

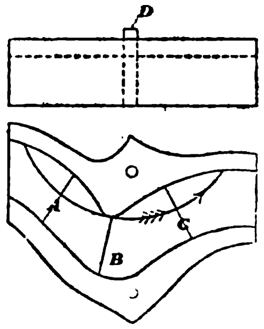


Fig. 3.

of the steam is admitted into the cylinder the spring is compressed, the crank-pin slides in the groove to the position shown in the dotted lines, and the shaft begins to revolve. As the pressure of the steam in the cylinder while the engine is in motion is less than that in the boiler itself, as soon as the shaft begins to turn the pressure against the spring is relieved, and it forces the crank-pin back to its usual position. It is only necessary to adjust the tension of the spring, by means of the nut shown in the drawing, so that it will resist a pressure slightly less than that usually carried in the boiler. After that the action is entirely automatic.

CAM MOTIONS.*

THE peculiarities of the particular kind of cam to be considered can best be described by reference to that form of it shown in Fig. 1.

It will be seen that there is a shaft carrying a flange, and on that flange there is a roller set a considerable distance from the centre of the shaft. This roller fits the slot in the cam so that it may move freely, but have no lost motion.

When the flange revolves in the direction of the arrow, the slide to which the cam is attached will reciprocate, and its motion will be modified by the shape of the slot within which the roller travels. The shape of the slot here is an arc struck from the centre C.

The effect [of a cam in which a roller operates within a slot of irregular shape is not calculated from either side, but by the central line between the two sides. This will not affect the cam in Fig. 1, because both sides and the central line are struck from a common centre, as C. In fact, this particular cam gives precisely the same motion as would be produced if the cam were removed entirely, and the centre C were on a stud attached to the slide F, and this stud were connected to the roller by a link or connecting rod of a length equal to the distance from the centre C to the centre of roller.

In a slot of one arc, as here shown, or in a straight slot, as indicated by the dotted lines A D and B E, a block, as G, may be employed instead of the roller. But, however preferable such block may be theoretically, it is found in practice to be quite inferior to the roller shown; in respect of friction, economy, and lasting quality.

Instead of an arc, if the cam in Fig. 1 was of a shape as the straight dotted lines A D and B E, the reciprocating motion of the slide would be in exactly the same time at one end of such motion as at the other. With the arc shown, however, the motion is much accelerated when the roller passes to the right of the centre line *a b* of the shaft toward, and from, the centre C, and, of course, is correspondingly reduced during the other half revolution.

In Fig. 2 this cam is shown as operating a hinged lever.

The acting part of the cam is made from three arcs, H A, A B, and B G. The arc A B, when occupied by the roller, as in Fig. 2, coincides with the path in which the roller moves, so that, while the roller is moving from A to B, the lever will be at rest. But it will be at rest only once in each revolution of the flange. It is practical to make this rest equal one-sixth of the time of revolution, and have no noise. The rest A B is as practical in a cam in the slide, Fig. 1, as it is in the lever, Fig. 2.

If a straight slot were made in this lever, the centre line of which is indicated by the line I K, the rate of movement would be greater than the roller passed between the shaft and the fulcrum, and less when it should pass on that side of the shaft opposite the fulcrum. The lever would be reversed at the moment the roller reached the arc C D, whose centre is the fulcrum K, and the difference in the time of each sequent oscillation would vary as the distance between this arc and the line E F. This difference must be considered in the design of cams.

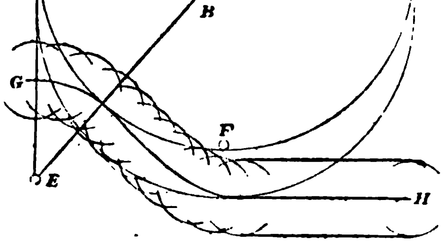


Fig. 5.

Fig. 3 illustrates the needle bar cam of a sewing machine. This is the most practical form this style of cam has taken. There have been probably twenty millions of such cams made and used in different kinds of sewing machines, and, after many attempts to get a satisfactory equivalent for this device, it is the most effective thing for the purpose yet found.

The peculiar thing about this cam is that it receives more motion than the throw of the roller gives it. It will be seen that a roller travelling as indicated by the arrow will have forced this cam down to the extreme when it has reached the point A. Then to reach B the cam must be raised so as to bring the roller arc indicated by the arrow to the middle of the slot B. Again, to reach C, it must be returned to the lower position. Thus it is possible with this cam to strike two blows at one end of a stroke, and, if required, one of them may be thrust farther than the other. This is called "second motion."

To design a cam having two motions at one end of the stroke, as in Fig. 4, indicate the centres A and B a distance apart equal to the required short second motion. Then with a radius equal to that of the roller on the flange, describe the crescent J K from these centres. On the inner arc of the crescent indicate the time or degrees of rotation L and M to be consumed in making this second motion, and through L and M draw the lines B E and B D. Then draw the lines J E and J D from each end of the crescent parallel to each other, and to the line between the centres A and B. Draw the arcs F H and I G from the intersections E and D as centres. The centre C will have to be obtained experimentally, and must have a position that will give the arc H I, touching the outer arc of the crescent, and joining smoothly both arcs F H and I G.

This rule cannot be taken to construct all such cams, but it will indicate the main features of them all. This crescent, however, will be found of advantage in almost every cam of this character where the amount of second motion and the time used in making it must be accurate.

In Fig. 4 only the centre line is given. In Fig. 5 is shown a cam which has more motion than the throw of the roller, but no second motion. This is of advantage where the room is limited sidewise. The usual method of getting two lines parallel to the central G H is indicated.

It is always to be preferred that the places in cams of this character where the roller reverses its motion within the cam, and begins to return over its track, should be at right angles to the movement of the cam, or nearly so. If not, there is likely to be noise.

All the cams here given are as applicable to a lever as to a sliding device. In designing a central line for this kind of cam, no curve must be made that has a radius as short as half the diameter of the roller to be used in it. If a radius be so short, an angle will be found at the exact point the centre has occupied. If the radius be shorter there will be a loose place at the point the centre occupied which nothing can cure. Have the radii as long as practicable.

I have known a roller in a cam similar to Fig. 3 to maintain a speed of more than 3,000in. per minute. The cam, roller, and roller stud were hardened. This duty was not continuous, but stopped about eight minutes in each hour. The work done was to reciprocate a bar, which, complete, weighed perhaps 3oz., a distance vertically of about 1$\frac{1}{10}$in. and about 900 times per minute. In addition to this it perforated layers of hard linen cloth $\frac{1}{16}$in. thick, with a needle more than $\frac{8}{100}$in. in diameter.

At the end of three months' wear of this kind the cam was found to be in good order. The roller was slightly worn, but the roller stud was most worn, being oval and about $\frac{3}{1000}$in. smaller in one direction than it was originally.

These cams are now usually made of machinery steel for sewing machines, and case-hardened. In some instances the groove is partly drop-forged into them, but in others the blank is punched from the flat stock, and the groove is milled from the solid. Everything considered, perhaps this latter plan is the better one. In which case the preferable procedure is like this:

Make the die ·01in. larger than finished model, groove side up. Pickle the scale off the stock, and anneal it before punching. Flatten in drop press, groove or punch side down.

Make a punching die to exact model size and re-punch the blanks, groove side down. This reverses the punching operation, and will, if done well, make the edges equal to a mill cut, and quite square on both sides. The groove side will require no milling if the flattening is good, but it should be lapped so that the burrs, &c., may be taken off, as that side is down in the next operation, that of milling the back or the seat on which it is attached to its bar.

In the cam shown in Fig. 3 the position on the bar is got by the projection D. The top of this will not ordinarily be required to be milled, because the groove may be cut deep enough to accommodate every reasonable variation in this height. Therefore there need be but two cutters in the gang to mill this seat as shown, but if there be other shapes added to it other cutters may be required.

The groove now only remains to be milled, which is admirably done by machines made by a number of first-class makers.

Just here I wish to say a word about the "burring" of steel after it is milled, and all I have to say is that such burring and cornering generally costs more than the milling operation that precedes it. It is all handwork of a tedious kind, requiring care and judgment. Perhaps some genius can see a way to do this work by tools.

SWITCH FOR CHARGING STORAGE BATTERIES FROM ARC CIRCUITS.

AN ingenious switch, a view of which is given in the accompanying illustration, has been devised for charging storage batteries from arc lighting circuits without opening or interrupting the circuit. It is the invention of Mr. W. S. Hill, of Boston, Mass. The switch has four contacts, an electromagnet, and a lever actuated by a spring. When the lever is raised, as shown in the cut, the

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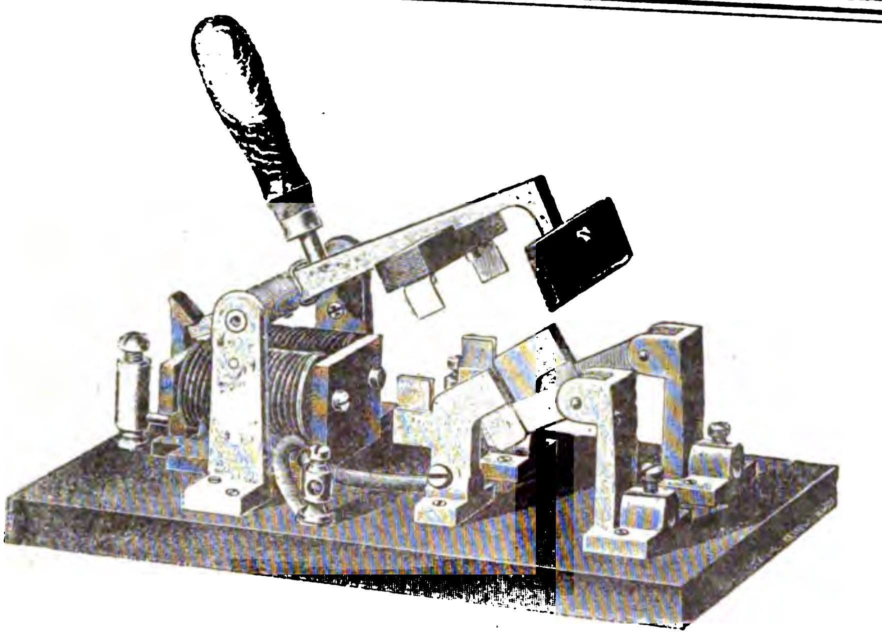
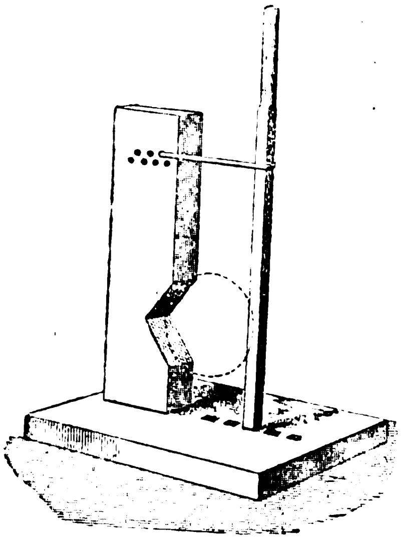
* By A. D. PENTZ, in *American Machinist.*



magnet, the four contacts, and the batteries to be charged are all connected in series between the two binding posts. The latch that holds the lever up is held by the pull of the magnet on an armature. Should anything occur to open the circuit for an instant, the magnet will be demagnetised and the latch be drawn back by a spring, releasing the lever which will then drop and close the circuit between the two main line contacts, restoring the circuit. At the same time the connection between the main and the battery contacts is broken, thereby disconnecting both ends of the battery circuit and preventing its being short-circuited on itself. With slight modification, the same device is used to cut out the batteries when they have been sufficiently charged. In this case the position of the magnet is reversed, and it is made to release the latch, when a predetermined amount of current is passing through the magnet, the circuit through the magnet being connected in shunt to the terminals of the batteries.

A USEFUL CLAMP FOR WHEELWRIGHTS.*

I SEND a rough sketch of a clamp which I have found better than anything else for use in boring holes through large hubs, where a 2in. or a smaller hole is required. It can be used on any



machine in which the auger runs horizontally, and its cost is trifling.

In making it, I took a piece of pine plank 2in. thick and 18in. square for the base, and made several mortises in it to hold the foot of the lever. I framed a standard on one side, about 6in. wide and 24in. high, and put the bottom of it on a line with the mortises. Then I cut a triangular piece out of the standard, as shown in the sketch, so that the centre of it would be of the same height as the auger when the clamp rests on the base of the boring machine. The object of this triangular opening is to bring the centre of the hub at the same height as the point of the auger, and to prevent the hub from turning when boring. The lever should be a piece of oak or ash, about 1¼in. square and 30in. long. One end fits loosely in the mortises in the base, and the top is rounded for convenience in taking hold of when in use. The hasp is a piece of ⅜in. round iron, about 16in. long, each end of which is bent at right angles, as in the drawing. Several holes $\frac{7}{16}$in. in diameter are bored near the top of the standard, to receive one end of the hasp. In using the clamp, place the hub in the triangle in the standard, put the bottom end of the lever in one of the mortises in the base, and bring the lever up against the hub with force enough to prevent it from turning round when bored. Then put one end of the hasp on the outside of the lever, the other end in one of the holes in the standard, to clamp it tight. The spring of the lever will enable the hasp to be adjusted to the right hole. Place the centre of the hub against the point of the auger, and bore halfway through; then turn both clamp and hub around, and bore the other end until the holes meet. In the case of very large hubs, while one man places the hub in position, another will be needed to tighten it in the clamp. Anyone who tries this clamp once will appreciate it.

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* By GEORGE E. DANIELS, Rowley, Mass., in the *Blacksmith and Wheelwright.*

SCIENTIFIC SOCIETIES.

THE LANTERN SOCIETY.

ON Monday, the 11th inst., at 20, Hanover-square, the hon. secretary, Capt. Gladstone, R.N., read a paper entitled, "Westminster Abbey," illustrated by 40 slides, entirely his own work. He began by describing, with the aid of a map, the position of the Abbey and of the various ecclesiastical buildings which in former times surrounded it, pointing out at the same time the modern names of the old sites which in many instances had reference to buildings which had long since disappeared. He next showed a plan of the Abbey, in which the age of each part could be distinguished by the character of the shading. The slides of the exterior and interior were next shown, the lecturer pointing out in each case all that was of historical, architectural, and archæological interest.

It will be needless to dwell upon the excellency of the pictures, as everyone who knows anything of Capt. Gladstone's work is aware of its uniform technical finish and artistic merit. But one of the special features of the lecture was Capt. Gladstone's intimate acquaintance with the details of ecclesiastical architecture, which enabled him to trace every variety of style in the ancient and complex structure of the Abbey. Thus he showed in one of the slides that within the space of 2ft. there could be seen examples of three successive styles of architecture executed by three different kings—viz., Henry III., Henry V., and Henry VII. And to this he added an almost equally full knowledge of all the history and archæology connected with the building. One amusing fact he noted, by the way, was that the familiar phrase of "Robbing Peter to pay Paul" had its origin not in the history of the great Apostles, but in the story of our two great city churches; St. Peter's Abbey at Westminster having been shorn of much of her revenues to swell those of St. Paul. It is also interesting and instructive to note that the only tomb in Westminster destroyed by the Puritans was that of the only Puritan king, Edward VI.

After the lecture Mr. Vesey, in proposing a hearty vote of thanks to Capt. Gladstone, said it was the best lantern lecture he had ever heard. The vote being carried unanimously, the proceedings terminated.

SCIENTIFIC NEWS.

THE absolute values of the magnetic elements as taken at the Parc St. Maur observatory by M. Th. Moureaux, were presented to the Paris Academy of Sciences recently. The secular variations in declination and inclination amount to 5·2′ and 1·6′.

Two of the minor planets were found recently on some of the photographic plates taken by Dr. Max Wolf last month. One has been identified by Dr. Berberich as No. 275; but the other is probably new, and if so, will reckon as No. [illegible] It appears that it was observed by Dr. Palisa on the 31st of December, and is most likely new.

The concluding part of "Old and New Astronomy" will shortly appear, and with the index will complete a work of the very greatest value to students of the sublime science. Messrs. Longmans are the publishers.

The death is announced, at Kew, on Thursday last week, at the age of 75, of Mr. Walter Hood Fitch, F.L.S., the well-known botanical artist. Mr. Fitch, who had been in ill-health for some two or three years, will be best remembered by his connection, extending over many years, with the *Botanical Magazine*, and for his illustrations of the grand Victoria Regia water lily, and the chinchonos or Peruvian-bark plants. In recognition of his merit as a botanical artist a Civil List pension of £100 a year was granted to him several years since.

The distinguished French naturalist, Jean-Louis-Armand de Quatrefages, who died on the 12th inst., was born on February 10, 1810, at Bertheznnée, in the Department of the Gard. After taking a distinguished degree in medicine at Strasbourg, he became professor of zoology at Toulouse; but finding provincial life unsuited to his tastes, he settled in the capital, and in 1850 he obtained a professorship at the Lycée Napoléon. Five years later he was called to the chair of Anthropology and Ethnology at the Museum of Natural History, and henceforth his life was devoted to work at the Jardin des Plantes. Prof. de Quatrefages was a copious and elegant writer, known popularly by such works as his "Souvenir d'un Naturaliste," of which an English translation in two volumes appeared in 1857. He contributed to the "International Scientific Series" a volume entitled "The Human Species," which was published in 1879. The deceased professor was well known as an opponent of many of the views of Mr. Darwin. De Quatrefages' "Crania Ethnica," first published in 1875, and subsequently extended with the co-operation of M. Hamy, is recognised as a standard work. His "Etudes des Races Humaines" was written when he was on the verge of 80 years of age. In 1879 Prof. de Quatrefages was elected a Foreign Member of the Royal Society.

Mr. Benjamin Scott, well known as the Chamberlain of the City of London, and respected as one of the most distinguished officers of the Corporation, having entered the service in 1827, died the other day in his 79th year. Mr. Scott, who was the author of a work on the Catacombs of Rome, was a Fellow of the Royal Astronomical Society, having been elected into that body in 1860.

Matthew Berkeley Hill, who was born in 1834 at Hampstead, and was distinguished by his surgical skill, died the other day, to the great regret of many friends in the profession, and of innumerable patients who have experienced the advantages of his skill in his hospital practice.

In reference to the epidemic of influenza, it may be mentioned that, at the meeting of the Society of Medical Officers of Health, held on Monday, at 20, Hanover-square, a paper was read by Dr. Richard Sisley, upon "Influenza, and the Laws affecting Public Health," when the meeting passed unanimously the following resolution:—"In the opinion of the Society of Medical Officers of Health, influenza is a dangerous infectious disease."

Attention is drawn to the fact that in the *European Magazine* of December 1813, the following remarks appear:—"Influenza or epidemic cold. Such is the term given by medical gentlemen to the disorder now so prevalent in this country—sometimes fatal in its results among children. 1st. Its general symptoms are rigor, or shivering, as in an ague, intense sneezing, running at the eyes and nose, hoarseness of voice, pains in the head, chest, and limbs, oppression on the lungs, and astonishingly rapid respiration at night, with intermittent fever and spasmodic affections during sleep. 2nd. Its certain cure is effected by a gentle emetic of ipecacuanha, frequently aided by small cups of some warm tea or plain water, and a dose of strong infusion of senna on the following day. An ounce of manna dissolved in half a pint of spring water may be taken in a tablespoonful at one time whenever the cough is troublesome. 3rd. The diet should be roasted apples, broths, barley-water, tapioca, or weak gruel. 4th. The clothing warm, but not heavy. Flannel underdresses are highly beneficial; a flannel shift at night has proved essentially useful also. A slight coal fire in the nursery and in the bedroom is indispensable—not to heat, but to dry the air of the chamber."

Prof. Huxley, as Dean of the Royal College of Science of London, thinks that many who may have arrived at the conclusion that the institution, which began so humbly in Jermyn-street 40 years ago, and is now important enough to ask a favour of the Chancellor of the Exchequer, was, from the beginning, intended for a school of mines alone, and that, as such, it has grown to its present dimensions and justifies its present claims. If (he says) I am right in this supposition, the report must be erroneous, because no one knows better than my friend, Sir Lyon Playfair, the remoteness from fact of any such supposition. No one had more to do with the original plan of the school, and no one deserves more credit than he for the first attempt to found a broadly and liberally-organised technical college in this country by the establishment of the Government School of Mines and of Science applied to the Arts, in Jermyn-street, in 1851, and its subsequent reorganisation, two years later, as the Metropolitan School of Science applied to Mining and the Arts. From that time onwards the name of the institution has undergone several changes; but, in substance, it has never been narrowed to a simple school of mines. As a chemical school it has possessed at least an equal practical importance; as a school of geology and of biology it need not be ashamed to speak with its enemies in the gate. At the present moment the title of Associate of the Royal School of Mines is given to those who pass out in two of the eight divisions into which the instruction of the Royal College of Science at South Kensington is divided, and I am afraid that without the other six there would not have been the least necessity for the council to press for larger accommodation. Prof. Huxley says that about three-fourths of the work of his colleagues seems to be publicly ignored.

This year's Naturforscher-Versammlung will be held at Munich from September 12th to 17th, and the Gerrman Society for "Oeffentliche Gesundheitspflege" will meet at Würzburg from the 17th to the 20th of the same month.

The Council of the Royal Meteorological Society have arranged to hold an exhibition of instruments, charts, maps, and photographs relating to climatology at 25, Great George-street, from March 15th to 18th, and they invite all who can to help them with the loan of anything of the kind suitable for exhibition.

Superintendent Johnson, of the Deaf and Dumb Institute, of Indianapolis, Ind. (U.S.A.), has been making some interesting experiments with the phonograph, and believes that in connection with it he can teach the majority of the deaf mutes under his charge to talk. He finds that the instrument concentrates the sound at the drum of the ear in such a way that many of the pupils, otherwise deaf, are enabled to hear. He tried the phonograph with 27 boys and 29 girls. Of these only three girls were unable to hear anything at all. Twenty boys and 20 girls could hear instrumental music, while 11 boys and 15 girls could distinguish spoken words. Of the 56 whose hearing was tested by placing the phonograph tubes in their ears, 28 could hear best with the left ear and 14 with the right, while 11 heard alike with both.

M. Delprat, Director of the French Ecole Supérieure d'Aërostation, is exhibiting at the Palais des Beaux Arts, on the Champs de Mars, a flying machine of his invention. It is very simple, being a sort of aërial velocipede. The rider, by the aid of treadles, moves a twin screw placed above him, by means of which the machine should rise into the air. When he has arrived at the desired height another screw, placed on one side, is also brought into action, and, by means of a large fan-like rudder, M. Delprat thinks the machine can be made to advance in the required direction.

In a rain-making experiment made near Mozufferpur, under the direction of Mr. Lees, executive engineer, three charges of dynamite, each 20lb. in weight, were fired at intervals of about nine minutes, from a wire suspended 50ft. above the ground. So far as could be observed, the explosions had no appreciable effect on the atmospheric conditions. In the United States the experiments are reported to be successful; but perhaps in that country they make the experiments when there is a possibility of successful results.

Anthropology in South America (a rather wide address) is to be worked up, for it is rumoured that a sum of 20,000dol. has been placed at Prof. Putnam's disposal for the purpose by a Connecticut gentleman. Such work of the kind as has been done would seem to indicate that there are many discoveries to be made in the country, especially in the part best described as Central America. The sum allowed Prof. Putnam is to be devoted especially to the procuring of objects of anthropological interest for the Chicago Exhibition of 1893. A portion of the exhibit will be cliff-dwellers' relics, gathered in Colorado, Utah, Mexico, and Arizona.

At a recent meeting of the Brussels Academy of Sciences, a note was read by Prof. J. Van Beneden, "On the Study of Heat and Light Phenomena Accompanying Electrolysis," by MM. E. Lagrange and Hoho. In an electrolyte of dilute sulphuric acid, a positive electrode having an area of 180sq.cm. was immersed, whilst the negative electrode consisted of a wire of copper 0·25mm. in diameter, submerged to a depth of 0·5mm. below the level of the liquid. On passing a current from accumulators through the electrolyte, the ordinary phenomena of electrolysis were observed. When the electromotive force was increased, a kind of decrepitation, resembling the fizzing noise which is heard when drops of water fall on a hot metal plate, was produced at the negative electrode. The liquid about this electrode appears to be in a state of ebullition. The phenomena increased in distinctness as the difference of potential between the negative electrode, and a point in the liquid 3mm. from it, approached 16 volts. At intervals, when the difference of potential had reached 16 volts, a number of luminous points were produced between the electrode and the liquid, and their frequency was found to increase with the difference of potential. The author has studied the phenomena, using electrodes of Pt, Cu, Zn, Sn, Fe, and C of different dimensions, electrolytes of different degrees of dilution and different natures. He finds, among other things, that the phenomena commence when the electromotive force is the same (for a given degree of acidity), whatever the nature of the electrolyte. The intensity of the current increases, *cæteris paribus*, with the sections of the electrodes, and varies with the nature of the electrode. For the same degree of acidity, the same electrode, and the same amount of immersed surface, the intensity of the current tends to remain constant, although the electromotive force varied from 76 to 98 volts.

THE value of the farm products of the United States in 1891 amounted to 700,000,000dols. more than was produced in 1890.

Recovering Gold and Silver by Electricity.—A French photographic journal describes a method of recovering the gold and silver waste of photographic processes by means of electricity. The process consists of suspending in the solutions containing these metals a plate of carbon to the positive pole of the battery, and a zinc plate to the negative, the two being separated by the space of about 1¼in. With the closing of the circuit from any ordinary battery there is formed on the zinc electrode a black deposit, which falls to the bottom of the solution. This deposit, after being removed and dried, is melted in a crucible, forming an ingot of metal.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

POTSDAM SPECTROGRAPHY—DIGNITY AND IMPUDENCE — TERRESTRIAL ORBITAL VELOCITY—"C.G.S" MEASURE—SUNSET ON CHIMBORAZO—COMETS—THE "CONNECTION OF THE PHYSICAL SCIENCES"—THE PASSAGE OF THE PLANE OF SATURN'S RINGS THROUGH THE SUN—THE BEST FORTY BOOKS—DISTILLING WATER—MAGNIFYING POWER OF MICROSCOPES—DEBASED ENGLISH.

[33082.]—THE December number of the *Monthly Notices* of the Royal Astronomical Society contains a paper by Prof. H. C. Vogel, which should be read by every one interested in the subject of stellar spectroscopy. It is "On the Method of Determining the Velocity of Stars in the Line of Sight," and gives a detailed description of the apparatus employed at Potsdam, and of the methods adopted of measurement and reduction of the photographic negatives obtained by its aid. There cannot be the smallest doubt that the Potsdam observations greatly exceed in accuracy any that have hitherto been made, and that any results which are discordant with those obtained by Prof. Vogel and Dr. Scheiner must unhesitatingly be rejected. With the example of these eminent men before us, though, and in the light of the frank and elaborate exposition of their method, we may look forward to its speedy adoption in this country. One very notable result deserves repetition here, and shall be given in Prof. Vogel's own words:—"I will," he says, "remark in conclusion that the velocities of the stars have proved to be much smaller than was to be expected from direct observations. The mean result for forty-seven stars is 10·6 English miles. Among them six have a velocity less than 2, and five less than 20 miles; the greatest is that of *a* Tauri, about 30 miles. Fifteen of the stars have a positive and thirty-two a negative motion." So that some of the fanciful hypotheses founded on the alleged great velocity of approach and recession of numbers of stars, will have to be given up altogether.

It is gratifying to know that the splendid work done at Potsdam has met with due appreciation from the Académie Française, who by the award of the Prix Valz "pour l'ensemble de ses travaux rémarquables sur la spectroscopie," have rendered worthy homage to Prof. Vogel, and shown that no mean jealousy has been allowed to operate in depriving him of an eminently well-earned tribute to his invaluable labours.

All who remember the discussion which took place at the Royal Astronomical Society, on the 8th of last May, when two youthful and extremely "bumptious" gentlemen got up or were put up to maintain the "magnesium fluting" origin of the chief nebular line, will appreciate the *spiritual* character of the reproof contained in Mr. Keeler's foot-note (at the bottom of column three) on p. 437. An attack by people of Messrs. Gregory and Taylor's scientific status upon anyone who has done such work as Mr. Keeler has, irresistibly suggests the yapping of two toy terriers at a fine Nubian lion.

"J. M. R." (query 76223, p. 449), should favour us with an example worked out by his method. He might select the end of March or the beginning of April, when the earth is very nearly at her mean distance from the sun, and when her orbital motion is approximately 18·395 miles per second.

In reply to "G." (query 76231, p. 449), "C.G.S." is the contracted form of "Centimètre-gramme-second," a system suggested by the Unit Committee of the British Association. The centimètre is the unit of length, the gramme the unit of mass, and the second the unit of time. The unit of force, called the "dyne," is that acting on one gramme for one second, and generating a velocity of one centimètre per second. The unit of work—i.e., the work done by the force working through a centimètre—is called an "erg." "G." should consult

Prof. Everett's "Units and Physical Constants," published in 1879, for details.

"Chrysomela" (query 76251, p. 450) may take the dip from the top of Chimborazo as being 2° 20′ 21″. This is corrected for refraction: the geometrical dip would, of course, be larger. The mean horizontal refraction would be, as in every other case, about 34′ 54″. Hence, to determine the time of sunset on, say, the 22nd of January, we should get the sun's zenith distance thus—

	90°	0′	0″
Dip	2	20	21
Sun's semi-diameter		16	17
Mean horizontal refraction		34	54
Zenith distance of sun's centre	93°	11′	32″

"Chrysomela" doubtless knows how to proceed now. If not, he can refer to page 264 of your XXVIIth volume, where he will find an example worked out *in extenso*. There are no tables giving refraction for a zenith distance exceeding 90°. Why on earth should there be?

"Am. Astro." must forgive me for saying that query 76258 (on p. 450) is simply a ridiculous one. "About 1873" is meaningless in such a connection. No less than seven comets (none of them conspicuous ones) appeared in that year. Possibly your correspondent is thinking of Coggia's comet, a fine one which remained visible for some six months in 1874. It will probably return A.D. 7585, so that "Am. Astro.'s" chance of seeing it again is, on the whole, remote. The next large comet whose return can be confidently looked for is Halley's, which will be here in 1910; but of course a comet of great size, having either a parabolic or hyperbolic orbit, may come to us out of space at any time.

My answer to "Am. Astro.'s" other query (76265) on the same page is, that Mrs. Somerville's "Connection of the Physical Sciences" is about as useless and inappropriate a book as he could well select, if his object be to ground himself in astronomy. There are dozens of works which he might study more profitably. If he will tell me specifically to what branch of astronomy he proposes to devote himself, I will give him the names of books which he may read with advantage.

The late Mr. Proctor, in his classical monograph on "Saturn and its System," gave in his Xth table, October 29, 1891, as the date of the passage of the rings' plane through the sun. He nowhere states whose tables of the planet he employed in his computations, but in the November number of the *R. A. S. Monthly Notices* the Rev. A. Freeman, as the result of a series of his own very carefully made observations, concludes that the "plane of Saturn's rings probably passed through the sun's centre on November 1, at about 6 a.m., or possibly one hour, or two hours at most, earlier." It would be interesting to trace this discrepancy to its source.

May I ask "Vehmgericht" (letter 33065, p. 463) to which of Loomis's books he refers under his number 18? because, the best known of them, Loomis's "Practical Astronomy," will scarcely be needed if the reader possesses Chauvenet. Loomis's "Treatise on Astronomy" is excellent. Perhaps this is the work that "Vehmgericht" means.

Is "B. F." (reply 76153, p. 469) thoroughly sure that his law is correct? Perhaps he will quote the Statute under which "you must apply to the Inland Revenue for liberty, under stringent laws," to distil *water*. The 43 and 44 Vict. c. 24 refers to spirits.

In reply to "Lucida" (query 76234, p. 474), the magnifying power of a microscope is never found by calculation; being always determined experimentally, for very obvious practical reasons; but the principle on which magnification is effected is this: Assuming 10in. to be the distance of distinct vision, and the combined lenses of the eyepiece to have a focus of an inch: then will that eyepiece magnify ten times. Now let us suppose that the image of the object is formed ten times as far behind the object-glass as the object itself is in front of it: then will its linear dimensions be ten times as great as those of that object. Now the object magnified ten times by the objective will be further magnified 10 times by the eyepiece, whence the magnifying power of the microscope will be 100 times linear. In practice a micrometer ruled to 100ths and 1,000ths of an inch is placed on the stage, and carefully focussed, and then a rule divided to 10ths of an inch is held parallel with it at a distance of 10in. from the other eye, and shifted about until the micrometer lines coincide with divisions on the rule. For example, if one of the divisions of ·01in. corresponds with 1½in. on the rule, the microscope magnifies 150 diameters. Or, suppose that one of the divisions of ·001in. just covers 0·45in. in the rule, then this indicates a power of 450. An even more accurate way is to project the image of the micrometer (by means of the camera lucida) 10in. from the eye, and measure this with compasses ten times along the rule. Thus if one of the divisions of ·001 on the scale repeated ten times along the rule measures 6·25in., we know that one such division must measure ·625in., and the microscope magnify 625 times linear. Bear in mind that the very thickness of the covering-glass of the object alters the magnifying power, as does, of course, any alteration in the length of the tube; because the farther that image is from the objective, the higher does the amplification become.

I venture to think that among the many recent attempts made in the United States to debase the English language, the invention of the noun which I have italicised in the following cutting from a Californian paper has not been surpassed:—"For some time the astronomers in charge of the Lick Observatory have complained that they have been seriously hampered in their work by a *shortage* of funds."

A Fellow of the Royal Astronomical Society.

PHOTOMETRIC AND PHOTOGRAPHIC MAGNITUDES OF STARS.

[33083.]—Having been lately comparing some of the star magnitudes in the *Harvard Photometry* and the *Draper Catalogue*, it seems to me that photometric and photographic magnitudes (at least, as the latter phrase is used by Prof. Pickering) do not correspond; but that with all the brighter stars (when not too bright to be photographically measured) the former are considerably higher than the latter. According to Pickering's Introduction, the two magnitudes ought to correspond when the spectrum is of the kind which he designates A (the largest sub-division of the first type). The following is, I think, a pretty complete list of the stars with this spectrum whose photometric magnitude is under 3·50, and whose photographic magnitude is given in the *Draper Catalogue*. Your readers can judge of the correspondence for themselves:—

Star.	Photometric Magnitude.	Photographic Magnitude.	Star.	Photometric Magnitude.	Photographic Magnitude.
β Auriga	2·07	3·54	β Aries	2·79	3·67
α Ophiuchus	2·18	2·88	δ Cassiopeia	2·84	3·73
γ Ursa Major	2·56	2·89	β Eridanus	2·87	3·61
β Ursa Major	2·60	3·80	τ Cepheus	2·90	3·77
η Ophiuchus	2·62	3·05	ζ Taurus	2·98	3·37
θ Auriga	2·67	3·49	α Scorpio	2·99	3·75
β Libra	2·74	3·14	δ Capricornus	3·01	3·51
δ Leo	2·75	3·20	α Libra	3·02	3·30
γ Corvus	2·76	3·28	γ Pegasus	3·04	3·46
o² Canis Major	3·05	3·50	γ Lyra	3·31	3·53
δ Cygnus	3·05	3·27	φ Sagittarius	3·33	3·55
β Canis Minor	3·07	3·35	θ Aquila	3·39	3·58
ζ Aquila	3·10	3·54	β Cepheus	3·39	3·85
γ Boötes	3·10	3·45	δ Ursa Major	3·41	3·71
β Triangulum	3·12	3·96	δ Aquarius	3·42	3·82
δ Corvus	3·13	3·40	δ Aquila	3·46	4·03
δ Hercules	3·26	3·70	θ Leo	3·47	3·61
ζ Draco	3·27	3·61	μ Serpens	3·48	3·74
μ Lepus	3·29	3·55	λ Orion	3·49	3·46

After these figures it is not so surprising to find that the difference in the case of Aldebaran amounts to 2·94 magnitudes, and of Antares to 2·58, these being the two largest differences in the *Draper Catalogue*, and the two brightest stars whose photographic magnitudes are given in it. The two kinds of magnitude are evidently not comparable at any considerable distance from the point where they give equal values for stars with the spectrum A.

Dublin, Jan. 16, 1892. **W. H. S. Monck.**

γ CETI.

[33084.]—With regard to Mr. Sadler's letter and advice concerning γ Ceti, I have tried it once or twice with power 100, but fail to divide it, although my imagination has sometimes carried me so far as to think that I could see a thin, black line. A closer examination, however, dispelled the illusion.

Last night (Jan. 12) about 10.30, although nearly full moon, the sky was beautifully clear, and I thought I would try my terrestrial eyepiece, power 36, on the Trapezium, and was greatly delighted to see *four stars*, far more distinctly than I have ever seen them. Indeed, on looking at them through my 100 power, although much wider apart, they were not near so brilliant.

Will Mr. Sadler say if he can see the companion to the Polar Star with 2¼in. glass, with power 100? I cannot say I have ever seen it, although I think my glass is a very fair one. In what direction is the companion to be seen? **Jimmy.**

RIGEL.

[33085.]—Amongst the many star-tests for small telescopes mentioned by your correspondents of late I do not remember to have seen any notice of Rigel as a test for these instruments. As I have lately become the owner of a glass of 2¾in. clear aperture, and as Rigel was one of the first objects examined, I may be pardoned for sending you my experiences.

I did not at first, or, indeed, after several trials, succeed in seeing the companion plainly; but with further experience I have found this object so easy, that I should not be surprised to hear of its being seen with 1¾in. aperture.

I find the chief points to be attended to are—to be very careful about focussing, and this of course it is presumed the student would be. 2. Use a low power—50 is ample—the companion is not a close one, and does not require a high power, which I find renders it much less plain.

3. Do not attack the object when shining brightly on the meridian, as the glare of the large star is more overpowering in that position; but try it rather when risen about half-way. By attending to these points I find the view of the companion to be so clear as to be readily seen even by young and totally inexperienced persons.

I should be glad to hear of the success of some smaller glasses on the same object. **Orion.**

THE PROPER MOTIONS OF THE STARS —THE ICE AGE.

[33086.]—With regard to the determination of the sun's motion in space by means of the proper motions of the stars, I am inclined to think that the elementary method which I suggested in your columns of the 1st inst. is, after all, the best. On examining Mr. Dunkin's process, I find that he begins by assuming that stars of nearly the same magnitude are at nearly the same distance from us, which researches on parallax seem to show is not the case; and he then proceeds to class as of nearly the same magnitude stars which (as photometrically measured) differ by 2½ magnitudes in his first class, and by fully 2 magnitudes in his second. Indeed, if some such process were not adopted, the classes would be too small for use.

I do not think the mode of classification by the amount of proper motion is much more satisfactory. If the sun accounts for one-half of the proper motion of the stars (and I think this supposition is not much in excess of the truth), then the true proper motion of a star whose apparent motion is 0·1″ annually will range from 0·05″ to 0·20″, according to the circumstances. There are several other objections which will probably occur to your readers.

Sir Robert Ball's discovery of so serious an error in the writings of Sir J. F. W. Herschel and Dr. Croll, as "F.R.A.S." refers to, will be rather startling to those readers who, like myself, have read both books without discovering that they contained any slip of the kind. Sir Robert Ball doubtless would not make such a charge without good grounds, and it is probably because the error does not at all affect the general argument in either book that it has been passed over by so many readers without detection. My edition of Herschel's "Outlines" is that of 1883. I referred to the pages indicated by "F.R.A.S."; but could discover no such statement. Can it have been silently suppressed by the editors after the author's death? Of course, if the Northern Hemisphere received 50 per cent. of the solar heat in summer and 50 per cent. in winter, our winter would be the hottest season at present, since it is the shortest. My edition of "Climate and Time" is that of 1885. I have been unable to find any such assertion in it, whether ascribed to Herschel or not. Did Croll drop the statement as well as Herschel? Both writers usually proceed on the assumption that we receive much more heat in summer than in winter; but neither of them have, I think, attempted to determine the relative proportions. I do not know of any earlier determination of these than Dr. Haughton's, to which I already referred your readers.

Dublin, Jan. 12. **W. H. S. Monck.**

THE QUADRANTIDS.

[33087.]—There has undoubtedly been a good display from the Quadrantid radiant during this last return of this annual shower of meteors. Mr. Backhouse, Sunderland, Mr. Corder, Bridgwater, Mr. Ferrington, Shrewsbury, and the writer, all found meteors abundant during the watches at the early part of January. The point of radiation—that is, the centre of the tracks of the meteors where they crossed each other when projected backwards—differs as found by the various observers. The mean of the observations to hand gives 232° + 54½° as the probable centre of radiation.

The writer found the tracks to give an extensive area of radiation. Mr. Corder found three separate centres. This I take as corroboration of the area of radiation found by observations made at Leeds; and Mr. Milligan, recording the stationary meteor, also helps to corroborate this.

It is interesting to learn that Mr. Milligan also found radiants at 132° + 28° and 207° + 18°, as these confirm Mr. Corder's observations at 181° + 29° and 210° + 19° as centres of activity.

I shall be glad to learn Mr. Milligan's estimation of the time of maximum of the shower. The hourly rate as seen from Leeds was 25 meteors, from 12h. 50m. to 13h. 50m. **David Booth.**

70, North-street, Leeds.

PROJECTILES AND THE ROTATION OF THE EARTH.

[33068.]—Mr. H. Wake (letter 33055) is undoubtedly correct in saying that a projectile fired vertically would fall a little to the west of the point on the earth's surface from which it is fired.

For the sake of those who are not well up in kinematics and dynamics, I will begin with a homely illustration. Suppose two railway trains running on parallel lines a few hundred yards apart. If a rifle is fired from one train exactly square to the line of railway, the bullet will hit the other train at a point exactly square with the line, provided both trains are going at the same rate of speed; but if the other train is going slower or faster than the one from which the bullet is fired, the bullet will hit the other train before or behind that point.

Now, suppose the two trains are running on two circular lines having the same centre, and suppose the radius of one circle to be double that of the other; if the two trains keep abreast of each other, although they are both moving with the same angular velocity, yet the actual velocity of the outer train is double that of the inner.

Suppose the inner train running at 40ft. per second, the outer must travel at 80ft. per second. If, then, a bullet is fired from the inner train to the outer in the direction of the radius, and suppose the bullet takes three seconds for its flight, it would, instead of hitting the object aimed at, strike at a point 3 (80 − 40) = 120ft. behind it; or in symbols, deflection = t (L − l), t being time in seconds, and L and l the lengths of the arcs.

Suppose, for simplicity, we fire the gun at the Equator, and the ball is fired to a height h, from whence it returns to the ground, then we get this proportion—

$$\frac{\text{length of arc at } h}{\text{length of arc on ground}} = \frac{R + h}{R},$$

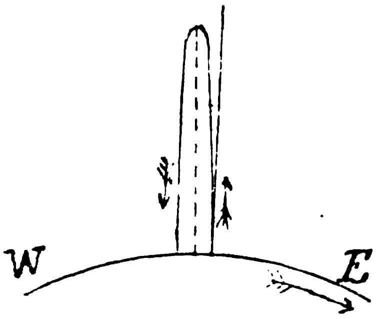
R being the radius of the earth. Now, suppose t to be the number of seconds the ball takes to rise h feet, and c the distance (measured on the ground) that the earth revolves in one second, we get from the above equation—

$$\text{Length of arc at } h = \frac{tc\,(R + h)}{R} = tc + \frac{tch}{R}$$

and as the deviation from the vertical will be the difference between the two arcs, we get deviation from vertical at $h = \frac{tch}{R}$.

To take an example, suppose h = 1,600ft., the time of flight would be the same as that for a fall of that height; then the formula $t = \sqrt{\frac{2h}{g}}$ gives the time, from which t = 10secs. R is about 20,920,000ft.; and as the revolution of the earth is 1°, or 69 miles in four minutes of time, it will revolve in one second 1,518ft. = c. Substituting these in the last equation, I find that the deviation from the vertical at h is 1·16ft., or about 1ft. 2in.

The return curve downwards will be different. The ball, having arrived at the apex (see figure),



will be moving horizontally, and we have to find the velocity relative to the vertical line. In the expression $\frac{tch}{R}$, as this has nothing to do with gravity, h is not necessarily a function of t; hence all we have to do in order to find the velocity is to divide the distance by the time. This gives $\frac{ch}{R}$ as the horizontal velocity, and as this velocity (unlike that of the rising curve) will be constant, drop a perpendicular (see dotted line), and use this as a new line of reference; and as the ball will take the same time to fall to the ground from h as it did to rise to that point, the distance west of the new line on the ground will be $\frac{tch}{R}$, which is exactly the same as the distance from the first line; hence the whole distance from the first point will be twice the above, or in feet, 2ft. 4in.

The falling curve is the half of a parabola, with its focus on the dotted line near the top; but the rising curve is not one of the conic sections.

I have not considered the resistance of the air in the above to avoid complication, but this would only shorten the deviation by a small amount.

Bath. M.I.C.E.

EXPERIMENTS IN ELECTROSTATICS.—I.

[33089.]—The following series of experiments is designed to illustrate in an elementary manner the modern theory, according to which the seat of the phenomena of electrification is in the delectric, and not in the conductor:—

1. *Effect of Rubbing Glass Rod.*—Rub a glass rod with a piece of silk or a piece of cloth covered with an amalgam of tin and mercury. It will be found that the glass rod has thereby acquired the property of attracting to it light objects, such as small pieces of paper, fragments of metal foil, bits of cotton, wool, or thread, or pieces of hair. Generally, after the object has touched the glass rod, it flies from it as if repelled. The rod gradually loses its power, and after a time has to be rubbed again with the silk.

Electrification.—Any body exerting an attractive force on other bodies similar to that described in this experiment is said to be "electrified"—to be in an "electrical state," or to have acquired "electrification." To electrify a glass rod by rubbing it is called "exciting" it.

2. *Attraction of Pith Ball.*—Suspend a small pith or gilt oak ball by a flax thread from any convenient support. Bring the excited glass rod near the pith ball: it will be deflected towards the rod. The deflection of the pith-ball will be observed to increase as the glass rod is brought nearer to it, until finally they come in contact.

This experiment shows that the power which an electrified body possesses of attracting an unelectrified body increases when the distance between the two bodies decreases. This follows, from the mechanical principle, that the force required to deflect a pendulous body from the vertical increases with the amount of the deflection.

3. *Attraction of Excited Glass Rod.*—The glass rod, after being excited, is suspended in a horizontal position by means of a stirrup and thread at its centre. This having been done, bring a piece of metal close to one end of the glass rod. The rod will be attracted by the piece of metal (Fig. 1).

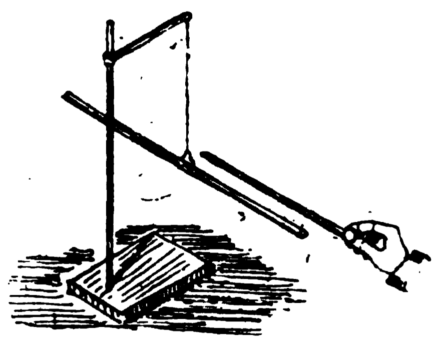


Fig: 1

Let us now consider what are the general results deducible from the preceding experiments. The first experiment shows that the excited glass rod exerts an attractive force on *all* surrounding objects. We note that the attractive force is not influenced by the material of the objects attracted, and there is no reason for supposing that it is influenced by their weight. The obvious reason that heavy objects are not actually moved is that their weight is sufficient to overcome the comparatively feeble force of electrical attraction. The second experiment shows why distant objects show no attractive force; for, since the force becomes less as the distance becomes greater, the force of electrical attraction will ultimately become too feeble to be sensible. The last experiment confirms the preceding conclusion. For, since "action and re-action are equal and contrary," it follows that if the glass rod exerts a mechanical force on surrounding objects, then surrounding objects must exert an equal mechanical force on it. It appears from the second experiment that the attractive force is greatest between the excited rod and the objects nearest to it; and in the last experiment the attraction between the excited rod and the piece of metal near it overcomes the attractive force between the excited rod and the walls of the room on the other side.

Repulsion.—Let us now see what explanation can be given of the repulsion observed in the first experiment. The only mark of electrification is the mutual attraction between an electrified and an unelectrified body. If, now, a light body in contact with the excited glass rod becomes electrified, it will become electrically part of the rod itself, and will be attracted by surrounding unelectrified bodies. It will, therefore, fly away from the rod, provided there is no attraction between it and the glass rod. This explanation, though sufficient, is not the only one that can be given. We may suppose that there is an actual repulsion between the excited glass rod and any body that has come into contact with it. But in either case we come to the conclusion that the body is repelled because it becomes "electrified," that is to say, it passes, by contact with the excited glass rod, into an electrical condition similar to that of the glass rod itself.

The above results may be summarised as follows:—

I. An electrified body attracts every unelectrified body in its neighbourhood.

II. The attraction between an electrified and an unelectrified body increases when the distance between them decreases.

III. An unelectrified body may become electrified by contact with an electrified body. This proposition is expressed as a possibility, because the repulsion is not invariably observed.

Practical Notes.—A glass tube about 30in. long and 1in. in diameter may be used in the preceding experiments. The amalgam for spreading on the cloth is made by rubbing together in a mortar a small piece of tinfoil and one or two drops of mercury, the proportions being such as will produce an amalgam of a pasty consistence. This is spread on a piece of cloth having a rough surface. As the amalgam is the actual rubber, the material of the cloth is not of much consequence, the cloth merely serving to retain the amalgam. The action is much improved by warming the glass rod and rubber before the fire. Cloth covered with amalgam is preferable to silk without any amalgam. The pith ball should not exceed ¼in. in diameter. Cork does equally well if coated with metal foil. It is best to suspend the ball by means of a flaxen thread from a metal support. It is necessary to have a steady support for the glass rod in the third experiment. An ordinary retort stand answers the purpose very well. A thread, or, better, a piece of fine silk, must be tied to the ring of the retort stand, and the other end fastened to a small stirrup, which may be easily cut out of a piece of tin, or sheet zinc, and which must be bent so as to form a kind of hook, into which the glass rod may be easily slipped. It is best to ascertain previously the point on the rod about which it balances, and mark it with a scratch, so that the experimenter may at once get the rod properly balanced after exciting it. The best result is obtained by holding a metal bar, about a foot long, parallel to the glass rod, and close to it, as shown in the illustration. G. J. B.

VIOLIN MATTERS.

[33090.]—I am sorry that "Scio" did not at once proceed to business, because I hoped much from him, and I dislike mere criticism in any form (indeed, it was the severe form of rebuke, editorial and otherwise, that I noticed years ago, which led me to cease endeavouring to offer my very small, and doubtless valueless mite of assistance to inquirers in your pages), and I did hope that "Scio" would have furnished us in his contribution (33018) with those exact, correct, and essential particulars in violin construction which Mr. Pickering did not deem of sufficient importance to need detail, but without which no ordinary amateur could build a violin that would turn out a satisfactory instrument. It may be egotistical in me to say that I have been over sixty years (I began at the age of four) a violin player, and at the age of nineteen had collected 18 violins, one viola, one violoncello, and two double basses. The cause that led me to purchase so many violins at that early age, was that I possessed so sensitive and accurate an ear that I detected in each instrument, after purchase, some defect; either the "wolf" on a certain note in some instruments. or a nasal bleat on the G, F, or B of others, and very often other instruments good in tone on the E and A strings, were weak on the D and G strings; while others would be rich in tone and playable under slow music, but sloppy and inarticulate when rapid or arpeggio passages were being played; hence the difficulty in securing a perfect instrument.

From the age to which I have referred, I have devoted very much time and money in having had made (for it requires great and unusual skill, and other almost hidden and not-to-be-taught requirements, to which I claim no pretension to constitute a successful violin maker) copies from several of the great masters. Notably I had the belly taken off a Stradivarius, and had a pair of calipers specially constructed so that a deviation in thickness as slight as a B of E note was visibly registered on a dial at the other end, and we traced a copy of the back and belly of the Strad. upon cardboard, and divided them by pencil lines into ¼in. sections, making at each ¼in. square the variations in thickness of the Strad. Every thickness and minute detail were observed and copied. Weeks were occupied in correspondence, &c., in going from place to place to obtain a wood to correspond with the grain and fibre of the original, and in this we were very successful, with the addition of ascertaining the age of the wood—over 50 years since it was cut into blocks. The man who made this copy was a most skilful workman whose heart was in his work, a work of love, which cannot be said of many workmen nowadays,—and he had devoted all his lifetime to the construction and repair of stringed instruments. I have never seen such work as that man produced; and this particular copy to which I allude was a perfect masterpiece of workmanship, and as like the original as it was possible for any copy to be; but, alas, in tone it was of the most ordinary violin quality—fairly equal, but somewhat muffled, and totally deficient in that bright, ethereal, and mystical tone which the real Stradivarius possesses. The same man took similar pains in copying a Pannona bass with slightly better results; nevertheless, the A string was always weak and thin in tone, and though the belly was taken off and thinned, bass-bar altered, &c., nothing seemed to improve it much.

While not desiring for one moment to question or cast reflection upon Mr. Pickering's undoubted talents and knowledge, and his earnest and generous desire to assist amateurs in violin construction. I cite these two, out of many, instances, to show, from my experience, what little chance there is of an amateur making a grand, or even satisfactory, instrument (unless by mere fluke) upon the wanting-in-many-important-detail instructions of Mr. Pickering.

Just after the experiments above referred to—some 38 years ago—I purchased direct from Vuillaume of Paris, and made by him, a most beautiful copy of a Guarnerius—one of the handsomest violins as to timber, model, and work, I ever saw; but it was very weak on the fourth string; some notes were tubby, and it required a good deal of the "whip" to make it go; and, like many of Vuillaume's make, it got tired in grinding through a long orchestral rehearsal. My experience of this instrument reminds me of the chin-rest incident related by Mr. J. H. Schucht (32998) of his friend Mr. S. Anderson. Not liking the varnish which Vuillaume had put on, I had the bad taste to have it scraped off. The man I employed scraped the actual wood, thus reducing its thickness and when I restrung the instrument it was going more unsatisfactorily than before. It seemed absolutely wanting in timbre, and I found that by holding it firmly under my chin, and placing the fingers of my left hand on the belly whilst I pressed my thumb against the back—making a clamp of my hand—and then bowed away across the open strings as one does in tuning, the tone of the instrument was greatly improved so long as my hand "clamped" the instrument. At that time glass soundposts and bridges were, very foolishly, much talked about, and, taking up a glass bridge, I broke it in two, and gummed one of the pieces (about 1½in. by ¾in.) on to the cheek of the violin about an inch from the finger-board. So long as this remained on, the instrument was very remarkably improved in tone, "talked" freer, and had better intonation. But this affixture was unsightly, inconvenient, and somewhat dangerous. So, yielding to the solicitations of a very clever amateur friend, I let him take the belly off, and construct a new one upon purely scientific principles, of which he appeared a complete master. We obtained a splendid piece of wood—reedy and fine in grain, and soft in texture—from one of the Wardour-street shops, and a most carefully constructed and, apparently, faultless belly was put on, resulting in constituting the fiddle equal all over in very mediocre tone, and weak and utterly wanting in brilliancy—in fact, muffled. In this condition it remained, until some years after I heard of a clever Swiss, who had come over to London as a repairer, and to him I took the original belly, told him to put on a deeper and larger bass-bar, and to put on inside, under where I had stuck the piece of glass—an oblong patch of wood 3½in. long and $\frac{1}{30}$in. thickness, and then to remove the new belly and put in the original, with the above described additions, the effect being improvement in every respect, greater brilliancy and power (superior to many so-called real Guarneriuses I have heard) over the whole instrument, the only noticeable defect being a little weakness in tone of the 4th string in *some* keys, which I have since got rid of, and will explain how later on. Although still possessing many instruments (among them an Amati and a red-and-gold Steiner), I now invariably play upon the Vuillaume Guarnerius.

And now as to the mode by which I improved not only the weakness of the 4th string of the V. Guarnerius, but also its brilliancy, and rendered it infinitely more correct in intonation, while stopped fifths and double stopping generally became more easy and certain than in any of my other fiddles. And it may be gathered from what I shall endeavour to convey, how essential is the exact position of the *f* hole, which Mr. Pickering passes over so lightly; and, if my memory serves me truly, such writers upon violin construction as Fiulk, Feravezy, Silvester Ganasi, Agricola, and Fétis insist upon the importance of the exact position of the *f* holes and of the two notches opposite each other—one slightly above the other—the object of the notches being to show accurately where the bridge is to go—viz., on a line drawn from *f* to *f* between these two notches. To show how essential is correctness in this matter, I now state that in all the experiments with the V. Guarnerius I took for granted that so clever and painstaking a workman as M. Vuillaume would have been correct to a hair's-breadth as to the position of the *f* notches, until one day, quite in recent years, I applied my rule, and found the distance from the *top* of body (i.e., the purfling nearest the neck) to the centre-line between the notches only measured $7\frac{3}{16}$in. instead of 7½in. The rule given by Stradivarius for the position of the bridge of a 14in. body is 7½in. to 7⅝in. Accordingly, I removed the bridge from the position it had occupied all these years backwards $\frac{6}{16}$in., the soundpost an equal distance backwards and slightly outwards (?), and now the instrument is, as I have stated, the most satisfactory one I possess. And I humbly suggest to all players to apply the rule test as I did, and regulate bridges and soundposts as I have done, and I am sure they will find their instruments greatly improved thereby—notably the harmonics.

After many years of observation and experience, the inference I deduct is that the position and size of the *f* holes are of the utmost importance, even to shape; and that the exact position of the bridge must be shown by the exact position of the notches, behind which, not less than $\frac{3}{16}$in. from bridge, should stand the soundpost.

May not all the difficulties I encountered in the above instrument be attributable to the incorrect marking of the *f*-hole notches? Readers who are familiar with the very clever writings of M. Fétes will remember that one of his works open with:—"Despite all contrary assertions based upon pretended monuments, the Oriental, Greek, and Roman ancients were unacquainted with instruments played with a bow. As I stated in the 'Résumé Philosophie de l'Histoire de la Musique,' the bow comes from the West; it was introduced throughout Europe by the Western Nations." Yet C. Russell Day, Captain Oxfordshire Light Infantry, in a very clever and fascinating work which every musician should read, entitled "The Music and Musical Instruments of Southern India and the Deccan," proves beyond doubt that the violin, flute, harpsichord, from which spring our piano and guitar, were in use many hundred years before they were known to us, and that the bow was invented by a celebrated Indian king 5,000 years ago, and he shows the existence in India of really intimate expressive melodic music capable of the greatest refinement of treatment, and altogether outside the experience of the Western musician. **Grinder.**

VIOLIN-MAKING.

[33091.]—Being greatly interested in violin-making, may I ask Mr. Pickering to kindly give me, if possible, the measurements of the finest Stradivarius violin extant? I mean the width of the upper and lower portions of the belly at the broadest part, and the width of the waist at the narrowest part? I read that the best model for the belly is a gradual rise of the whole surface, from the extreme edges to the bridge, at which part it should be ⅝in. above the level of the edges. Will Mr. Pickering say if this is correct, and tell me the dimensions of the Stradivarius bass-bar. I have had imported a special set of the very finest violin wood, so should like an answer before putting this in hand. I may say I have made several violins, which have turned out fairly satisfactory.

Will Mr. P. say what he thinks of baking the wood, which I know the high-class German pianoforte manufacturers do with the bellies of their instruments. **C. H. Austin.**

[33092.]—In reply to "E. E. M." (leter 76267), permit me to say that in a general way the soundpost may be placed as follows: Measure a distance 6¾in. from the bottom of the belly along the central line or join, and through this point draw a line at right angles to the join. Place the soundpost ⅜in. behind this line, and ¼in. from the join. The bridge should stand on the described line. If your violin is 14in. long, the above line should pass through the inner notches of the *f f* holes.

Raffaele Trapani, in Napoli, Anno 1800. The characteristics of this maker are: Large pattern flat model, purfling deeply laid, edges sharp, scroll heavy. He is mentioned by Harte and Fleming.

Glasgow. **D. W. D. Flowerday ("Scio").**

[33093.]—Various theories have been put forward in answer to Mr. Monk (letter 32996) as to the reason for reducing the depth of violin ribs towards the head. The same question could be asked with equal reason as to the difference in width between top and bottom—across the face of the instrument: the answer to both is the same.

May I be permitted to point out that the ribs diminish in depth—or should diminish—exactly in the same proportion as the top end of instrument bears to the bottom across its extreme width. The reason appears to me simply and clearly a fine sense of proportion and balance of parts—nothing more or less. This proportion is founded on a theory briefly stated in a letter appearing in the "E. M.," Sept. 11th, 1891, and I will not occupy your space by re-stating it.

I fail to see how Mr. Schucht's ingenious diagram (33037) can apply to the strain on a violin back, which can have no possible tendency to straighten, being braced completely round by the ribs, blocks, and linings.

I should be very much obliged to "Scio," or anyone who is well up in acoustics, for an opinion as to the influence of shape on the tone of a violin.

John Rae.

40, Bolan-street, Battersea Park, S.W.

[33094.]—I hope Mr. Wenham will not suppose that he was imagined to be ignorant of small openings being required in a violin. He, however, distinctly states once more in his last letter that these may be made in the sides, and I again state the apertures must be made in the front in order to give the best result, on account of the facts given in my former letter. I am glad that my remarks have brought Mr. Wenham's experiment forward, and hope he will find the reference to his previous communication. His remarks about the air-space of a violin will lead the amateur violin-maker to think that the air-space is a matter that does not require much attention. I believe they will find it wants considerable practical experience to form any judgment upon it.

In some experiments with wooden resonance boxes, I found that while a wooden box and a wooden tuning-fork could be made to give the same tone, yet the weight was very different, and there is no analogy between a tuning-fork and the case of a violin. In a violin the wood gives its sound by forced vibrations; but a tuning-fork is merely an instrument for the storage of mechanical energy, and the sound it can produce is entirely dependent on the quantity of air it can act against.

J. Sutcliffe.

LATHE MATTERS.

[33095.]—Since writing my last I find that the attachment for cutting epicycloidal patterns is a known, if not well-known, machine. My apology is that I have very few opportunities of seeing other lathes than our own. It consists of a dividing plate mounted on slide-rest; the cutter is mounted on a slide on the face of this, thus enabling it to be rotated as well as the work. If still wished, I will forward a sketch or photograph of the one I use: it was made by my father, I believe, on the lathe it is used on, and with the file, and could, therefore, be made on any lathe having a slide-rest.

By the way, will Mr. E. R. Dale kindly give a sketch of the *interior* of the hot-air engine (letter No. 33070, p. 465) and size that would be required to drive a Singer's sewing-machine? Could it be used in India, in a temperature of from 80° to 90° F.?

N. D. La Touche.

Stokesay, Craven Arms, 15th January, 1892.

HEATING SURFACE OF SMALL VERTICAL BOILERS—ENGINE CASTINGS.

[33096.]—I have been struck by the great number of queries in back volumes for the proper size of boiler for a given engine. "T. C., Bristol," has given a great amount of information on the subject, and "Glatton" has given a rule which, however, does not seem to satisfy the querists. I have been testing the rule by a great number of examples of boilers in back numbers, and it seems satisfactory, and it can, perhaps, be put in a way that will be more easily understood by all. I assume that in all vertical boilers, under one horse-power, the heating surface is of about equal value, the thin surface of the model boiler being compensated for by the greater heat of the coal fire of the larger and thicker boiler. I assume also that the heating surface (H.S.) should be in proportion to the amount of steam consumed per stroke, provided that an average rate of revolution and pressure be taken. For the sake of simplicity in comparing, I take 200 revolutions, and 20lb. per square inch for the pressure; then if the revolutions be 100, the H.S. may be one half, and if the required pressure be 60lb., the H.S. would be three times that given by the rule, since it is evident it will require three times as much steam to fill a cylinder with 60lb. steam as with 20lb. steam.

Now, then, taking the rule given by "Glatton," Vol. XLV., page 86, and taking L to mean the number of inches during which steam is admitted, D the diameter of cylinder, and C a constant = 15, we get $H.S = 15 D^2 L$, which gives a proportion of 20sq.in. of H.S. to every cubic inch of cylinder capacity, when rev. = 200, and pressure 20lb.

This is so simple a rule that anyone can understand and remember it. If there are two cylinders to fill, then double the H.S.; if the pressure be double, then double again; if the revolutions are to be 400, double a third time, and give 80sq.in. of H.S. per cubic inch of cylinder capacity.

Will "T. C." and "Glatton" kindly say whether this rule meets their views, or whether they think the rate of 20 should be higher or lower?

Perhaps I may be allowed to say here that I have just received from Mr. Milnes a set of castings of the ¼H.P. steam-engine, the drawing of which, with description of method of construction, appears in the current vol. of *Work*. I wish to bear testimony to their excellence. The patterns were made under the superintendence of "J. H.," and the design has his approval. There are about 50 patterns, as castings are provided for even the smallest parts to facilitate the work. Amongst such a multiplicity of small parts it is easy to make a mistake, and I was glad to find a conscientious person like Mr. Milnes willing to undertake to supply them. For prices see 6d. Sale Column. **F. A. M.**

[33097.]—Mr. Calver (letter 33064) expresses himself as amused at the idea of a "polishing pad as large as a mirror," and asks "How can you press evenly a soft puffy cotton-wool pad from 6in. to 18in. diam.?" I ask him in return, Is it necessary to try? I used a pad formed of a disc of 1in. wood 12in. diam., edges rounded and well and evenly padded with sheet cotton wool (extra wool in centre graduated to the edges to form a suitable convex surface), and covered with a very fine soft chamois leather, the edges of which were tightly drawn over and secured at the back of the wood disc, thus forming a soft but even and firm pad, which in use proved excellent, removing the blue film gradually all over, and producing an even polish. I hope Mr. Calver will give it a trial.

The idea of a large pad is that of another correspondent in the "E.M." to whom I am obliged, as with a small pad it certainly is very easy to over-polish in spots.

Southampton. **T. A. Skelton.**

[33098.]—Mr. Calver, in letter 33064, records his failures in silvering a 12½in. mirror. Amateurs will surely take courage from this, and "try again." And should they have the same failure as recorded by Mr. Calver, instead of throwing the solution down the sink (as I have done scores of times), gently heat the lot as they are—that is, the chemicals—with the mirror immersed. Care must be taken not to apply too much heat to melt the pitch supporting the mirror, or there may be an accident of a serious nature by breaking either the mirror or the bowl holding the chemicals. Also do not keep the mirror immersed any longer than the time that there is a good film of silver on the surface of the chemicals, as this causes serious tarnish. If this should happen, make a new beginning, and do not waste time in trying to polish the tarnish; and do not make any regrets, because you will get equally as good a film next time by the same process, and you will have learned to take out the mirror a little earlier than before, when you will find a beautiful film on the glass. Do not touch it with anything except water—clean water; this should be just warm, to save risk of accident. Give it plenty of clean water, and when you are satisfied the chemical solution (which would adhere to the mirror when taken out of bath) has all been washed off, stand the mirror upright a few moments, when the greatest excess of moisture will drain off. I dry the rest off in front of a good fire and practically roast the film, taking care not to touch it during the whole of this time. When all the moisture is driven away, the film of silver will polish in the manner described by other writers.

Next time Mr. Calver fails, will he kindly try my experiment? There will be no risk, as he need not have any mirror in the solution. If he does not get a silver film on his otherwise useless solutions, I shall be very much surprised. **David Booth.**

70, North-street, Leeds, Jan. 15.

DUKE OF CLARENCE—HIS DEATH—ITS LESSON.

[33099.]—We must go back to the memorable Wednesday, the 6th day of January, for the origin and cause of the illness. It appears that, 1st, "he had walked, carrying a gun, through several coverts." This meant, for him especially, rather laborious exercise, and which, as probably he was "well wrapt up" with woollen clothing *next* to the skin, as well as outwardly, possibly with some additions of seal or other impervious skin, all this would, of course, cause free cutaneous transpiration—i.e., sweat. Now, mark what that meant. That sweat, discharged from the pores as vapour, would with a Jack Tar have passed off, mingled with the free circulation of the atmosphere unimpeded over the really important parts of the body—the chest and shoulders; but with the Duke that vapour condensed in and saturated the (under) woollen, porous, absorptive fabric forming his clothing. Then comes into play when, 2ndly, "luncheon was served [the Duke being then set in his sweat-saturated underclothing across chest and shoulders] . . . . and during the meal the Duke complained of feeling *chilly*." Every student in the natural sciences, every tiro in chemistry, would repel with indignation the suggestion of his incapacity to explain the *rationale* of the vapour, at say 210°, circulating through the little glass tube, becoming a fluid when passing through that part wrapt with a bit of wet rag. But the human body's surface, &c., not only makes its own vapour, but supplies also the fluid to form and to feed its own condenser!

Ah! but that's quite far too simple a consideration for the intellect, alike regal as medical, of 1892. **The Lydney Dispenser.**

MICROSCOPE TUBE-LENGTH AND RESOLVING POWER

[33100.]—In the discussion of the relative merits of the English and Continental tube-lengths, one argument in favour of the English tube seems to have escaped notice, namely, that it gives, with any individual lens, a distinct advantage in resolving power. Taking the values for the different tube-lengths recently adopted by Prof. Abbe, the gain in resolving power for the English tube with a (true) 4in. object-glass, is as much as 43 per cent., with a 2in. 13 per cent., and with a 1in. 5 per cent. With a ½in. the difference falls to 1 per cent., and with higher powers it becomes imperceptible, but still a gain in definition of 5 per cent. with a 1in. o.g. is not to be despised.

The advantage of the long tube may easily be observed practically by taking an ordinary optician's 4in. objective (probably really about a 3in.), and inserting a diaphragm behind the lens about ¼in. diameter, and examining the $\frac{1}{100}$mm. lines on a stage micrometer—it will be found that these are distinctly separable with a 10in. tube, but vanish when it is shortened to the Continental standard.

This seems at first sight contradictory to Prof. Abbe's formula, which makes the number of lines per inch resolvable by any lens $= \frac{2}{\lambda}$ N.A. But we have only to examine carefully the definition of numerical aperture, viz., N.A. = n sin. u, to see that N.A. is itself a variable quantity. The matter may be simplified by leaving out the term n, that is, by considering only non-immersion lenses, in which case N.A. = sin. u. Let R = the semi-diameter of the lens, f = its focal length, and T = the optical tube-length. Then, so long as the lens is focussed at its true focal length, and the rays issue parallel beyond it, sin. $u = \frac{R}{f}$. But in practice, of course, the lens is withdrawn farther from the object, so that the rays converge above to form an image at a distance depending on the tube-length. Call this anterior conjugate focus f'. Then $f' = \frac{Tf}{T-f}$. And, therefore, in the practical use of the microscope, we get the modified expression, depending upon the value of T, N.A. $= \frac{R(T-f)}{Tf}$. It evidently follows from this, that measurement with the apertometer only gives the N.A. for the particular tube-length used in the experiment, and that a lens should not be described as of such and such N.A., without mentioning the length of tube with which it is intended to be used.

Of course the deficiency of resolving power with the Continental tube-length might be made up for by either increasing the diameter or deepening the curves of the lens. But this involves more careful correction and increased expense. So that the argument may be put this way: The short tube, in order to give the same results in the way of resolution as the long, requires to be fitted with a more expensive lens. **H. G. Jameson.**

LOCOMOTIVES.

[33101.]—Mr. W. E. Brown (p. 466, No. 33076) states that Messrs. Hawthorn and Co. was the first firm to adopt the "four fixed eccentrics" for locomotives. I should be glad if he would give any facts or dates to support the assertion. I have devoted much time and attention to the matter, and am of opinion that the first engine ever constructed with four eccentrics was the Swiftsure, built by Forrester and Co., of Liverpool, for the Liverpool and Manchester Railway, 1834. I have in my possession a blue-print copy of the Newcastle and Carlisle Railway Company's locomotive list giving the names of the first fifteen engines; also a photograph of the Comet. It has been claimed that the Comet had four eccentrics in 1835. This, however, does not appear to be the fact, as the engine had the two hand-gear levers for working the old loose eccentric motion. **Clement E. Stretton, C.E.**

40, Saxe-Coburg-street, Leicester, Jan. 16.

LOCOMOTIVE WORK.

[33102.]—I am pleased to see the letter of Mr. C. Rous-Marten, p. 467, No. 33077, he being one of the old correspondents who wrote upon locomotive work many years ago in your columns.

I have no desire to "start another discussion on speed"; but the fact remains that locomotives forty years ago were capable of attaining, with suitable loads, speeds quite as high as those attained at the present day. As long ago as 11th May, 1848, Mr. Gooch had the 9.15 train from Paddington run to Didcot, 53½ miles, in 47 minutes, and a speed of 78 miles an hour was attained on parts of the journey. To outdo that trip, the Liverpool, upon the southern division of the London and North-Western was tested three weeks afterwards, and the late Mr. Crampton informed me that it attained a speed of fully 79 miles an hour.

Mr. Pearson, of the Bristol and Exeter Railway, with a view to win back for the broad-gauge the honour of the highest speed, designed his 9ft. wheel engines, and in the year 1853 he attained a speed of "just under 81 miles an hour." That speed was then, and still is to this day, the highest recorded on railways in this country. We often *hear* about 90 and 100 miles an hour, but such speeds have not been attained on rails.

The Cornwall, built at Crewe, 1847, ran at very high speed, fully 78 miles an hour. The special express from Holyhead to London, Jan. 5, 1862, carrying the "Mason and Slidell" despatches, ran for several miles at a rate of "just under, if not quite, 80 miles an hour."

Mr. McConnell claimed that his large 7ft. 6in. Bloomer type of engine had attained "within a fraction of 80 miles an hour." The Great Northern 8ft. and the Midland 7ft. 6in. engines have both attained just under, or, practically, 80 miles an hour.

Mr. Marten (p. 467) appears to conclude that because a Great Northern engine has run at 80 miles an hour, it is not strange that another engine should give a higher result. Why should any engine give a higher result than the Great Northern? I have read Mr. Martin's letter most carefully, but at present fail to see any such reason.

It is a well-known fact that a light engine with a light load will run at a speed quite as high as a heavy engine with a heavy train. The advantage of modern engines is that they take a *long train* at a high speed.

For many years the limit of locomotive speed was the Bristol and Exeter result of 81 miles an hour; but since the wheels of those engines were reduced to 8ft., it would appear that 80 miles an hour is the maximum, and that can only be obtained upon falling gradients, with a very light load, and under the most favourable circumstances. **Clement E. Stretton, C.E.**

Leicester, Jan. 16.

CALCULATIONS CONCERNING THE LENS.

[33103.]—The microscope in a simple form consists of two convex lenses, one of which, the object-glass, is placed at a distance from the minute object to be examined a trifle greater than its focal length, the effect being to form an enlarged image at the other side of the lens, or, roughly speaking, is the reverse of what is shown in Fig. 1 of my first letter (32968, p. 351). The other, or eye lens, being placed at a distance less than its focal length from such image, magnifies the same, so that the magnifying power of the microscope means the number of times the *object* is enlarged, apparently, and obviously equals the product of the magnifications produced by the two lenses.

As, for example, suppose F and F_1 = focal lengths of object-glass and eyeglass, distance of distinct vision = x inches, and distance between object-glass and object = F + $\frac{1}{20}$in.

We may first find d, the distance of o.g. from the lens, by—

$$\frac{1}{d} - \frac{1}{F + \frac{1}{20}} = \frac{1}{F},$$

and then we have the number of times image is larger than object from—

Size of image : size of object : : d : F + $\frac{1}{20}$ = s times, say.

Now, distance of distinct vision = $x$in.; therefore the eyeglass must be at such a distance from the o.g. image as to make it *appear* to be x inches away from the eyeglass. If D_1 = the distance required, we find it from—

$$\frac{1}{x} - \frac{1}{D_1} = -\frac{1}{F_1}$$

And then—

Size of o.g. image : size of e.g. image : : D_1 : x, or magnification = s_1 times, say.

Then the magnifying power of microscope = $s \times s_1$, and distance between lenses = $d + D_1$. If the tube, as in some forms of microscope, be lengthened, the power is altered, because for the same lenses and observer the o.g. image must remain at the same constant distance from the eyeglass, ∴ the distance between o.g. and object must be altered, and such alteration makes a difference in the size of the image formed by such lens.

The object-glass is generally substituted by an "objective" composed of a number of *lots* of lenses in combination—that is to say, each lot may be made up of lenses in contact. Also, the eyeglass becomes, say, a Huyghens eyepiece. On account of want of adjustment and for other important reasons, it has been supposed that there is a practical limit to the resolving power of the microscope, and I see that in the December number of the *Journal* of the Royal Microscopical Society for last year there is the substance of an interesting and clever article on the subject by Dr. S. Czapski. He arrives at the result that whereas at present, with the large apertures and white illumination, we are able to resolve structures which contain somewhere over 2,000 elements in the length of a millimètre, it will be only possible, assuming perfect lenses, &c., to resolve structures containing somewhere about 4,000 elements to the millimètre. **A. Gadd.**

CALCULATIONS CONCERNING THE LENS.

[33104.]—In reply to "F.R.A.S." (letter 33047, p. 442), the figures given were intended to represent inches, and I don't wonder at him being amused at them in the peculiar form they appeared, through want of proper care on my part.

Perhaps, owing to the fact of my being in the engineering profession, it came natural to write inches in that way.

In the first part of my last letter it should read $M = \frac{F}{f}$ instead of what is there printed.

A. Gadd.

OVERTAXED BRAIN.

[33105.]—"LANCASTRIAN" says: "Phosphorus, much vaunted, is valueless; the same applies to arsenic and lime, and, I am convinced, to the whole list of (homœopathic) drugs mentioned by the 'Lydney Dispenser.'" Having myself seen the good effects of phosphorus and phosphoric acid in such cases, I beg to quote Dr. Hughes's remarks on the value of the latter remedy: "The chief sphere of phosphoric acid is the *nervous system*; and the condition it influences here is one of debility without irritability (in this contrasted with China). When we find brain or cord, sight or hearing, thus affected—as from continned grief, over-exertion of mind or body, &c.—phosphoric acid is an invaluable remedy, well deserving the name of 'tonic.' It is to nervous debility what iron is to anæmia." In reference to calcarea phosphorica, the some author says Dr. Ringer (Professor of Therapeutics in University College) gives us the latest estimate of its efficiency. He recommends it in most forms of mal-nutrition and defective cell-growth . . . and for the bad effects of town life, including brain-fag. He gives one or two grains of the salt three times a day. The homœopathic uses have been made with the lower triturations."

"Lancastrian" says: "Surely homœopathy has existed long enough to stand or fall by its own accomplished results." Quite so; one result being that there are about 12,000 medical men practising homœopathy in the United States. Should any readers of the "E. M." like to know a few of the results as proved by statistics, I should recommend them to procure "Statistics of Homœopathy," 1½d., post free, from Messrs. J. Bale and Sons, 87, Great Titchfield-street, W.; or "Homœopathy: its Principle, Method, and Future," by A. O. Pope, M.D., 1s. (E. Gould and Son).

"Let those who lose laugh; they will be sure to who win." Those who have studied homœopathy can well afford to laugh at such remarks as "Lancastrian's." It is an undeniable fact that those who know most about homœopathy always speak the most highly of the system and its results, whether in trifling ailments or in the most serious diseases.

P. Ferrum.

SIR ROBERT BALL gives in the *Fortnightly* some interesting details of Mizar, the middle star of the three which form the tail of the Great Bear, which have been learned by means of the new processes of stellar photography. Prof. Pickering's photographs of the spectrum of Mizar's principal component exhibited, as other stellar spectra did, a profusion of dark lines. It was noticed that the lines sometimes appeared double and sometimes single. Presently it appeared that this opening and closing of the lines was a periodical phenomenon. The interval between one maximum opening of the lines and the next, was fifty-two days. It was plain that the object could not be a single star; it must consist of a pair extremely close together, and in rapid revolution. Hence astronomers have arrived at the conclusion that the period of revolution of this star system is 104 days, and that the speed with which each of the component stars moves is about fifty miles a second. The distance of the components is inferred to be about one hundred and fifty millions of miles.

REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75694.]—**Logarithms: Proportional Parts (U.Q.)**—I do not think the reply given by "Mistral," p. 468, is quite what was wanted, correct though it is. I fancy that theory, more than rule, is asked for. I cannot refer the questioner to any textbook; but perhaps the result of an independent study of the subject may give the required information. It should be borne in mind that interpolation by means of proportional parts can only be correctly performed when both series are in arithmetical progression. That is, if the logarithms of numbers in arithmetical progression were likewise in arithmetical progression, then the arithmetical mean of any two logarithms would be the logarithm of the arithmetical mean of the two numbers corresponding thereto. But a glance at the "differences" will show that the logarithms are by no means in arithmetical progression—the differences diminishing as the numbers increase. Roughly, the differences vary inversely as the numbers; and the greater the numbers are, the nearer do they approximate to this as an infinite limit. Thus, if the difference between the logs. of 10,000 and 10,001 be ·000434 . . . that between those of 100,000 and 100,001 is ·0000434 . . . and so on. In fact, as the numbers increase, the more true does it become that the difference between log. x and log. $(x + 1)$ is $\frac{M}{x}$, M being ·43429448 . . . (By the way, $\frac{M}{x}$ is what is called, in the Differential Calculus, the "differential coefficient" of log. x.) Now, since the logarithms of successive numbers are not in arithmetical progression, it follows that interpolations made by means of proportional parts are always more or less incorrect, and only express the truth as far as a certain number of decimal places—the number of such increasing *twice* as fast as the number of figures in the numbers. Thus—

No.		Error.
10005	....	·000054 . . .
100005	....	·00000054 . . .
1000005	....	·0000000054 . . .

This means that if the log. of 10005 is sought by taking the arithmetical mean of the logs. of 1000 and 1001, the result is too little by ·000054. And so on. It will be seen that the correction to be added varies inversely as the squares of the numbers. Consequently, since ·0000054 is the geometrical mean of the two errors first in the table above, it should correspond to the geometrical mean of 1000 and 10,000, which is about 3,162: and as a matter of fact this is so, for if we calculate the log. of 31,625 by taking the arithmetical mean of the logs. of 3,162 and 3,163, we shall find the result is too little by ·0000054. In conclusion, I may mention a curious error made by "Vega" in his beautiful reprint of Vlacq's 10-figure logarithm tables. Being desirous of affording facilities for finding the logarithms of numbers containing 10 figures (proportional parts alone not giving the results always correct to 10 places), he gave a table of the corrections to be added to the proportional parts. But he overlooked the fact I have pointed out, that the errors vary inversely as the *squares* of the numbers; and, therefore, his table makes the corrections throughout rather greater than they should be.

T. S. BARRETT.

[75739.]—**Fan (U.Q.)**—I fail to see what you need fans at all for. If burners are properly constructed on the Bunsen principle, the discharge of the gas itself into the larger tube just beyond an opening will cause the ingress of quite sufficient air. In fact, in a gas-stove which I have, the fault is, I am convinced, that it causes too much air to enter, and so the excess is not employed in combustion, but merely passes through the flame and carries away its heat. **A. E. B.**

[75750.]—**Question in Arithmetic (U.Q.)**—This looks like an examination question purposely meant to mislead. However, at the end of five years each tree should have 10sq.yd. of ground, and the acre being 4,840sq.yd., the number of trees per acre is 484, which, at 1s. 3d., gives 605s. as the value of the trees on one acre. The question does not say if the 20 per cent. for expenses is per annum or not; and it will not do to be deceived by the erroneous idea that five years at 20 per cent. per annum plus the value of the trees has already made them worth less than nothing. I mention this because a young friend of mine jumped to this false conclusion at once. So deducting 20 per cent., or 121s., from the 605s., it leaves 584s. as the value of each acre at the end of the first five years; and if one-fifth of the trees were cut down each year, the yearly income would be 116s. 9½d. As the question mentions that the trees increase in value each year, let us now see at what rate. At the end of six years they will each require 12yds. of land instead of 10, so that the acre will only grow 403⅓ trees; but they are now worth 1s. 3d. plus 1s. 3d., or 2s. 6d. each, so that the acre is now worth 1,008s. 4d., which, less 20 per cent., or 201s. 8d., is 806s. 8d., and cutting down one-sixth of them each year, the annual income is 134s. 5d. The yield is therefore greater than it was after five years, and it is necessary to find if this increase of value ever ceases, and, if so, when? Similarly, at the end of the seventh year, with 345$\frac{5}{7}$ trees to the acre, worth 3s. 9d. each, the value of the acre is 1,296s. 5d., which, deducting expenses, and divided into seven parts, gives a yearly income of 148s. 2d. At the end of the eighth year, with 16sq.yd. per tree, and 302½ trees to the acre, worth 3s. 9d. each, the value of the acre is 1,512s. 6d., which, less expenses and after division, gives 151s. 3d., or £7 11s. 3d., the answer given. On working out the value of the acre after the ninth and tenth years it will be found that the yearly income is diminishing after this eighth year, so that this is the greatest yearly income; but from one acre. But the question says per acre, and not one acre, and as most of these questions of double progressions have more than one solution or maximum, we will proceed. Effectively, if eight acres were planted, one acre might be cut down every year, and thus each year the income per acre becomes 1,512s. 6d., less 302s. 6d., or 1,344s. 5d. To get an approximate idea of the progress of the two progressions, if we reckon out the value every 20 years, we find that after 100 years the acre, less expenses, is worth 2,323s. 2½d.; after 120 years, 2,397s. 4d.; and after 140 years, 2,389s. 8½d.; so that there is clearly another greatest income here. By the same method it may be easily located and estimated, and if as many acres are planted as the number of years, and one acre is felled each year, the greatest annual income per acre is obtained. As I have already said, the question is misleading. MISTRAL.

[75767.]—**Dry-Plate Developer (U.Q.)**—Messrs. Mayfield and Co. probably prefer to keep the composition of their developer to themselves. However, the following, which is Edwards' formula for a one-solution hydroquinone developer, works in a very similar manner, is possibly identical, and will doubtless answer your purpose. "It has found great favour with many amateurs, principally on account of its not staining the fingers. It can be used several times over, but naturally becomes less energetic and slower in action after having been used, so that for short exposures fresh solutions should be used: Carbonate of soda (granulated), 100gr.; sulphite of soda (crystals), 480gr.; hydroquinone, 100gr.; water, 14oz. MISTRAL.

[75796.]—**Explosion (U.Q.)**—Water can hardly be described as a good conductor, unless it is acidulated (and this, of course, would not do in a receiver), or perhaps your current is not strong enough. Many old boilers on the Continent used to be fitted with a water indicator as follows:—A hole was drilled through the top of the boiler, and fitted with a gland to make it steam-tight. Through this gland passed a wire, attached at one end to a heavy float floating on the water inside the boiler, which was almost counterbalanced by a weight at the other end of the wire, after the wire had passed over a pulley above the boiler, and the rising or falling of this weight showed the variations of level of the water in the boiler. At many railway stations a similar arrangement may be seen on the water tanks. If the same idea could be applied to your receiver, or to the top of the gauge-glass, or to a tube added to the receiver for the purpose, and the outside weight, being insulated from the wire, were attached to one of the wires from the battery, the weight in falling as the water rises might be, perhaps, so arranged as to touch a metallic insulated contact communicating through the bell with the other wire from the battery, and, so completing the circuit, cause the bell to ring when the water rises.

MISTRAL.

[75821.]—**Golf Balls (U.Q.)**—There is an excellent press called the "Home" press, which makes and remakes golf-balls creditably. See advertisement in the paper called "Golf." I have seen good balls made by this machine.

N. D. L.

[75903.]—**Incandescent Gas-Lights.**—Thanks to "S. G. R."; but as an old gas-burner—*id est*, burner of gas for household lighting, for cooking, for chemistry laboratory, and for furnaces for melting metals, I cannot understand the smell of a good Bunsen being bad. In my opinion, a well-constructed burner (Bunsen) ought not to give any smell. In my opinion, no gas ought to be burnt for any purpose without a regulator to control the greatest amount of gas that can be burnt; and, certainly, as far as I have gone with the incandescent gas, this fact is impressed on my mind. Here, where I cannot have gas unless I make it myself—not a difficult operation, as I used to make it for my amateur chemical Fletcher furnaces—I shall not make gas unless I find the good burner which I fancy the incandescent gas-burner is, though it may want to be improved. I have bought a burner and mantles, and I have induced a friend, a manufacturer, to try the burner for me. Meantime, I want to hear all that your readers can say for or against. X. Y. Z.

[75903.]—**Incandescent Gas-Burners—Products of Combustion.**—"A. X." speaks without authority, if he will pardon me for saying so, when he states that "all forms of Bunsen burners," &c., are certainly more injurious than luminous ones. The products of combustion of Bunsen and illuminating burners are alike—viz., CO_2 and H_2O. The gases which escape combustion are those which are really injurious. As I pointed out last week (75903), the amounts of acetylene (C_2H_2) and carbon monoxide (CO) given off from the outer zones of the two classes of burners have been determined, and in a case of Bunsen v. luminous burner, the former has the advantage. In many textbooks, the statement made that the outer zone of a luminous flame is one of complete combustion is not true. Far from it. It is really a zone in which the luminosity is destroyed, in the same way as the entrance of air destroys that of the Bunsen—i.e., by dilution and cooling. In this zone the mischief is done, for here the coal-gas sinks below the point of its ignition, and considerable quantities of marsh-gas, hydrogen, carbon monoxide, and acetylene escape into the air, and render it dangerous to life. I quite agree with "A. X." that these gases escape more readily when the flame is applied to a cold surface. Under such circumstances, (1) the temperature of the flame in immediate contact with the cold body is so lowered, that the flame (as such) cannot exist over a small area; and (2) over still larger area the temperature is not sufficient to bring about the decomposition of the heavy hydrocarbons. Even in such cases of "checked combustion" the Bunsen bears favourable comparison with the luminous burner, as the following numbers from actual experiment show:—

Parts per 100.	Bunsen.		Luminous.	
	Inner.	Outer.	Inner.	Outer.
Carbon monoxide	3 69	0	2·45	2·58
Acetylene	·04	0	·27	0
Hydrogen	3·55	·47	2·08	0

Iota Dash.

[75903]—**Incandescent Gas-Lights.**—In reply to "Z. Y. X.," the mantles of these lights are very fragile, and must not be touched on any account, and every reasonable care should be taken to avoid jolting the gas bracket or pendant on which they are fixed. The bracket should therefore, if possible, be fixed without swivel joints, and the pendants not to slide up or down. At the same time, see that the burner and chimney when fixed previous to inserting the mantle is perfectly upright. "Z. Y. X." should intrust the care of the burners to one only of his servants, and instruct her when lighting to ignite them at the top of the chimney, not with a match, but a wax taper, and should the gas take fire on the inside of the Bunsen tube, as it often does the first time, turn off the gas-cock instantly for a moment and then relight; otherwise the chimney is liable to be cracked and soot deposited on the mantle. About once in five or six months a new mantle is required, and when putting on the new one the Bunsen burner should be taken off, carefully inspected and cleaned, and a new steel wire gauze fixed over the mouth of the burner. The glass chimney must be cleaned once a week, and carefully avoid touching the mantle, as, if this is torn or misplaced, the gas-flame will impinge against the glass chimney, and break it. The lighting power of the 1892 mantle just introduced, is increased threefold over that of last year, and it is said that the light first emitted, instead of rapidly decreasing in use, is now only slightly reduced in a period of several hundred hours; but, of course, the experience of this is only limited at present to the manufacturers. The 1892 mantle also requires far more care in setting up to work, but these are difficulties which the makers, I have no doubt, see, and will remedy as soon as they can. One is well repaid for the trouble involved in this system, by the splendid light, and only half the usual consumption of gas, and therefore only half the usual amount of heat given off by the ordinary burner. An inch pressure of gas is necessary for these burners, and it is useless to turn the tap of the bracket full on, as it then gives less light than if only half-turned. With the burner thoroughly clean, and the wax burnt off the mantle when first fixed, the experience of "S. G. R." is entirely unknown to me, and it is my impression that the mantle has a very excellent influence on the properties of the atmospheric flame, though, not being a chemist, I cannot enter into this matter, except practically. F. B.

[75920.]—**Injurious Combustion Products.**—Your correspondent states that "the products of combustion in all forms of Bunsen burners are certainly more injurious than those of ordinary illuminating burners." May I ask on what authority he makes this extraordinary statement, which is the exact reverse of the truth? The products of checked or imperfect combustion of coal-gas are certainly injurious and offensive, but this is a different matter altogether, and it is evident the actual facts have got considerably mixed in your correspondent's mind. Thos. Fletcher.

[75976.]—**Explosion (U.Q.)**—In the arrangement you mention there are two causes of high resistance: (1) The great thickness of water; (2) the smallness of the contact with the water of the wire through the water-gauge. These would necessite the employment of very high battery power. Diminish the resistance by making the wire dip very near the boiler-plate, and bend it round in a curve, so that the water will touch a considerable length at once. A. E. B.

[76003.]—**Aluminium (U.Q.)**—I am inclined to believe that the springiness you mention is one of the fundamental qualities of this metal, and therefore inseparable from it. A. E. B.

[76004.]—**Blower for Organ (U.Q.)**—The only cheap motive power for blowing a small chamber-organ of ten stops where neither water pressure nor gas is available, is a juvenile specimen of the genus Homo. No doubt, as you state, heavy weights could, by an arrangement of chains, wheels, and cranks, be made to return for this purpose the force which you conferred upon them; but then your postulate is cheapness, by which it is excluded. I think without much trouble the motive-power which I suggest could be regulated so as to work intermittently. A. E. B.

[76004.]—**Blower for Organ (U.Q.)**—Why not use a petroleum or hot-air engine? The apparatus you refer to is probably that illustrated on p. 547 of Vol. LIII., No. 1377 of the "E. M." For other purposes, I have kept a sharp watch for years for every kind of light motor, and although during that time I have seen several weight motors, I have never yet found one of any use. The same objection applies to all: that there is more work to do in winding up the weights again, than there would be to do the work itself at first, for with the motor this is increased by the losses in friction, &c. On the Continent I have seen dog-tracks in use, and with one of these a dog might be used to wind the weights up again; but the S.P.C.A. might have something to say to it in England, although there is not the slightest cruelty; or a wheel like the one the venerable old donkey at Carisbrooke Castle worked in for something like forty years. If there is an electric main in your locality, you might use a small electro-motor, and if not, it might possibly be worked by current from primary batteries, from accumulators charged by a small dynamo and windmill, or by current produced by a turbine and dynamo in any convenient stream near you. Mistral.

[76016.]—**Silvering Specula (U.Q.)**—To purify caustic potash with alcohol it is moderately heated in the most concentrated spirit. The caustic potash dissolves in the alcohol, and a crystalline deposit forms at the bottom, which is principally composed of sulphate of potash and chloride of potassium. A syrupy liquid is found above the deposit. It is mostly formed by the carbonate of potash which has dissolved in the water taken from the alcohol. The alcoholic liquid is decanted with a siphon by distillation. About two-thirds of the alcohol is then removed (this is absolute alcohol), and the liquid remaining in the retort is poured into a silver capsule where its complete desiccation is finished as rapidly as possible. At the end the heat is increased up to dull red to melt the hydrate of potash, which is then run out on a silver plate. The alcoholic solution generally turns brown during the evaporation. This is due to a change in a small portion of the alcohol under the influence of the oxygen in the air and the potash. A brown organic acid is thus produced which remains in combination with the potash. But at the moment when the potash melts this completely loses its colour, the organic acid is destroyed, and gives carbonic acid, which remains in combination with the potash. The potash thus purified, although still containing some carbonate, is quite free from chlorides and sulphates. To obtain it quite free from carbonic acid, it is sufficient to redissolve it in water, and to boil it with a small quantity of lime-paste; it is then left to cool, and is kept with the lime in a well-closed bottle. The liquid contains a little lime in solution. This can be precipitated by pouring into it after decantation a few drops of carbonate of potash. The decomposition of the carbonate of potash by the lime only takes place easily when the liquid is very dilute. The resulting solution of potash is, of course, very weak, and a lot of water has to be evaporated to obtain the solid potash. If the carbonate of potash is dissolved in a small quantity of water, it cannot be brought back to the caustic state, even by a prolonged boiling with a large excess of lime. Besides, when a very concentrated solution of caustic potash is boiled with carbonate of lime, the potash takes up nearly all the carbonic acid from the lime. It is, therefore, to be expected that with a solution of carbonate of potash of a certain strength, the decomposition of the carbonate of potash must cease at a certain limit, which cannot be overcome by prolonging the operation. It is even possible to go backward, and to again form a new amount of carbonate of potash if the liquid gets too concentrated by the boiling. Potash forms two distinct and defined hydrates, one with one part of water (about 16 per cent.), the other with five parts of water. Since writing the above I have come across some old notes which, perhaps, throw some light on the reaction in the solution you give. With all the soluble salts of silver, potash and soda give brown precipitates of dydrated protoxide of silver, insoluble in an excess of reactif. Ammonia produces in neutral solutions the same precipitate, but completely soluble in an excess of reagent. If the solution contains a large excess of acid, ammonia does not then make it turbid, because a soluble salt of ammonia and silver is formed, which is not decomposed by an excess of ammonia. The carbonates of potash and soda give a white precipitate of carbonate of silver, insoluble in an excess of reactif. Carbonate of ammonia produces the same precipitate. This dissolves in an excess of carbonate of ammonia and in caustic ammonia. The oxide and the carbonate of silver precipitate are decomposed easily by heat, and give a spongy mass of metallic silver, which becomes aggregated by percussion, and has all the physical characters of malleable silver. Protoxide of silver is a powerful base which combines even with the weakest acids, and completely neutralises the strongest acids. Thus nitrate of silver is perfectly neutral to coloured reagents. This being so, I would suggest that the reaction must be rather complex, that the potash is really the reducing agent, that the sugar only serves to hold the protoxide of silver, &c., in solution in the way that gum used to be used in ink, and that the heat finally produces the metallic silver. It is stated in Vol. XXXIV. p. 133, that "The use of the acid is to convert the sucrose to glucose, that almost any acid will serve, but that nitric seems the most effective, and that the quantity does not matter to a grain or two." In the same volume Mr. Calver, on p. 327, writes that it works "better with double the quantity of sugar solution, especially if white loaf-sugar is used. Sugar-candy is, of course, richer in saccharine." Mistral.

[76030.]—**Dwelling Houses (U. Q.)**—I should think a letter to the Registrar-General at Somerset House might elicit some information leading you on to the right track. I believe you would have to pay pretty heavily for the information, as it is so comprehensive; and, as regards the £18 limit to rental, apparently capricious. A. E. B.

[76030.]—**Dwelling-Houses (U.Q.)**—*Whitaker's Almanack* of this year states on page 617: "The number of inhabited houses returned at the recent Census was 5,460,976, showing an increase of 13 per cent. upon the number at the previous Census," which was in 1882. This would make the number of inhabited houses in 1881 about 4,832,722, therefore the number of houses built in ten years would be about 628,254, and in one year 62,825; but this is only as to inhabited houses. "It appears, on the other hand, that the number both of uninhabited houses and of houses building showed in 1891 a decline from the numbers in 1881." The report of the Census, and probably some of the Blue Books, also the Income-tax returns, would seem to be likely sources of information. Mistral.

[76040.] — **Converting a Grandfather's Clock.**—It is extremely doubtful whether it would be worth while to attempt to convert a grandfather's clock into a chime clock, for it is just as well to have new work when going to so much trouble. L. T.

[76042.]—**Wheel Valve.**—If there can be said to be any "proper" way, it is that the direction of the flow should tend to close the valve. "Amateur" asks for "steam or water"—surely there must be some conditions which will determine the best position in each case. As a rule, let the inlet be over the valve. R. S.

[76044.]—**G.W.R. Tender.**—Is this tender fitted with a bogie, or only the ordinary tender attached to the locomotive, with a bogie? "Anxious" might, at least, make his question plain.

T. L. R.

[76053.]—**Bicycles.**—Probably the only advantage of a bicycle with a long wheel-base is that it is not so liable to slip when turning a corner. The object of most makers is to make the wheel-base as short as possible, the little wheel almost appearing to touch the big one. In the case of "safeties," the long base is believed to give greater comfort in riding. M. L.

[76056.]—**High-Pressure Boiler.**—The defect here seems to be that the cold water must all be warmed up. The querist does not give any idea of the arrangements of the pipes,—that is, of the circulation; but he can find several sketches in back numbers that may help him. M. T.

[76057.]—**Galvanising.**—What capacity plant does the querist want? If he intends to embark much capital, I would advise him to see a few existing works first. NUN. DOR.

[76066.] — **Condensation in Lead-covered Hut.**—Free ventilation will prevent the condensation—if it is condensation of moisture that is meant. R.

[76071.]—**Model Loco. Boilers.**—Should not this querist refer to the articles by "J. H." on this subject? It is all very well to make a model loco. boiler to scale, but as to getting it to work is quite another matter. In fact, mechanics of the old school consider such things absurdities. They are not models, nor anything else. W. S.

[76073.]—**Lalande-Chaperon Cell.**—Full descriptions of this cell, and methods of mounting it, have been given in back volumes. I suspect that "J. H. R." has made some mistake, as those cells I have seen worked very well—so far as producing a current was concerned. C. T.

[76074.]—**Mill-Work.**—The querist asks some one to tell him how to make a small hand-mill. Does he mean a coffee-mill, a flour-mill, or what sort of mill? L. S.

[76080.]—**Typewriter Ribbon.**—I believe the ribbons of most typewriters are charged with the usual mixture of aniline and a little glycerine. D. M.

[76083.]—**Cork-Cutting.**—Corks and the rings left after the corks are cut out are now cut by machinery; but the makers seem very reticent in making their machines known. I suppose it is only because it is a manufacturer's business that replies on such a subject have not been forthcoming. VIDEO.

[76084.]—**Earthquakes.**—Earthquakes have no special influence on the barometer; but that instrument generally shows some signs of their approach—the meaning of which signs is not appreciated until after the event. OHMI.

[76092.]—**Glass.**—Does this querist mean silicate of soda? The ordinary salt glaze or porcelain glaze of china ware would seem to answer the requirements, which are not stated too lucidly. NUN. DOR.

[76097.]—**Dulcimer.**—A dulcimer is an instrument that is scarcely worth making; but the longest string on a full-size should be about 4ft. and the shortest about 18in.; it depends on the scale and the tension. A bichord is quite enough for a dulcimer, and the strings (chords) should bé about ½in. apart, so as to give clear striking space. The best way is to see one of those now made, and compare with the old ones. W. J. E.

[76182.]—**Small Steam-Boiler.**—If "Moonlight" has any regard for his own safety, he will not work his boiler at 100lb., as advised by "Draughtsman Patent Light Co." The shell is strong enough for anything, provided the weld is properly done; but the flue will not bear working at more than 50lb. with a proper factor of safety. If "Draughtsman" will work out the W.P. by $\frac{89600 \times T^2}{L \times D}$ = W.P., which is Lloyd's formula, he will find this. Also, we have no information as to the ends. I presume they are flat and welded to the flue-tube and shell; but as we have no description given as to their construction, I think it was exceedingly premature of "Draughtsman" to advise any safe pressure, to say nothing of such a pressure as 100lb. Such queries as these are "kittle-cattle" to deal with at the best of times, and the safe working pressure of a boiler is not a thing to be settled like a suit of old clothes. J. H. H.

[76210.] — **Torsion Balance.** — I must thank "Iota Dash" for kindly sending a reply to my question, but it does not touch my difficulty. My first solution of the question was based on the formula: $H \times ml \times sin.\ \theta$, which, of course, gives the correct solution. But Coulomb made no such consideration; and if the directive action of the earth was equal to 35° of torsion for 1° of deflection, it was taken as 35° × 24 for 24° of deflection, in accordance with the law that the "force of torsion is proportional to the angle of torsion." This is what puzzles me; as, if it had said "proportional to the sine of the angle of torsion," I should have had no difficulty with regard to this solution; but then I could not have understood the torsion balance. I shall be glad to be helped in my difficulty. STUDENT.

[76220.] — **Electro-Motor.** — Arrange your 10 Bunsens in five sets of 2 in parallel; connect these five sets in series. This will give you about 10 volts, and you can safely draw off 10 ampères for a few hours. Make an upright Kapp-type motor, about 7in. high, with F.M. cores 1½in. diameter, 4in. high. Pole pieces about 3in. to take an armature 3½in. in diameter, 2in. deep. Wind A. with about 1lb. No. 20, F.M. with 3½lb. No. 14, connected in series. S. BOTTONE.

[76221.] — **Spritsail v. Gaff.** — By all means have a gaff and boom for that size boat. You would never manage to set or lower the sprit alone, and, in case of your slipping, you might let it go through the bottom of the boat. The utility of a spritsail is that the mast is shorter; and it can generally be stowed in the boat; but you would find this impracticable with a half-deck. For the most convenient way to make the halyards fast, refer to "E. M." of Nov. 6th, p. 248. JERSEY ARTILLERY.

[76221.]—**Spritsail v. Gaff.**—A sprit is not a handy sail; you had better have a balanced lug. The foot is laced to a yard, which swings with it. It is not necessary to peak it in going about. It sets well, and has only one halyard, while a gaff has two. You can carry a small mizzen with it. Have a downhaul, and lead both halyard and downhaul aft, and you can get your sail down in a moment, which is important in sailing single-handed. F. S. A.

[76221.]—**Spritsail versus Gaff and Boom.**—The sprit of a spritsail for a 30ft. boat would be a rather formidable spar, and by no means easy to handle, single-handed, in a wind. I should think it a very dangerous sail for a boat this length, sailed single-handed. It is an awkward sail to reef, and reefs upwards, as you cannot lower the sail—a dangerous thing in a wind and sea. Taking down the sail, too, is difficult and dangerous, unless the snotter travels up and down the mast, and is worked by a halyard. There are other dangers of the spritsail which I need not particularise. Much the best rig would be, I think, a standing lug, and spritsail for mizzen or jigger—as it is usually called in my part of the world. A sprit is very convenient here, and being small, can be almost instantly set and taken in. I should recommend D. Blackburn to have the places where the mast is stepped well strengthened, and to use a strong mast and no stays. If caught in a blow and heavy sea, and he has to run for land or harbour, it is a great advantage to be able to let the lug blow right round and hang out in front. It has thus great power in keeping her head off the wind, and prevents broaching-to. If you are by yourself at sea and it comes on rough, it is very difficult to shorten sail. It is a good plan to have two places to step the mast, as in summer a jib is often carried, and helps to balance the larger after-canvas then carried. I have done a fair amount of small-boat, single-handed sailing, mostly in the open sea or lakes, but have no wish to be mistaken for an authority, and merely give my conclusions for what they are worth, hoping other boating men will do the same, as I am quite as anxious to get wrinkles as to attempt to give them. LANCASTRIAN.

[76225.] — **Crucible.** — You do not give the weight of your buttons of bullion. I assume that they are not above 1oz. You cannot separate the silver from the gold by remelting with anything. You must roll them out as thin as possible, and part them in the wet way. If lead is present, the buttons must first be cupelled to remove it. To part, there should be, at least, 2½ times as much silver as gold. This is judged by the colour of the button. If there is not enough silver, more must be added by cupelling with the help of a little lead. If you have no means of cupelling, treat the buttons as follows:—Roll or hammer thin, and if there is enough silver, dissolve in nitric acid—first dilute, then concentrated. This will dissolve out the silver and lead, leaving the gold in a black cake, or powder. Filter off the argentiferous liquid, and re-melt the black gold. The silver liquor: Precipitate the silver as chloride with hydrochloric acid. If lead is present, it also comes down as chloride. Filter off liquid, which can be thrown away. Wash the precipitate on the filter paper with boiling water, to remove the lead. Dry the silver chloride, and re-melt with an equal bulk of carbonate of soda. A silver button is obtained. If you have not enough silver (2½ times), and cannot cupel, dissolve the whole in aqua regia—2 parts hydrochloric, 1 nitric acid. Evaporate the liquid to dryness; take up with dilute hydrochloric. Filter off the silver and lead, and treat as above. The gold liquor: Precipitate the gold by excess of ferrous sulphate. Filter off, and treat as before. This is very brief, so write again if it is not clear. (2) Try Johnson and Matthey, of Hatton-garden. H. P.

[76225.]—**Crucible.**—Gold and silver mixed, and perhaps lead and other metals. At once proceed to make sure, as far as you can, that the silver is in excess. If not, paradoxical as it may appear, add more silver. Melt all together, and be careful that when cooling the mass is shaken. Then add nitric acid; this will burn (qy. a correct term) or at least dissolve out all the silver, and most, if not all, of the other metals. When the nitric acid ceases to act, filter, and you will then have the gold undissolved, and nitrate of silver, and nitrate of most of the other metals, lead included. From this point you have to diverge and treat the solid residuum (probably all gold), and the filtered solution separately. To the solid residuum add aqua regia, i.e., three parts hydrochloric acid and one part of nitric acid. Thus you will get terchloride of gold. Precipitate the gold from this solution with protosulphate of iron. Filter; take the solid residuum (a brown powder) and melt in a crucible, and you have pure gold. Next take the solution of nitrate of silver and nitrate of most other metals, lead included. To this solution add common salt or hydrochloric acid sparingly till no further white powder (flocculent) is thrown down. Take notice that an excess of the precipitating material may redissolve the silver chloride if in excess. If you watch carefully you will get chloride of silver and nitrates of lead and other metals. Now filter, and you will get a bulky mass of pure chloride of silver (AgCl). Wash this defeatedly with pure (i.e. chemically pure), distilled water. Never let the whole flocculent mass get dry, but let it be well washed to get rid of all the nitrates of other metals. Now take pure zinc and drop it into the moist chloride of silver, adding pure sulphuric acid. Put it away to act, and add sulphuric acid till all the zinc has been dissolved, and the white flocculent mass has been converted into a grey powder. This latter is pure silver, and only wants melting *without* a flux, and you will have pure silver. Thus, out of the mixture you mention, you will get pure gold and pure silver. Z. Y. X.

[76228.]—**Cataract.**—I am glad to be able to tell "Gyp" that a friend of mine was told, more than two years ago, by an eminent London oculist, that he had cataract coming in both eyes, that total blindness might result, that he could do nothing for him, and that he should be only too glad to know of anything that would do good. The next day he consulted an eminent homœopathic physician. His verdict was that the dimness would all clear away if the patient would follow his advice. Although he never gives his eyes much rest, his eyes give him no more trouble than they did two years ago. If "Gyp" will get a copy of "Curability of Cataract with Medicines," by J. C. Burnett, M.D. (3s. 6d., the Homœopathic Publishing Co.), I don't think he will regret the outlay. Calcarea, phosphorus, silica, sulphur, and Natrum muriaticum are some of the medicines most frequently found useful, according to the indications for each. It is a constitutional affection, and requires constitutional and persistent treatment. P. FERRUM.

[76230.]—**Round Haystack.**—The answers to this query do not appear to take into account the truncated conical shape of a round haystack, and Mr. W. Herbert has not allowed for the conical top. From "Molesworth," volume of a cone is given by area of base multiplied by one-third of perpendicular height, and of frustum of a cone, one-third of the height multiplied by the following:—Sum of areas of ends plus square root of product of the same; or, in mathematical symbols: Volume of cone $= \frac{1}{3} A \times H$. Where A = area of base, H = height. Volume of frustum of cone

$$= \frac{1}{3} H \left(A + a + \sqrt{A \times a}\right).$$

A and a = areas of ends, H = perpendicular height between. As a simpler practical rule, measure (1) circumference at eaves, (2) circumference at base, (3) height base to eaves, (4) height eaves to point (perpendicularly, *not* along slope). For volume of lower part, add (1) and (2) together, halve, square, multiply by 0·07957, or, say, 0·08. Multiply this result by (3)—result is volume of lower part. Next, multiply square of circumference at eaves by 0·08, and this by one-third of (4); this gives volume of upper part. This is not mathematically accurate; but would probably be quite near enough.

Stokesay, Craven Arms. N. D. LA TOUCHE.

[76248.]—**Sulphur in Coal-Gas.**—For the information of "Agros," I may mention that a very quick and reliable method of testing for sulphur in coal-gas is that known as Harcourt's. The gas is passed over ignited platinised asbestos, and then a solution of (I think) lead acetate. The darkened colour of the lead solution is compared with a given amber-coloured fluid of a definite tint, and by an empirical rule the amount of sulphur may be determined in a known volume of the gas. I am quoting from memory, and so am not very definite. IOTA DASH.

[76254.]—**Phonograph.**—Pivoted lever styluses are the best: the lighter they are the better the results. A great deal depends upon the form of stylus and hardness of the wax. A good composition is 1lb. of ozokerite and ¼lb. of carnauba (vegetable wax); the cylinders require careful cooling, or they will crack. As regards diaphragms, I use micro glass, thinned down with fluoric acid, the glass being waxed at the edges. The reproductions from my phonograph are quite audible through a funnel, especially cornet records. H. G. SUGGETT.

[76260.]—**Diabetes.**—Having suffered from the above complaint for two years, I went to London and saw the celebrated Dr. Pavey. The following is what you may eat:—Butcher's meat of all kinds, poultry and game, shell-fish and fish of all kinds, fresh, salted, or cured; soups, beef-tea, and broths made from meat, but not thickened, eggs in any way, cheese and cream cheese, butter and cream, greens, spinach, turnip tops, turnips, French beans, Brussel sprouts, cauliflowers, broccoli cabbage, seakale, vegetable marrow, mushrooms, watercress, mustard and cress, cucumber, tomato, lettuce, endive, radishes, celery, vinegar, oil, pickles; that is a good list of vegetables. Nuts of any description, except chestnuts. Instead of sugar, if you wish to sweeten tea, coffee, or custards, use saccharin; it is rather expensive, 5s. per ounce, but it goes a long way; just a small pinch is enough for a large cup of tea or coffee. The bread question is where the difficulty comes in, at least that is my stumbling-block. Many people say "Oh, I could easily do without bread." I tell them to try it for two or three days. Almond, bran, or gluten bread, made for diabetics, is very expensive—4s. per pound. It can be obtained at Callard's, Oxford-street, or Blatchley's, 167, Oxford-street. The cheapest way for a poor man to proceed is to buy common bran, wash it thoroughly twice in boiling water, to extract all the starch, then thoroughly dry it; grind it to a powder in a small coffee-grinder, if you have not an easier method; then make it up as ordinary bread with yeast, put in sufficient wheatmeal to bind it; it is very unpalatable, but it will soon lessen the complaint. I take pills twice a day, by Dr. Pavey's orders, and, if possible, would recommend anyone suffering from the above complaint to go straight to Dr. Pavey, and get his prescription for them—it is the cheapest in the long-run; he is an authority on the disease, perhaps the greatest in the world. I don't believe one doctor in a hundred can do you any good. I saw several before going to him, all to no purpose: now I am a different man altogether. His charge is £2 2s. the first visit, £1 1s. the second. One more word of advice—Don't spend money on quack medicines; save it up until you can visit a good man. There is no cure for diabetes, but it can be greatly reduced.

James T. Gowing.

Souter Point Lighthouse, South Shields,
Durham.

[76262.]—**Serpentine Marble-Turning.**—Polish with very fine emery—very fine—and then with putty-powder. For cement, see Holtzapffel. The cement looks like a hard soap, but water will not dissolve it. Resin is the base. But I should use common glue, taking care to heat the stone and the face of the chuck. Serpentine dust will not do the harm to a lathe-head that one grain of emery will do, but yet it will clog the head; so oil well, and take care to keep the hole to the cone covered after adding the oil. Z. Y. X.

[76262.]—**Serpentine Marble-Turning and Polishing.**—Having spent some time in Cornwall, I may inform "W. R. W." that after the work has been turned in a very simple lathe, it is first polished with emery-cloth, dry; second, lead-paper, with emery and water; third, leather, with emery and water; fourth, corduroy, with crocus. It is no wonder that the cement smells of resin, as it is one of the ingredients; but as it is difficult to make good on a small scale, I shall be glad to supply it in any quantity at 1s. 6d. per pound. A ring tool is used to hold the turning-tool firm on the tee-rest, through which the end of turning-tool is placed, the latter being held just above the centre by the left hand, and the ring-tool in the right.

Sherborne. E. R. Dale, F.S.Sc.

[76269.]—**Gas.**—You can obtain an illuminating gas of high candle-power by passing air through sawdust (or some other substance exposing great surface), contained in an ordinary bottle, the inlet tube, delivering air, reaching to within ½in. of the bottom, and the outlet just passing through the cork. This "gas" may be burnt in a Bunsen burner to give heat. It should not be passed through rubber tubes more than necessary.

C. G. Moor.

[76270.]—**Camera.**—Presuming that "Mudville" means a really "pocket" camera and an extension over 7in., I am afraid he will find a difficulty in getting what he wants. I have wanted such an article for the last twelve years, and have seen nothing satisfactory. A camera that would bear the description was made some time ago by the Sciopticon Co., 28, Colebrooke-row, London, called the "Sciopticon camera." It may still be made, and may suit if an extension to about 6in., with power to use a shorter-focus lens, both being fixed distances. Probably the Eclipse Hand camera, by Shew and Co., Newman-street, might suit. R. O. H.

[76272.]—**Statuary.**—For elastic moulds, *vide* pages 19-20 Watt's "Electro-Metallurgy" in Weale's series. For the hardening processes used in plaster of Paris moulds, a very full description is given in section 140 of Smee's "Elements of Electro-Metallurgy." To polish images as sold by the Italians, there are several modes given in "Workshop Recipes." All these subjects are too lengthy to transcribe. Eos.

[76273.]—**Pianoforte Tuning.**—You place the damping stick between the wire to your right (of the pair of strings) and the wire belonging to the next note to your right. This enables you to tune the wire or string to your left. Having done this, you remove the stick, and tune the other string (the one to your right) until it is perfectly in unison with the first one tuned. The stick, of course, must be placed slanting—that is to say, it must be inserted between the hammers, two or three notes to your right of the note to be tuned. The check-action is by no means new. In fact there are now no pianos constructed without this device.

S. Bottone.

[76274.]—**Rendering Iron Hot by Electricity.**—To do what you propose is quite impossible. It would take something like fifty ½gal. chromic-acid cells; so you see it is out of the question. It might be done by a jet of mixed air and hydrogen, and if you will give further details, I will make you a sketch. C. G. Moor.

[76274.]—**Rendering Iron Hot by Electricity.**—It would require a current of at least 7,500 ampères to bring an iron rod of 1sq.in. section to a red heat. A chromic-acid cell exposing 16sq.in. of negative surface, gives 25 ampères, hence your cell must expose 300 times this, or 4,800sq.in., or have plates 33sq.ft. in size. Will this do? S. Bottone.

[76275.]—**Fresh Water from Sea-Water.**—The difference between sea-water and fresh water is that sea-water contains common salt in solution, which cannot be removed by precipitation, as your friend suggests. Distillation is the only plan, and then filtration through charcoal, in order to let the distilled water become aërated, without which it tastes flat. C. G. Moor.

[76275.]—**Fresh Water from Sea-Water.**—Your impression is right, and what your friend tells you is incorrect. The impurity of sea-water consists mainly of chlorides, which are very difficult salts to remove from a solution. I believe there are only two compounds which could remove the chlorine element—viz, salts of silver and mercury, the chlorides of which are insoluble, one very expensive, the other poisonous, and both quite unsuitable for rendering sea-water potable.

A. E. B.

[76277.]—**Blushing.**—Is "Neros" quite sure he is not as nervous as his son? If so, the cause is plain. Good plain food and plenty of out-door exercise is better than all the medicine. Shakespeare uses an expression indicating blushing as a sign of ingenuousness. Who has ever seen a criminal blush? I should think, from what you state, that your son is of a thoughtful, imaginative turn of mind. If you do not harass him, I should say he will in time get the better of it; but do not physic him for that alone. A. E. B.

[76279.]—**The Ether.**—The generally-accepted theory of the ether is, that it is an almost infinitely elastic fluid substance filling all bodies as well as all space, the luminosity of a body being due to an extremely rapid vibratory motion of its molecules, which is communicated to the contained ether, and by that propagated to indefinite distances in all directions in the form of sperical waves. According to this theory the ether is simply a vehicle for the transmission of vibratory motion from one body to another, as from the sun to the earth. To account for the effects of the vibratory motion upon the receiving body, the upholders of the atomic theory of the constitution of matter assume the existence of physical agents or natural forces, such as gravitation, cohesion, heat, light, electricity, magnetism, &c., acting upon these atomic elements of matter. Now the question arises whether the different ways bodies present themselves to our senses are properties inherent in matter, or due to the action of certain physical forces. In other words, is there, or is there not, any distinction between matter recognisable by the chemist, and these incoercible physical agents? Are they, or are they not, separate entities? In former letters I endeavoured to show by the undulatory theory of light, as given in Dr. Lommel's treatise, by the doctrine of the conservation of energy, by the law of gravitation and its instantaneous action, that all the various phenomena exhibited by the bodies around us are due to properties inherently possessed by the matter composing them. That is, throughout the whole cycle of changes a body may undergo, whether changes of volume and condition from a solid to a gas, or variations of temperature, so long as the mass remains unchanged, its energies continue constant in amount. Therefore, by this theory, the properties of the ether are properties of matter, and the ether is matter. O. T. O. H. P.

[76280.]—**Taunton Dynamo.—To Mr. Bottone.**—The machine, of the dimensions given, is too narrow at tunnel to admit of a nicely wound ring armature, while it is too short to allow of an economical Siemen's or drum armature. I would, if I were you, modify the dimensions as follows: Tunnel, 2¼in. diam. 5in. long. Pole pieces, 2¼in. high, 1¼in. wide, bored out to take the armature and leave rather better than an inch clear top and bottom. Field-magnet cores, long, square, with rounded corners, 4in. wide, ⅜in thick, 3½in. winding space. Yoke 1in. thick. The yoke and one field-magnet and pole-piece cast in one piece. The other F.M. and pole-piece in another, to be afterwards fitted and bolted up. They should be malleable castings (Lowmoor iron). Put ½lb. No. 20 on the armature (either drum or H), and 4lb. No. 22 on the field. Connect up in shunt. Commutator 1½in. by 1¼in. Output 50 volts, 2 or 3 amperès.

S. Bottone.

[76281.]—**Running Dynamo with Light Load.**—You do not say whether your dynamo is compound wound or plain shunt. Probably the latter. In this case try what altering the position of brushes does. If this produces no good effect, your only remedy will be to add some coarse wire coils on the field-magnets, so as to convert it into a compound-wound machine. How is your commutator? Is it badly grooved, or got "flats" on it. Have it trued up if it has, or else you will soon ruin the machine.

S. Bottone.

[76282.]—**Electroplating.**—No end of recipes for silver solutions have been given in recent numbers. The universal solution is double cyanide of silver and potassium, and containing about 1oz. to the gallon. It is ampères you want in plating, and low E.M.F. (volts). Your dynamo of 95 volts would be useless for small work; use two or three Bunsens or three or four Daniells.

Sheffield. J. T. S.

[76282.]—**Electroplating** with a dynamo of such high E.M.F. as 98 volts cannot be very satisfactory. Running the dynamo slowly will diminish the E.M.F., but will diminish the current *pari passu*, or even more. Still, by running the dynamo very slowly, and exposing a large surface in the depositing vat, something may be done. Consult Bonney's "Handbook for Electro-Platers," which I advertise. It is the best handbook on the subject.

S. Bottone.

[76282.]—**Electroplating.**—Nitrate of silver 3oz.; dissolve in distilled water; add gently solution of cyanide of potassium. This will throw down the silver as a white precipitate. Care must be taken not to add too much cyanide, otherwise the precipitate will become redissolved; and, on the other hand, if not enough be added, all the silver will not be thrown down. It is well to take a small quantity of the solution out and test it separately; if no precipitate or cloudiness appear, then all silver is down out of solution. Next stir the precipitate briskly, allow to settle, pour off water, again add water (that has been boiled) and well wash the precipitate, pour off water, add distilled water in which cyanide of potassium has been dissolved until all the precipitate becomes dissolved, and, by the addition of distilled water and a little free cyanide, make up to 1 gallon. Dynamo not more than 4 volts; ampères, according to surface of cathode, about 20.

S. Robert Bonney, Electroplater, &c.

[76283.]—**Sea Error of Chronometer.**—If a chronometer had a pendulum escapement your argument would apply. The escapement-wheel of a chronometer does not act by its weight, but by its mass, which would be the same in the moon as at Manchester. A. E. B.

[76283.]—**Sea Error of Chronometer.**—"Horologist" has discovered a mare's nest not quite in keeping with his designation. If he reflects that the ability of the balance-spring to determine the number of vibrations that the balance shall make in a given time, depends on the amount of matter contained in the balance and its distribution round the axis of rotation, he ought to see that as those two factors are in no way affected by a change of latitude, the time cannot be affected by such change. The mistake he falls into is this, that under the old system of gravitation units, the mass of the balance would be a variable quantity according to latitude, but so also would the strength of the balance-spring, under that system, the one change balancing the other. However, under the new system of absolute units all this is remedied, and you have a constant expression for the strength of the balance-spring, whatever the latitude, and as the amount of matter in the balance is constant the time is unaltered. Unfortunately, the ability of the balance-spring to control the balance is greatly affected by temperature. + temperature means − strength, and *vice versâ*; consequently, as we cannot change the amount of matter in the balance, we have to change its distribution round the axis, which the ordinary compensation balance does with a small error of 3 seconds uncorrected out of a total error of over 6 minutes. The only effect of a change of latitude is to bring this error into relief through change of temperature. Chronometer Maker.

[76284.]—**Skates.**—I sharpened my skates up last Saturday by taking the blades out of the wood, fixing in a vice, and filing them crosswise. By this means I soon reduced them from the almost semicircular to the flat. A. E. B.

[76284.]—**Skates.**—Take skate to pieces, cut a slot deep in edge of inch board, bevel out with rasp or knife, so that the blade of skate will fit in tightly and snugly to its full depth, bolt or clamp the blade in the wood to prevent it moving, cut away the edge of board to the shape of the curve of the blade. Care must be taken that the face to be ground is at right angles to the sides of the board. Fasten a block of wood (with parallel sides) to the frame of the grindstone, so that when the piece of board (with skate in it to be ground) is presented to the grindstone with side lying on the block, the centre of face to be ground may be tangential to the circumference of the stone—i.e., at same height from frame as the centre of the stone. When one blade is finished, substitute the other and grind to same curve. R. O. H.

[76284.]—**Skates.**—Procure piece of board 6ft. long by 9in. wide by 1in. thick, stiffen it by clamping another board edgeways underneath it, a piece 4ft. by 3in. by 1in. will do for this, leaving 1ft. free at each end of long board. Now make a small hole ½in. from one end, and in the centre of 6ft. board, to take an ordinary French nail, which can be driven into anything convenient at the required distance from emery-wheel. The board will now work as on a pivot. At other end of board clamp skate-steel, with ordinary flat-shouldered screws and large washer, leaving edge of steel projecting over edge of board about ½in.; support this end at right angles to the centre of a 5in. emery-wheel, No. 80, and by moving steel backward and forward across edge of emery-wheel, will grind it to an exact 6ft. radius, which is best for all purposes but racing. Shall be pleased to explain further, if necessary. Stradivari.

[76285.]—**Lantern Tank.**—Do not fit your glass into grooves, but cut three pieces of wood to go between the two pieces of glass to form the bottom and two sides. Cut them neatly and flat, and you should have no difficulty, with the aid of a spirit-lamp, in rendering the tank or cell waterproof with marine glue. I have one which I made in this manner. A. E. B.

[76285.]—**Lantern Tank.**—I have several in use such as "Optics" mentions. Having tried many substances for inside coating, I find that a thick layer of Aspinall's black enamel is the most trustworthy. Some sulphuric acid has been in one of these cells since last September, and on examination to-day I cannot notice any bad result. The enamel has to be given a fair time to get thoroughly dry. Iota Dash.

[76286.]—**Engraving Tools.**—I had lessons from an expert with the diamond-pointed tool, so much used in watchmakers' lathes, and triangular-edged sailmakers' needles ground very sharp and fixed in a holder I also used with effect; but you should see and practise the art—written information is useless. Eos.

[76287.]—**Bronzing.**—"Workshop Recipes" contains a variety of processes under the above heading. Eos.

[76288.]—**Enlarging Photographs.**—Make them of ½in. deal, thickly varnish, and bake in a slow oven. Yes; diaphragms are used in enlarging for the same reason as in taking direct photographs, and, in that case, subject to the same laws as to exposure. A. E. B.

[76288.]—**Enlarging Photographs.**—Get sheet-steel the size you require, and if not near to bicycle enameller, paint with Aspinall's bath enamel, two or three coats inside and out. Bicycle enamel baked in oven is better, and only costs a few pence. I use 26 by 24, total cost, 3s. 4d. complete. Any tinman or ironmonger will turn up and wire the edges, if you cannot do it. Diaphragms are not often used for enlarging. Stradivari.

[76288.]—**Enlarging Photographs.**—I make wooden-sided dishes with glass bottoms, and use them for paper up to 23in. by 17in. The angles are strengthened with bands of light hoop-iron for the large sizes. The glass is fixed in rabbets with whitelead, and the woodwork varnished with copal inside and out. They apparently will last for ever if varnished once a year. The diaphragm used will depend on the lens, on the size of the enlargement, degree of sharpness required, and amount of light and time at command. R. O. H.

[76289.]—**Telephone.**—To Mr. Bottone.—Under the circumstances, I do not think a battery would improve matters much. The microphone described, in conjunction with a battery, could be used as a transmitter; but the effect would be better if several carbon pencils were placed between the upper and lower carbons, instead of one only. S. Bottone.

[76290.]—**Galvanometer Multiplier.**—The amount of wire proposed will do very well for your purpose. The mode suggested will answer for getting the needles as nearly of the same moment as is possible. But it is really of no great importance, because even if once attained, the perfect astaticity is destroyed the first time any considerable current passes round the coils of the instrument, since the needle inside the coil is subjected to twice the magnetising effect of that which the outer needle receives. S. Bottone.

[76291.]—**Onyx.**—I have never heard of any acid capable of acting on this very hard variety of chalcedony. A seal engraver's engine, with a stock of special tools and diamond dust, have been hitherto used to cut cameos. See Chapter XXV. Vol. III. of "Holtzapffel's Turning and Mechanical Manipulation," well illustrated. Eos.

[76293.]—**Wheatstone's Bridge.**—To Mr. Bottone.—Use copper strips, about $\frac{1}{16}$in. thick and ½in. wide. Let B be 30in. long, and the arms A A be 3in. long. A piece of German silver or platinoid wire, about 41in. long, and No. 26 or 28 gauge, will answer admirably. See my advertisement in Sale Column, and write to me. S. Bottone.

[76294.]—**Daniell's Gravity Battery for Electric Clock.**—The battery described by you is more of the Minotto type than the true gravity kind. Lay a stout sheet of copper connected to a guttapercha insulated wire at the bottom of your jar, cover this to about a quarter up the jar with crystals of sulphate of copper. Now, procure a circular cake of zinc, having an insulated copper wire attached to its upper surface, and suspend it by means of three ebonite hooks about 2in. below the mouth of the jar. Cautiously, and without agitating, fill the jar up to the level of the zinc with a dilute solution of sulphate of zinc. S. Bottone.

[76296.]—**Prolapsus Ani.**—My father some twenty years ago underwent a surgical operation for this complaint, aggravated by piles. This was completely successful, and he has enjoyed robust health ever since, being now over sixty years of age, playing football and cricket with the utmost zest. "Edina" may perhaps find such an operation the most effective cure. G. S. Kent.

[76296.]—**Prolapsus Ani.**—At the surgical instrument makers you will get the required support—a plug of ebonite or hardened guttapercha conveniently mounted on a band. Ointment of galls is beneficial in causing contraction and reduction of the protrusion, helped by topical application of the coldest water obtainable on rising and going to bed. Better than all, if you can afford it, would be electro-therapeutic treatment—in London the best for your money. Eos.

[76296.]—**Prolapsus Ani.**—If there are no other symptoms which preclude its use, you would possibly find benefit from wearing an anal pessary, which you could procure from Maw, Son, and Thompson. But from the fact that you have consulted medical men at home and abroad without receiving benefit, I am inclined to think that such a simple appliance as that I suggest would have been employed had there been any likelihood of its doing you any good. S. Bottone.

[76298.]—**Bisulphite of Lime.**—The so-called "bisulphite of lime" is not a definite chemical compound. It may be prepared by passing sulphur dioxide (SO_2) into milk of lime. It is a disinfectant, and is used as such by brewers to give beer stability. It can be bought far more cheaply than one could make it on a small scale. Iota Dash.

[76302.]—**Electrical.**—A piece of selenium would not act as proposed, whatever its width and length might be, as Ohm's law plainly shows—viz.,

$$\text{Current} = \frac{\text{Electromotive force}}{\text{Resistance}}$$

However you modify E and R, C cannot be made a cipher. In the case of electrolysis, a counter-electromotive force may be generated in the electrolyte; but I do not think selenium would operate in this manner. A. E. B.

[76304.]—**Carbonaceous Cement.**—To Mr. Bottone.—Finely-powdered graphite mixed with just sufficient gum-water to make an adherent paste. S. Bottone.

[76305.]—**Dynamo.**—Cannot say what may be wrong without seeing and testing it. Probably some short-circuit or false coils in armature. Can you send it to me, carriage paid?

Wallington. S. Bottone.

[76306.]—**Natural Phenomena.**—What! Puzzled again? If you had described the motion of the smut, as along the bottom of the drop and over the top, instead of up one side and down the other, the explanation would have been obvious—viz., that the wind, either from the shape of the smut or from its position with regard to some portion of the carriage, caught it more at the top than at the bottom, or *vice versâ*; the up and down motions were consequential. Probably the same action would also cause the superficial layers of the drop to rotate. A. E. B.

[76308.]—**Electrical.**—State number of ampères required, and I will give you a specification. I cannot without. S. Bottone.

[76309.]—**Medical Coil.**—Try whether you get a better shock by connecting one wire and handle to the clapper-pillar and another to the contact-screw pillar. A condenser will increase the secondary shock, not the primary. S. Bottone.

[76310.]—**Accumulator.**—To Mr. Bottone.—I do not think there is anything wrong so far. S. Bottone.

[76314.]—**Compound Machine.**—Dynamos are compound-wound (that is, wound with both series coils of low-resistance, and shunt coils of high-resistance), to enable them to work with equal output, whatever be the variations in the outer circuit. When the resistance is great, the shunt coils keep up the magnetism of the fields; when it is low, the series coils come into play. Sketches and rules for winding will be found in "The Dynamo: How Made and How Used." S. Bottone.

[76316.]—**Fine Art Casting.**—I think the delicate objects you mention were done by the burning-out process, which I described in these pages some years ago. As the designation implies, the natural object is imbedded in clay, then slowly dried, heated nearly red-hot, the ashes blown out with bellows, and the molten metal poured into the cavity. Eos.

[76316.]—**Fine Art Casting.**—There is no trade secret in this. For work which can be moulded in the ordinary manner it is only necessary to face the sand with some which has been carefully ground and sifted through the finest muslin. When the moulds are made, heat them slowly until thoroughly hot, so that the metal will not chill in running. A hot mould with a fine face, care, and experience will produce a perfect result. I have amused myself with this work twenty years ago, and have at the present time a good collection of the finest and most delicate castings which have ever been produced, in both bronze and iron. Thos. Fletcher.

[76317.]—**Ring Armature.**—If by any means the coils on the armature are short-circuited so that the current subdivides, it follows that the resistance must be reduced in like proportion. S. Bottone.

[76318.]—**House-Warming.**—If you will send me your name and address, with plans, and full particulars, I will communicate to you, free of cost, the best method of warming and ventilating a building. See address in address column. Bartlett.

[76319.]—**Electric Bells.**—I gave a design for almost precisely similar work, down the shaft of a colliery, about a year ago. I cannot find time to hunt it up just now; but if you cannot find it, I will look it up shortly. S. Bottone.

[76321.]—**Incandescent Lights.**—It might be possible to "scent water-gas" by passing it through light tar, carbon disulphide, or some such liquid with a good penetrating smell, and thus render its detection a question for the nose. Water-gas ($H_2 + CO$) is more deadly than coal-gas. (1) It is exactly ten times more poisonous, for it contains 50 per cent., whereas coal-gas contains about 5 per cent., of carbon-monoxide. (2) It will explode when mixed with far less an amount of air, for a mixture of water-gas containing only 10 per cent. of oxygen will explode, whereas coal-gas needs 30 per cent. of its volume before it begins to explode. Iota Dash.

[76322.]—**Testing Internal Resistance of Battery.**—If your two cells, joined in opposition, give a current, it proves that the E.M.F. of one is greater than the other. Testing for internal resistance may be done in several ways. (1) The simplest one is by Ohm's formula—

$$\frac{E}{C} = R.$$

This is the total resistance, and deducting the external gives the internal. (2) By tangent galvanometer and resistance coils. (3) By shunt method. (4) By Mance's method, for which see Sprague's "Electricity," p. 281.

Sheffield. J. T. S.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

Since our last, T. S. Barrett has replied to 75694; "A. E. B.," 75739, 75976, 76003, 76004, 76030; "Mistral," 75750, 75767, 75796, 76004, 76016, 76030.

75801.	Scroll Chucks, p. 272.
75821.	Golf Balls, 272.
75828.	Double Launch Engine, 272.
75850.	Small Arc Light, 272.
75851.	Midland Raiway, 272.
75853.	Small Riveting Machine, 272.
75854.	Hot-air Engines, 272.
75856.	Fish Refuse. 273.
75858.	Colouring and Stiffening Sea Weeds, 273.

76038.	Compensated Pendulum, p. 358.
76058.	Observing Chair, 358.
76063.	Influenza, 358.
76064.	Steam Jet Cupola, 358.
76068.	Great Western Engines, 358.
76100.	Air Current, 358.

QUERIES.

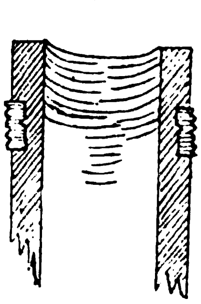
[76328.]—**To Mr. Bottone.**—I have at hand a bichromate battery of 12 cells. Construction: Zinc in porous cell; carbon plate in outer cell; exciting solution, saturated solution of salammoniac, and one part hydrochloric in porous cell; bichromate of potash and hydrochloric acid in outer cell; porous cells, 2½in. wide; carbon plates, 8in. by 2in. I want to know what candle-power incandescent lamp they would comfortably light? Also what voltage I could expect one cell to yield?—THOMAS W. BEAVLEY.

[76329.]—**Heating Bedroom.**—Will some mechanical reader be good enough to let me know the best manner of heating a bedroom by means of a fire all night, so that the fire will maintain the temperature without attention from 11.30 to 7 the next morning, and yet be secure from danger? Is there any special form of grate that will effect this, and if so, what description of fuel does it require?—LEX.

[76330.] — **Bichromate Battery.** — Would Mr. Bottone, or others, kindly tell me the number of cells and area of plates for bichromate battery to get 6 ampères at 50 volts? also the resistance of 65 yards of No. 16 B.W.G. copper wire?—GREG.

[76331.]—**Coil**—To MR. BOTTONE. —6lb. 38 silk-covered for secondary, four layers No. 16 for primary. Kindly give dimensions of a bobbin suitable for above, size of iron core, condenser, and probable length of spark when excited by a chromic-acid battery of 6 cells; also best insulation and number of sections.—L. C.

[76332.]—**Metal or Composition.**—Will any reader inform me of a metal or composition that I can mould or fix a collar into a groove in glass, having small studs to prevent its slipping round? See sketch. The material and mode of manufacture must be cheap, and not of a brittle nature, and capable of taking an outside thread.—PAULISTANO.



[76333.]—**Microphone.**—Will Mr. Bottone or one of the readers of the "E. M." kindly tell me what is wrong with the instrument which I have made according to the directions given in Mr. Bottone's book, "Electrical Instrument-Making for Amateurs." I made two microphones, one with a gas-carbon rod, and the other with graphite; the points are as sharp as I can make them, but I cannot get either to transmit voice, except very indistinctly. There is a peculiar rumbling sound all the time that anyone is speaking.—E. C. LESTER.

[76334.]—**Armature.**—Will Mr. Bottone kindly say number of revs. per minute a drum armature 9in. diam., with about 12lb. No. 10 wire on, should be run at to give 50 volts? Is it necessary to have a resistance board if I were to switch off, say, ten lamps, so as to avoid forcing the other left on? Dynamo is compound.—F. M.

[76335.]—**Large Lights.**—Could any reader tell me which of the large petroleum or other lights, such as the "Wells," "Doty," &c., give the best light, are most reliable, give least trouble, and most economical ones not requiring power? I wish an answer from someone who has a lamp under his charge, especially anyone who has more than one type under his superintendence.—CARBLEOL.

[76336.]—**Thermo-Dynamics.**—Would one of your mathematical readers kindly answer the following question?—If I wish to determine the relation between pressure, temperature, and volume when compressing a permanent gas in a cylinder impermeable to heat, is the following method legitimate?—

$$p v^{1·4} = \text{const.} = p_0 v_0{}^{1·4}$$

Also—

$$\frac{p v}{t} = \text{const.} = \frac{p_0 v_0}{t_0}$$

Hence—

$$v t^{0·4} = v_0 t_0{}^{0·4}$$

And—

$$\left(\frac{t}{t_0}\right)^{0·4} = \frac{v_0}{v} = \left(\frac{p}{p_0}\right)^{\frac{1}{1·4}}$$

$$\therefore \left(\frac{t}{t_0}\right)^{2} = \left(\frac{v_0}{v}\right)^{5} = \left(\frac{p}{p_0}\right)^{\frac{25}{7}}$$

—R. A.

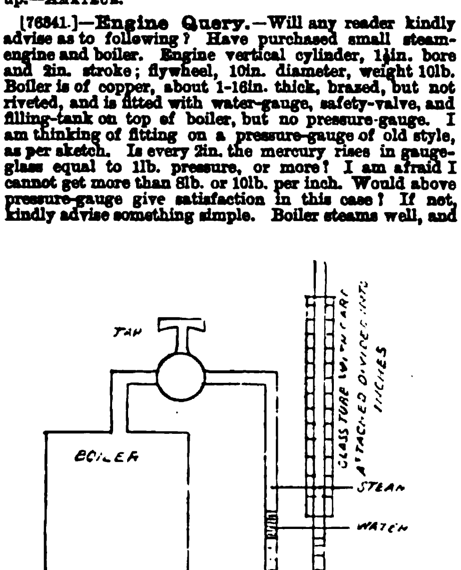
[76337.]—**Electrical Indicator Improvement.**—Will Mr. Bottone kindly suggest a simple mechanism by which the pointers of two dials (about 1,000 yards apart) can be made to revolve by the agency of the electric current generated from a Leclanché battery? The two pointers should revolve simultaneously when the circuit is closed, and the speed should be about double that of the "second" hand on an ordinary clock, though not jerky in motion. I thought of employing a small electro-motor with each dial, but am uncertain whether the make and break of circuit would start and stop the movement with sufficient promptitude. Probably a ratchet-and-pawl arrangement, actuated by an electro-magnet, might answer. A rough sketch would be esteemed.—F. E. K.

[76338.]—**American Organ Bellows.**—Will some one who knows inform me the number of springs, and of what strength, are required in the bellows (the reservoir I mean) of an American organ, with one row, two rows, and three rows of reeds respectively, and what will be the effect if I use more powerful springs than usual? Will it spoil the organ?—A. O. B.

[76339.]—**Equation to Curve.**—A curve is drawn on paper. How can I find the equation which represents it, or obtain an approximation thereto? Will some mathematical reader describe a method, or kindly refer to book in which same may be found?—STUDENT.

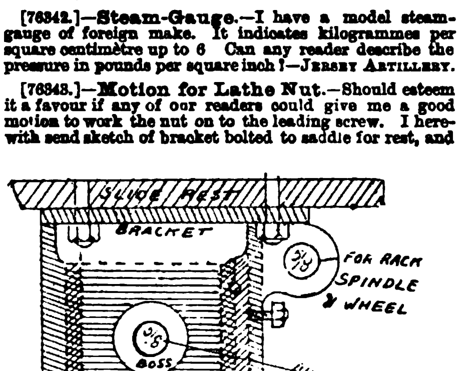
[76340.]—**Telephone.**—I have two farmhouses about three miles apart, and I wish to construct a telphone line between them. Please say what kind of instruments to use, and the resistance of induction coil and receiver. Will a "double pole" receiver be better than a "single pole" one? I have two carbon transmitters of four pencils each. I shall use iron wire for line, if it will not offer too much resistance. I understand how to connect up.—AMATEUR.

[76341.]—**Engine Query.**—Will any reader kindly advise as to following? Have purchased small steam-engine and boiler. Engine vertical cylinder, 1⅜in. bore and 2in. stroke; flywheel, 10in. diameter, weight 10lb. Boiler is of copper, about 1-16in. thick, brazed, but not riveted, and is fitted with water-gauge, safety-valve, and filling-tank on top of boiler, but no pressure-gauge. I am thinking of fitting on a pressure-gauge of old style, as per sketch. Is every 2in. the mercury rises in gauge-glass equal to 1lb. pressure, or more? I am afraid I cannot get more than 8lb. or 10lb. per inch. Would above pressure-gauge give satisfaction in this case? If not, kindly advise something simple. Boiler steams well, and holds about 2 gallons water and 1½ gallons steam. Fire-box underneath, and flues come up each side of boiler. Could I get a greater pressure than 10lb. with safety, considering there are no rivets? Also, what is the power of above engine with 10lb. pressure at 200 revs.? and should I gain much power by making engine horizontal, and taking full stroke from cylinder—viz., 2¾in.? The only alteration needful would be crank on flywheel shaft. —B. J. W. E.



[76342.]—**Steam-Gauge.**—I have a model steam-gauge of foreign make. It indicates kilogrammes per square centimètre up to 6 Can any reader describe the pressure in pounds per square inch?—JERSEY ARTILLERY.

[76343.]—**Motion for Lathe Nut.**—Should esteem it a favour if any of our readers could give me a good motion to work the nut on to the leading screw. I herewith send sketch of bracket bolted to saddle for rest, and think of fastening nut on to the slide, and working it up and down by some cam motion. The nut is not cast yet, so any alteration as regards the same does not matter. Everything in drawing is finished. The simplest way out of the difficulty will oblige.—VILLA.



[76344.]—**Artificial Leg.**—Can any of our readers help me by giving full particulars, with a sketch, of making an artificial leg for my little boy, whose leg was amputated above the knee about 12 months ago? I should want a working joint at the knee, and, if possible, an indiarubber foot, so as to do away with all mechanism at the ankle, which is, I have read, a source of constant worry to the wearer; and the leg to be so made that it can be lengthened to suit a growing child aged nine years. Being a worker in wood and iron, I shall not fear the job.—WILLIAM HENRY COWARD.

[76345.]—**Barlow Lens.**—Will "F.R.A.S." kindly tell me what advantage a "silvered" Barlow lens has over an ordinary Barlow?—BARLOW.

[76346.]—**Portable Electric Lamp.**—Can any of your readers tell me who is the maker of this lamp, and what the solution used in it is? It consists of a very nice case of American walnut, about 6½in. high, 4½in. square, to which is attached a large bull's-eye glass set in a brass frame, behind which is a small incandescent lamp, to light which the fly-nut has to be turned several times, which draws up a 4-cell vulcanite battery box against a 8-square piece of ebonite (inserted between the wooden cover and an indiarubber washer) to which eight flat carbons and four round zincs are attached. The chief disadvantage in this lamp is, if I call at a friend's house and wish to put out the lamp, the fly-nut has to be unscrewed, and the whole case taken off the cells, in which case the carbons and zincs drain off on to the table if put on one. The solution looks almost as clear as water, and if a piece of copper is dipped into it it immediately looks like silver. I find bichromate solution will light the lamp, and will also work a Leclanché cell.—PORTABLE LAMP.

[76347.]—**Coating Iron with Brass or Copper.**—Would "Mistral" or any of our readers kindly tell me if it is possible to coat small malleable iron castings—such as boathooks, rowlocks, &c.—with copper or brass, and if so, how would the cost compare with galvanising? —E. C. M.

[76348.]—**Rubber Band-Saw Tires.**—I should esteem it a favour if any of your readers could inform me of the best method to fasten together indiarubber tires of band-saws that have broken? I have three or four to hand which are useless to me at present; but if I can fasten them together, I can use them again.—ENGLISH.

[76349.]—**Gingerbeer Plant.**—Can any of your readers give information from personal knowledge as to the best method of cultivating this fungus (believed to be Mycoderma saccharomyces), reviving it from a torpid state, and procuring a new supply if needed? Failing this, where can the information be got from books or otherwise?—E. R. W.

[76350.]—**Model Arc Lamp.**—Being desirous of making a model arc lamp, I should feel very much obliged if any of our electrical readers would give me a few hints as to how to calculate the relative quantities and sizes of wire to be wound on the series and shunt coils of a brake-wheel type lamp? Also what is the least current and the lowest E.M.F. that would work a lamp of, say, 100c.p.? I should be glad of any hints as to size of carbons, &c. A sketch of the connections in a Brockie-Pell lamp would oblige.—MAGNETO.

[76351.]—**Cycling**—The following paragraph has appeared in two or three of our most popular papers:—"A mathematician has discovered that a bicycler can travel 15 miles over a good road on his wheel with less exertion than he can walk three miles." My idea of the matter is that the total energy expended is more for riding a certain distance than for walking, the excess being caused by the machine's own weight and friction. Will any of our correspondents kindly say if I am right? —CYCLIST.

[76352.]—**Polishing Celluloid.**—Could any reader inform me how to polish celluloid while it is revolving in the lathe?—F. YOULTON.

[76353.]—**Induction Coil.**—I have bought the fittings of an induction coil, and I want to wind it so as to get the longest possible spark. I have some No. 18 silk-covered wire, and some No. 38 silk-covered wire, which I want to use if possible. The coil is a vertical one, and the dimensions are: Length of core between the ebonite bobbin ends is 5¼in., diameter of ends 3⅜in., and the iron core, which consists of iron wires, is ⅞in. in diameter. To work this coil I have a four-cell chromic-acid battery, used to light a 2½c.p. lamp. What I should like is that I may utilise both battery and wire which I have got, and so save expense. A friend has told me not to wind it for an inch spark, as the coil is too small.—SPARK.

[76354.]—**Reagents.**—In my "Practical Chemistry" handbook, the several solutions recommended as reagents for testing purposes are stated to be one part of the salt dissolved in ten parts of distilled water, and so on. Will you kindly say if the one part of the salt is by weight, measure, or otherwise. I know water is the standard for specific gravities; but please say how the reagent solutions are made up.—WATER ANALYSIS.

[76355.] — **Small Arc Lamp.**—Will one of our readers kindly tell me how to make a small self-regulating arc lamp? I have a dynamo which gives a brilliant arc between two carbon pencils ⅜in. diam., but only about a minute, when the carbons want adjusting again. I have tried a weak spring, but it keeps the carbons too close together, so I get no current; when I separate them a fraction, the arc forms at once. I am willing to take any trouble to make it, but do not understand how to commence. A sketch would greatly oblige—A MECHANIC.

[76356.]—**Electro-Bronzing.**—Would any of your readers kindly inform me which is the best for electro-bronzing—by battery or dynamo—to make the best job of it, by an amateur that has a ¼H.P. gas-engine? Also what is the best book on the subject that gives all details how to work it and finish it off?—L. C.

[76357.] — **Arc Lamp.**—Will Mr. Allsop or Mr. Bottone please send sketch of lifting arrangement for carbon in arc lamp, and what gauge wire for 2,000c.p. lamp 500 yards from dynamo?—O.

[76358.]—**Dynamo.**—To MR. BOTTONE.—What size armature and field-magnet should I have for a 200c.p. Manchester type dynamo; also quantity wire and gauge, and what power would it take to drive it?—H. E.

[76359.]—**Dynamo.**—To MR. BOTTONE.—Wishing to construct a shunt-wound dynamo (Manchester type) of 150 candle-power, would you kindly inform me what width should the pole-pieces be for such a dynamo, using cog-ring punchings 4' 7·8" diameter for the armature? Also, please state what number of your 25 to the inch punchings should I require for making a suitable armature for the above size machine; also quantity and size of wire best suited for same?—CYMRO.

[76360.]—**Efficiency of Dynamos.**—Would any reader oblige me with a few fundamental comparisons regarding the efficiency of bi-polar and multi-polar dynamos?—ENGINEER.

[76361.]—**Velocity of Dynamos.**—How could I, with a dynamo of 110v. and 9a., obtain the due voltage, although diminishing the velocity of rotation from 2,100 to 1,400 revolutions per minute?—ENGINEER.

[76362.]—**Plaster of Paris.**—I have had to model and patch a Japanese (Imarie) vase with plaster of Paris, and afterwards stick in the patch with porcelain cement. As I am desirous of matching the plaster of Paris patch with the other part of the vase, could any of your readers kindly suggest a way of hardening the plaster of Paris, and advise the best way to afterwards paint it so as to resemble the glazed surface of the vase itself itself? I may mention that I shall require the following colours: Indigo, vermilion, white, and gold. Would the paints answer that are used in the Cloisonné art-work?—F. MASON.

[76363.]—**Noise of Steam.**—What is the cause of that rattling and banging noise made by a discharge of high-pressure steam into cold water?—A. E. B.

[76364.]—**Albo-Carbon.**—What is the nature and true chemical definition of that substance known (in shocking Latin) as albo-carbon?—A. E. B.

[76365.]—**To Mr. Thomas Fletcher.**—Will you kindly inform me what are the characteristics of the oxychlorides, oxyphosphates, and oxysulphates of aluminium, magnesium, and zinc respectively? I want a material which is plastic at first and sets without shrinking, and which will stand considerable heat. From experiments I made some years ago, I think I shall find what I want among the above; but I forget now what is the difference between them, and the information I ask will save me having to go over the ground again. Any information or suggestion will be thankfully received and appreciated.—W. M.

[76366.]—**Cleaning Wiped Solder Joints.**—I should be glad if someone would kindly tell me how to clean wiped solder joints, after having been fixed, to give them the appearance of being fresh made, as I think after being handled they look very bad, which is sometimes impossible to avoid.—YOUNG PLUMBER.

[76367.]—**Astro. Eyepiece.**—Would "F.R.A.S.," or some other friend, tell me what advantage an achromatic Kelner eyepiece has over the ordinary Huyghenian e.p., either low or high powers, as there is such a difference in price?—T. R.

[76368.]—**Examination Questions.**—Will some scientific reader kindly show me how to work out the following examples?—1. How many units of heat are given up by cooling pan gas consisting of 300kilo. HCl, 200kilo. steam, and 500kilo. of air from 200° C. to 50 C°? 2. A solution of HCl boils unchanged at 110° C. It has a specific heat of 0·93. Calculate the amount of heat required to raise a litre of such a solution from 10° C. to its boiling point. Sp.gr. of the acid is 1·1.—W. MASON.

[76369.]—**Phonograph.**—To MR. W. GILLETT.—Being engaged in my spare time in building up a phonograph according to your excellent articles which appeared a short time ago in "Ours," I would feel exceedingly obliged to you if you would kindly make your description of the "repeating lever," Fig. 15, a little more clear to me, as I cannot quite understand its action. I may state that I quite understand it so far as the size and shape of it is given; but cannot see clearly the use of the shoe *d*, also the small lever *f*. Am I right in supposing that this hinged lever travels along bearing against the under side of one of the guide-rods shown therein in section?—CYMRO.

[76370.]—**Eclipses.**—Would some reader who is familiar with Loomis's "Practical Astronomy" kindly take the trouble to help me in a difficulty? In the article by Mr. Slade in the "E.M." No. 1314, also in Loomis, p. 237, use is made of the phrase "relative equatorial hor. par.," equal, namely, to the difference between the parallaxes of the moon and sun; and this quantity is put down as the apparent size of the earth as seen from moon; so that, in projecting the solar eclipse, this is taken as the earth's semi-diameter compared with the moon's apparent semi-diameter. I can find to my own satisfaction, but at some length, that this ratio $p^1 - p : s^1$ is the ratio of earth to moon as seen from the sun, and, therefore, from anywhere; but this does not explain the meaning of the phrase, nor why it is assumed as obvious. Loomis calls it the apparent semi-diam of the earth if seen at a distance of the moon from the earth; but, surely, that would be independent of the sun, and would be p^1. The series of articles by Mr. Slade, calculating eclipses, &c., has been most interesting to me, and if someone would explain this point I should be additionally obliged.—W. N. TETLEY, 8, Malvern-street, Newcastle-on-Tyne.

[76371.]—**Subtraction Puzzle.**—

	Mile.	Furlongs.	Poles.	Yards.	Feet.	Inches.
From	1	0	0	0	0	0
Take		7	39	5	1	5

It is not allowable to reduce all to inches before deducting, but work the sum as it stands.—GLATTON.

[76372.]—**Mounting Parasites.**—Will anyone give me a hint as to preparing the above small insects? I should like to keep them sometimes a time before mounting?—MICO.

[76373.]—**Insect.**—I have some very small insects running about my secretaire over my papers; they are very small, and run very fast. What are they, and are they likely to do damage?—MICO.

[76374.]—**L. and N.W. Compounds.**—Can anyone say what is the advantage of "Greater Britain" over the ordinary N.W. compounds?—the cylinders being in both about the same size, I believe.—N.W. COMPO.

[76375.]—**Dry Battery.**—Can anyone kindly tell me the proportion of zinc oxide to plaster of Paris to be used in a dry battery, quantity required being about 1½ pints?—A. R. X. R.

ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, January 20, and unacknowledged elsewhere:—

E. B. FENNESSY.—Cassell and Co.—Tyro.—New Subscriber.—A First-Class Workman.—Traveller.—W. J. H.—J. A. Buffer.—E. C. Lister.—E. C. Lester.—Ampère.—Resistance.—A. G. W. Baxter.—J. T. Blackett.—Lennox.—Ramchullunder.—Doubtful.—New Reader.—Agnew.—Count.—I. L. M.—Old Subscriber.—One in a Fix.—Eos.—W. Pickering.—H. Sadler.—O. J. L.—J. R. C.—W. Stafford.

ERNEST. (A horse-power is an arbitrary unit of measurement, and means 33,00.lb. lifted one foot high in a minute. The French horse-power is 32,549ft.lb.—that is, pounds lifted one foot high. There is neither sense nor science in the rule; but it serves for rough calculations. Engineers always take indicator cards or put on the "brake"; but 33,000 is the unit. As to "men-power," it is, we believe, usual to take eleven men as equal to one horse-power; but why do you ask such questions?)—W. H. SIMCOX. (Any bookseller could have answered the question and procured the works for you; but they have been noticed in the usual way in back numbers. Denning's book is published by Taylor and Francis, and Cottam's star charts, or "Charts of the Constellations," by Stanford, Cockspur-street, Charing Cross.)—YE WILDE FOWLE. (You will find full particulars of all known useful incubators and regulators for incubators in recent numbers. Commence with the number for August 14, 1891, and read what follows in subsequent issues.)—B. G. B. (If you will refer to the many illustrations given in back numbers of recent date, you will find just the information you want, as dynamos of different sizes have been fully described as to sizes of magnets, wiring, &c.)—G. RUSSELL. (We do not know of such a book; but there are many giving descriptions of locomotives. For American types, see Forney's work called the "Catechism," or Edwards's work, published in London by Sampson Low and Co.)—ANXIOUS. (The price of Portland cement in America must obviously vary with the locality; but it is used there for concrete work as elsewhere.)—SLIDE RULE. (Most of the booksellers in Bristol can show you works on the slide-rule; but for opinions as to the respective merits of the different patterns, see the indices of back volumes.)—ABC, F. M. (Please see recent numbers or the indices of back volumes. The questions are not definite, and it is useless to guess at answers.)—A. HILL. (Don't know what you mean specially, but probably it is the letter on p. 400, Dec. 25 last.)—A. REAN. (We do not know: we suppose it is called the pedal.)—T. G. S. (Byrn's "Complete Practical Distiller," Trübner, 7s. 6d.)—W. S. P. (They have been given, and spectroscopes, in principle, are described in many of the textbooks.)—P. S. P. (You may perhaps scrape it off; but it cannot be "discharged" without destroying the paper.)—J. S. DAVIDSON. (Slag wool or silicate cotton is advertised in the *Building News* by F. Jones and Co., Perren-street, London, N.W. We cannot as a rule give addresses, or numbers of patents, &c., &c. If manufacturers do not like to avail themselves of the facilities we offer in our "Directory" (see back page), we cannot help it. We cannot be always giving addresses to inquirers, and you and others must, as we intimate in "Hints to Correspondents," have recourse to our Address Column.)—STUMP. (You mean anæsthetics in dentistry—not æsthetics! Cocaine is used by many, and is quite as safe as gas or ether. Chloroform is seldom used. We have no room, nor is there any need, for "a discussion" on the matter.)

Electricity v. Medicine.—The following is a list of some of the ailments that we know have been effectually cured by simply wearing one of Harness' Electropathic Belt appliances: Nervous Exhaustion, Neuralgia, Sleeplessness, Melancholia, Loss of Appetite, Indigestion, Constipation, Spasms, Flatulence, Torpid Liver, Nervous and Bilious Headaches, Rheumatism, Gout, Sciatica, Lumbago, "Weak Back," Kidney Complaints, hysteria, internal weakness, poorness of blood, feeble circulation, heartburn, &c. This is not a rash statement, but an actual fact, which can be verified by referring to the book of testimonials published at 52, Oxford-street, London, W., by the proprietors, the Medical Battery Company, Limited. A copy will be sent free by post on application, with descriptive pamphlet, to all those who are unable to call at the Company's Establishment, which, by the way, is the largest and only complete Electro-Medical Institute in the world.

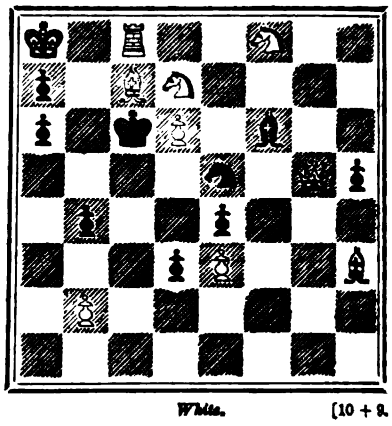
THERE are at present 2,250 kilomètres of telephone lines in Tunis, representing a total of 4,060 kilomètres of wire. These figures show that there has been an increase of 1,965 kilomètres of lines, and 3,520 kilomètres of wire within two years.

CHESS.

All communications for this column to be sent to the CHESS EDITOR, at the office, 332, Strand.

PROBLEM MCCXC.—By T. GUEST.

Black.



White. [10 + 9.

White to play and mate in three moves.

SOLUTION TO 1288.

White.	*Black.*
1. P-K R 3	1. K takes P (*a*).
2. Kt-Q B 6 (ch).	2. K moves.
3. Q mates.	
	(*a*) 1. B takes Kt, or B-K 8 (*b*).
2. Kt-Q 3 (ch), &c.	
	(*b*) 1. Any other.
2. Q-Kt 4 (ch), &c.	

NOTICES TO CORRESPONDENTS.

CORRECT solutions to 1288 by J. Nield, F. Slade, A. G. Fellows, and J. F. Moon and H. Fellows; to 1287 by J. Kistruck, H. Fellows, G. H. Inson, T. H. Billington (very objectionable key: duals also bad), Alec Anderson, L. Pfungst, R. W. Houghton, C. S. Bright, H. P. Hosken, W. L. Smith, and W. L. Martin; to 1286 by W. L. Smith, T. H. Billington (two duals), and G. H. Inson.

W. L. MARTIN AND L. PFUNGST.—Your attempts at 1286 are incorrect.

C. S. BRIGHT (Genoa).—Both your attempts at 1286 are incorrect. You had better write to the publisher on the other matter. We reciprocate your good wishes.

J. NIELD AND A. G. FELLOWS.—Thanks for the problem.

The new series of the *British Chess Magazine* opens well with the January number. There are two good portraits of the rival players, Steinitz and Tchigorin, with accounts of their past careers. Mr. Tomlinson again contributes an interesting paper, entitled "A Vacation Ramble and a Consultation," which is to be continued. There are some good annotated games, and the first batch of eight tourney problems, together with others.

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The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, JANUARY 29, 1892.

MOULDERS' ENDO-SKELETONS.

IN a previous paper, p. 341, I have written of the outer sustaining framework of moulds. In this, I redeem my promise made then to consider the inner frames,—the *endo*-skeletons. These comprise the "grids" proper,—the skeletons upon which *cores* are built.

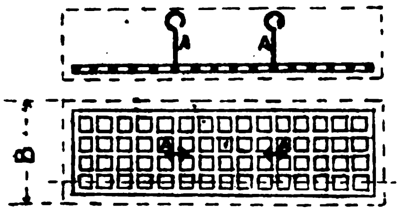
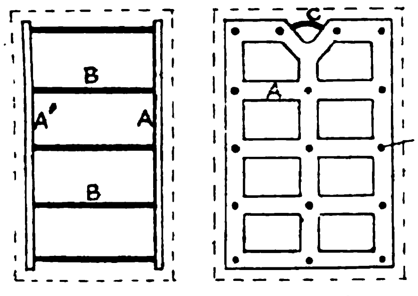


FIG. 1.

All cores, except those of very minute dimensions, are made upon skeleton frames; and these occur in quite as extreme diversity of form as the moulding boxes. They are wholly inclosed by the sand, being invisible when the core is finished. The simplest possible support for a core consists of an iron rod, or wire, inserted in a plain round, or square, core to prevent it from becoming broken. From these, to grids of elaborate form, there is an immense transition, both in shape and dimensions. Among the simpler types of grids are those upon which plain cores are built. But in proportion to the intricacy of cores, do the grids become more complicated. I can but illustrate a few of the leading types.



SIDE VIEW FRONT VIEW

FIG. 2.

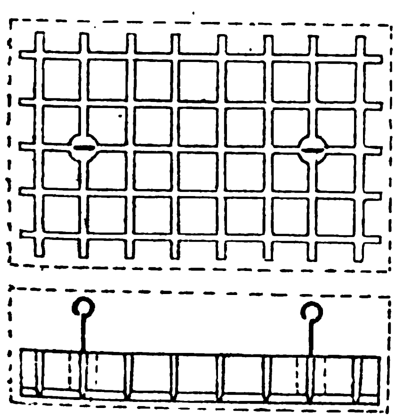


FIG. 3.

Any plain, cubical core would be built upon a grid of the general type, shown in Fig. 1. This is made of cast iron, run in open sand, and is moulded from a rough pattern. The moulds for many grids are, however, cut out in an open sand-bed by the moulder himself, with templets and trowel. The cross section of the bars in Fig. 1 is rectangular. The noteworthy points about it are that it is quite rigid, so that it will not spring by reason of the weight of the core, that it is nearly as long and broad in the core, the outline of which is shown by the encircling dotted lines, and that it is furnished with eyes, A, by means of which the core is lifted about. The eyes must not stand above the top of the core, but a little below. To lift the core about, holes are dug out in its top, round the eyes, which holes are filled up after the core has been finally lifted into position.

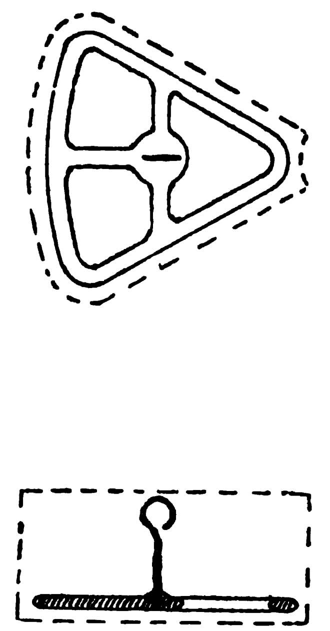


FIG. 4.

Of course a grid of this type need not be of rectangular form. Its plan view may be modified to suit a core of any outline, whether square, oblong, triangular, polygonal, or circular. In foundries, standard-pattern grids, with bars of various cross sections and strengths, are kept, and their moulds are stopped off to any outlines that may be required.

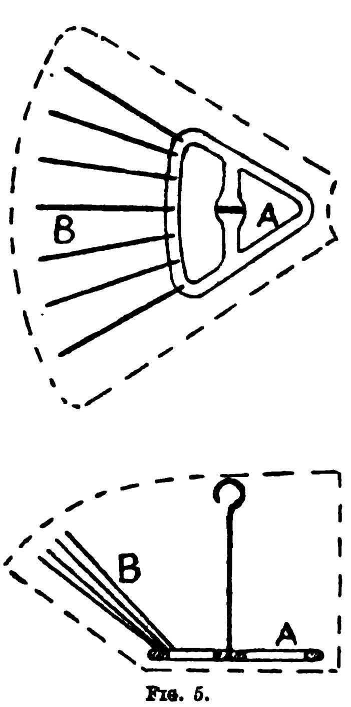


FIG. 5.

A grid of this type does not always lie flat in its core-box. If the core is deep relatively to its width, the grid must be put in edgewise, and this necessitates some slight alterations. The rods and eyes A are omitted, and provision is made for lifting the grid by means of an eye cast in, as at C, Fig. 2. This figure illustrates a double grid for a large, square condenser core. But supposing it to consist of a single plate, A, only, with its eye, C, then it would represent a grid of the type of Fig. 1 placed edgewise in a thin, vertical core. The figure 2, however, shows a framework of two plates, A and A^1, conected with cross-bars, B, of wrought iron, cast into A^1 and A. The outline of the core is shown by dotted lines.

The reason why a grid like Fig. 2 is used for this condenser core instead of a grid like Fig. 1, is because Fig. 2 affords that support to the deep sides which is lacking in Fig. 1. The latter form, therefore, is never employed for cores whose depth is considerable, that is, whose depth exceeds about the width B of the grid, and when of such depth it is usual to cast stout rods vertically in the grid, principally around the sides, to assist in supporting the mass of sand.

For very heavy cores, though relatively shallow, grids are made correspondingly heavy. Such a grid as that in Fig. 1 would not carry a massive core of large area, and weighing perhaps two or three tons. It would either spring, or crack. For such massive work, grids of deeper section are used (Fig. 3). In all respects except that of depth, they resemble the grid in Fig. 1.

For light and shallow cores, on the contrary, grids like Fig. 4, which represents a grid for the arm of a spur-wheel, are used. These are made to fit within the core-box, allowing a little clearance all round, and are lifted with a single eye. The rough outline of the core is seen in dotted lines.

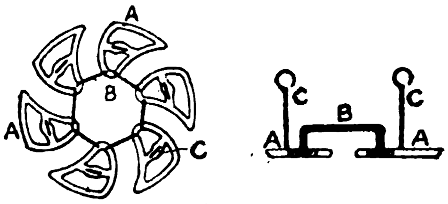


FIG. 6.

The form of grid for the cores of a bevel-wheel is shown in Fig. 5, and its relation to the latter is clear from the dotted outline roughly representing the core. Several rods, B, are cast in the plate, and are bent over as shown, to support the sand that forms the overhanging part of the core, which sand, without these rods would be unsupported by the plate A itself.

Grids of the general form in Fig. 4 are also used for the cores of pulley arms.

When moulding pulleys from a pattern, the upper half of the interior, or space included within the rim above the arms is usually carried upon a compound grid, Fig. 6, formed of several separate grids, A, as many as there are arm-spaces, connected with rods, B, arching over the arms. These are furnished with eyes, C, and upon the entire grid the entire upper portion of the pulley that lies within the rim is lifted.

If the pulley is of large diameter, and the grids therefore of correspondingly large size, two sets of arched rods will be employed, one set towards the centre, as shown, and a similar set at the circumference. Also the outlines of the grids will be modified; in the figure they are made for pulley-arms having a single curve only. Their outlines are varied for double curved, or for straight arms.

For a double-armed pulley, like Fig. 7, two sets of grids like Fig. 6, but minus the bridging connections B, will be used. One set will fit between the lower arms at A, and the other between the upper arms at B. But as the cods of sand between and above the arms are deep, a ring of cast iron, C, of the form shown in Fig. 8, is added near the top of the middle cod. This has to be broken and extracted after casting through the arms of the wheel. At the top the similar ring D is also added.

Grids for cores which are curved have to follow the curves of their cores. In the exhaust-passage cores of engine cylinders they consist only of round iron rods, bent, and laid in, and rammed in with the cores. In the steam passages also they usually consist of rods, as in Fig. 9, A. But in some cases these rods are cast into a block of cast iron, which holds them in place, and by which also the cores can be partly secured in position. This type of grid is shown at B, Fig. 9. The single rods shown at A are suitable for cores of small and medium sizes, the method shown at B is only used for large and heavy cores.

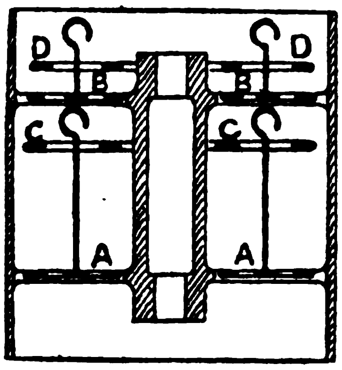


Fig. 7.

There is, moreover, a large class of cores in which skeletons of a totally different character are employed. The cores which I have hitherto considered are those rammed in core sand. These to be now noticed are struck up in loam. Of loam cores there are too kinds: those which are shaped with strickles, those swept upon revolving core bars, and those which are struck upon bricks.

Of those for which strickles are used, I will give only one common example: that of a grid upon which half the core for a bend pipe is made, Fig. 10. This consists of a rough kind of backbone, A, studded with little ribs or "prods," B, standing out to sustain the loam of the core—shown in dotted outline in the figure. Two such half-cores, strickled each on its grid, are stuck together to form a single core.

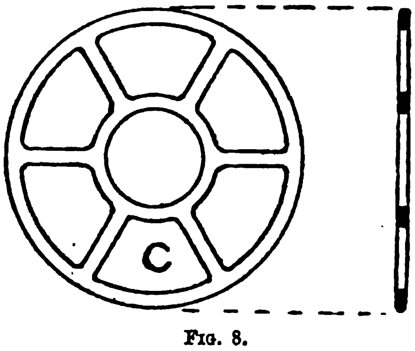


Fig. 8.

Revolving core bars are made in wrought iron like Fig. 11, A, and in cast iron Fig. 11, B. The former is suitable for bars of small size, the latter for large bars. They are the backbone of the core. When the core is small, no other support save the bar is necessary; but when it is large, core plates, C, in addition are required to complete a rigid and secure skeleton. When a core is of small diameter, there is a layer of hay-band wound round the bar and the loam is struck upon this. Another layer of hay-band follows, and then loam, each alternating with the other. But when diameters exceed a few inches, additional support has to be given to the loam and hay-bands; hence the reason for the use of the core plates C. These are made of cast iron, wedged upon their bars at distances of from 8in. to 10in. or 12in. apart. They are sometimes, when of large diameter, bound fast together with long bolts passed through all the plates from end to end. These bolts are, of course, not inserted until the hay-bands and loam have been wound round as far as the bolt-holes. Holes must be left in the ends of the casting to allow of the withdrawal of the bolts. The large holes cast in the plates C are put there merely to facilitate the fracture of the plates, previous to removal from the holes in the ends of the casting.

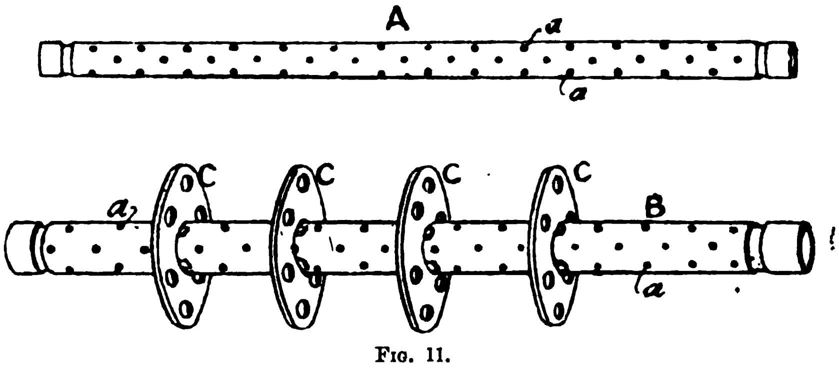


Fig. 11.

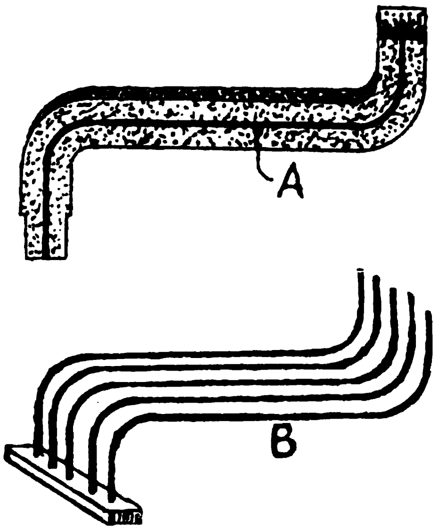


Fig. 9.

The small holes shown in the core bars, are vents for the gas to strike inwards from the cores, through the bars, and thence out of the ends. An entire article might be occupied with a description of the various ways in which these bars and plates are modified and rigged up to adapt them to different classes of work; but I must forbear.

In standard pipe work of large size, such bars and plates are not made use of. What are termed "collapsible core bars" are employed; that is, bars made in segments, hinged together in such a way that after the casting is made, the knocking out of wedges causes the segments to fall inwards from the interior of the casting, and relieves them, so that they can be drawn out endwise. In these bars, however large, a thin layer of loam only, without hay, is struck upon the surface of the iron bar, no plates being used.

When we come to large work of several feet in diameter, the endo-skeleton is made of bricks; no hay is used, and the loam is struck in a different manner. Instead of striking the loam against a bar turned in a horizontal axis, as in Fig. 11, it is struck against fixed bricks by means of a board swept round in a vertical axis. Both moulds and cores are made in this fashion.

The bricks are built in courses, roughly, in the same fashion as mason's work. But there is no great care exercised to make their end joints alternate. They do so in a very rough fashion; but as many broken bricks are used along with whole ones, the joints come in almost all fashions. The principal point is to have sufficient thickness of loam between the bricks to provide for due venting, and to use coarse loam here, and fine loam for finishing the surfaces.

A mould of this character is not, however, made wholly of bricks. These alone would not stand the moving about of the mould or core for parting, drying, and putting together. All the bricked-up portions must be supported upon suitable iron plates. Of course, the shapes of these plates will vary with every mould, but the type is shown in Figs. 12 and 13, A. These are cast-iron plates, made in open sand and covered with "jaggers," or "gaggers," or "prods," *a*, to hold the loam. The lugs *b* are simply for the purpose of slinging the plate and its supercumbent mass of bricks and loam in the crane.

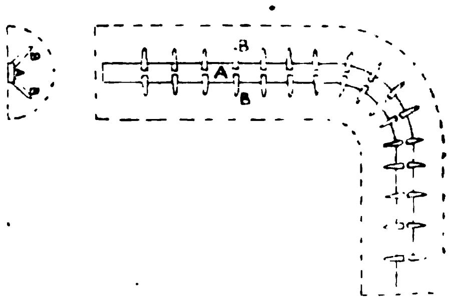


Fig. 10.

For the top or cope of such mould, the form of plate A, Fig. 12, is also used. If the top is perfectly level, then nothing but a thickness of loam is daubed over the gaggers, *a*, and swept level with a board. If the top is deeply dished, then one or two layers of bricks are laid upon the gaggers and loamed over, and struck to the outline required, with a board. To prevent the brickwork from tumbling off when the plate is turned over, some of the bricks are fastened to the plate with wire, passing over the bricks and through holes cast in the plate.

Fig. 12 shows a portion of the skeleton of the cope of a lead pan. First, there is the plate A, studded with prods, *a*, upon which the cope is built. B is the striking bar, and C the striking board. To give support to the bricks in this case, there are a number of arched segmental castings, D, made in open sand and bolted to the plate in radial positions. Between these castings, bricks

E, mostly broken, are fitted and well bedded in stiff loam. Over these the final coat of loam F is struck.

Fig. 13 shows a loam core. A is the plate, with lugs *b*, and eyes B; and C are the bricks shown in outside view, and also in plan and section. Upon this skeleton the thickness of loam D is struck.

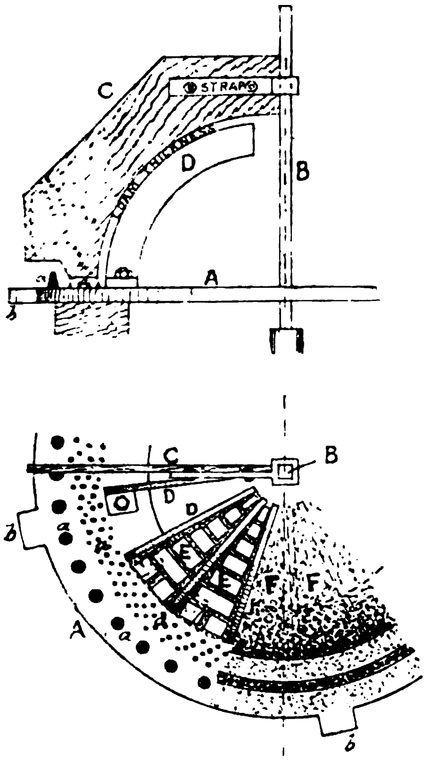


FIG. 12.

Since the skeleton is entirely incased in loam, it seems necessary to explain how this is accomplished. Observe, then, in the enlarged views at X and Y, that the plate A is studded with prods on both faces, and on the edge. At the commencement of striking the core, the plate A is set *upside down*, and the thickness of D' is swept over it. When dried, this is turned over, and the thickness of loam upon the opposite side daubed on, and the first layer of bricks bedded upon it, Then the building proceeds to the top.

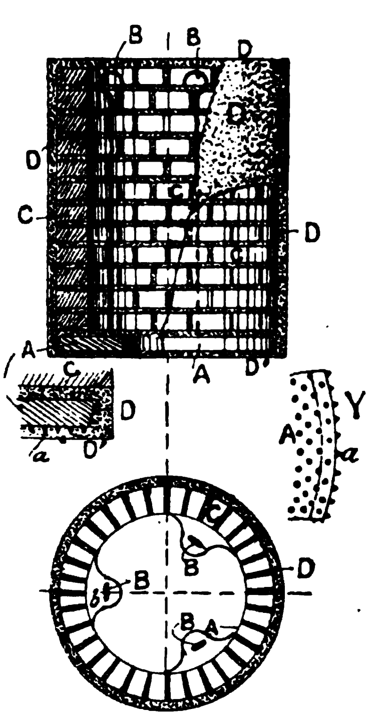


FIG. 13.

In most cores of this kind, three or four columns of bricks, made of dried loam, would be inserted between the common bricks. In very small cores, all the bricks would be made of loam. This allows for shrinkage, without risk of fracture of the casting occurring. Also, instead of courses of one brick deep of "headers," as shown, the bricks are frequently arranged circumferentially, one or two deep, or in no particular order, if broken bricks are largely used. Into details of these and many other matters I cannot enter in a paper of this kind.

I have said enough to show that the subject of moulders' skeletons is a very important one, equally important with] the ramming and venting, the securing and pouring of moulds. If the skeletons are insufficient and weakly, the whole subsequent labour will be thrown away. If they are rigid and ample, the basis of a good mould is secured.

J. H.

DEATH OF PROF. J. C. ADAMS.

ONE of the most distinguished discoverers in the whole history of astronomy died on Jan. 21 at Cambridge, when the Lowndean professor passed away after a long illness. John Couch Adams, M.A., Sc.D., LL.D., D.C.L., F.R.S., F.R.A.S., was born at Lidcot, near Launceston, in Cornwall, on June 5, 1819. He was educated first at the village school, and afterwards at Devonport, where he showed a great aptitude for mathematics and astronomy. In October, 1839, he entered at St. John's College, Cambridge, and graduating in 1843 as Senior Wrangler and first Smith's prizeman, he was soon after elected to a Fellowship, and became one of the mathematical tutors of his college. It seems that so early as 1841 Adams had devoted some attention to the problem the solution of which will for ever be associated with his name. Many years previous Alexis Bouvard had prepared tables of the motion of Uranus, but as time progressed irregularities were found in these, and in 1834 the Rev. T. Hussey addressed a letter to Airy in which he declared in decided terms that there must be another planet outside Uranus, a fact which Bouvard himself (who died in 1840) seems to have suspected. It appears that some remarks in one of Airy's reports first directed the attention of Adams to the problem, and he devoted himself to the difficult and enormous labour of solving it, with what result all the world knows, together with the rather miserable story which recounts how Adams forwarded to Airy in Oct. 1845 such provisional elements as clearly give him priority in the discovery of Neptune. Airy seems to have had some doubt and to have applied to Adams for further information, which was, it is stated, never received, nor for some unaccountable reason were Adams's results published at the time. Arago had in 1845 set Leverrier to work on the same problem, and on June 1, 1846, the Paris Academy of Sciences received Leverrier's results, which were almost immediately published, and the planet was optically discovered by Dr. Galle, of Berlin, on Sept. 23, 1846, although it must have been observed by Challis, who had been working with Adams's elements, at least two months before. A controversy followed which on the part of the French was carried on with some acrimony, and even now in many of their works all mention of Adams's share in the greatest discovery in the whole field of astronomy is omitted. Perhaps, as an impartial judge, the words of Prof. Simon Newcomb may be quoted. In his "Popular Astronomy" he writes: "As between Leverrier and Adams, the technical right of priority in this wonderful investigation lay with Leverrier, although Adams had preceded him by nearly a year, for the double reason that the latter did not publish his results before the discovery of the planet, and that it was by the directions of Leverrier to Dr. Galle that the actual discovery was made. But this does not diminish the credit due to Mr. Adams for his boldness in attacking, and his skill in successfully solving, so noble a problem." Those who have studied the question with the most intense interest are agreed that Adams was deprived of his right to the honour of first discoverer by the procrastination of Airy; but that fact does not detract in the least from the merits of Leverrier.

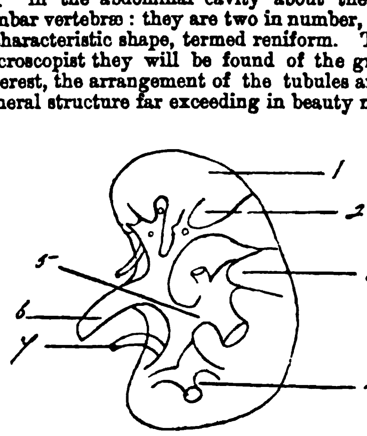
Prof. Adams did other brilliant work, especially in the more recondite mathematics, and rendered at least two other eminent services to astronomy, for to him it is admittedly due that we have now an adequate theory of what is known as the secular variation of the moon's motion, a phenomenon which the great Laplace succeeded in only partially explaining. It was a subject to which Adams's peculiar mathematical genius was precisely adapted; and although his theory was vigorously attacked at the time, it may safely be said that it is now universally accepted, and has admittedly, besides explaining the lunar peculiarity, thrown considerable light on the theory of the tides. Still more trying, perhaps, was the problem which Adams set himself to solve in connection with the memorable shower of shooting stars that occurred in November, 1866, and was known to recur about every thirty-three years. This particular swarm is known as the Leonids, and the problem was to find their orbit. Prof. H. Newton, of Yale, had been working at it, but it remained for Prof. Adams to give the precise solution, which he did in the *Monthly Notices* of the R.A.S. for April, 1867.

As Mr. Adams had not taken Holy Orders, his Fellowship at St. John's expired in 1852, and he was elected to Pembroke in 1853. In 1858 he was appointed to the Chair of Mathematics in St. Andrew's University, a position which he held only for a few months, when he was appointed to the Chair in Cambridge which he filled during the remainder of his life. Prof. Adams came before the public less even than the late Astronomer Royal. He was eminently quiet and unassuming, loved his University and his science, and spent the last 33 years of his life as an almost typical college don. Soon after his great discovery, several members of his college raised a fund with which to establish the Adams Prize, awarded every two years to the author of the best essay on some subject of pure mathematics, astronomy, or other branch of natural philosophy. In 1866 the Royal Astronomical Society awarded him its gold medal for his lunar researches, an honour he had previously received in conjunction with Leverrier in 1848. In 1884 he was one of the British delegates to the Meridian Conference at Washington.

PRACTICAL MICROSCOPY FOR STUDENTS.—XVII.

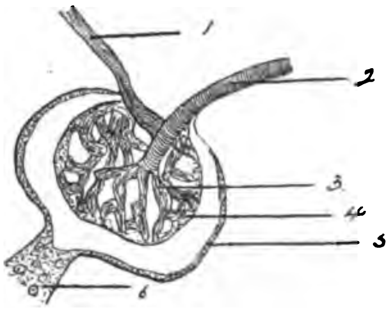
By FREDERICK DAVIS, B.Sc., Associate of the Pharmaceutical Society, &c.

THE glands known as the kidneys are situated in the abdominal cavity about the upper lumbar vertebræ: they are two in number, and of a characteristic shape, termed reniform. To the microscopist they will be found of the greatest interest, the arrangement of the tubules and the general structure far exceeding in beauty most of the other glands of the body. Each kidney is possessed of a depression termed the hilus; this will be found upon the inner side. Here the blood-vessels enter, and the tubes called the ureters leave and carry away the excretion in the form of urine to the bladder. If we cut a kidney down the centre longitudinally we shall observe the pelvis, a kind of cavity produced by the



Section through Human Kidney, showing—
1, Cortical portion; 2 and 3, Pyramids; 4, Medullary portion; 5, Calices; 6, Ureter; 7, Renal artery.

extension of the ureter; this again extends itself into a number of branches called the calices; these are twelve in number, and are connected with still further extensions termed pyramids. The pyramids go to form the portion called the medulla of the kidney. The student will observe, therefore, the kidney is divided into two portions—an outer called the cortical, and an inner termed the medulla. The apex of each pyramid is the recipient of a large number of little tubes, the ends of the "tubuli uriniferi," and these extending themselves to the cortical-portion end in little bodies called the "Malpighian capsules." These, then, would appear to be merely a mass of branches from the urine tubes. Each capsule is served with arterial blood by a branch of the renal artery, which, in its turn, again divides, and forms the so-called glomerulus. This, again, splits up into capillaries, which eventually collect themselves into the renal vein, and leave upon the same side of the Malpighian capsule as the artery enters—that is, opposite to the side where the urine-tube enters. It will be understood, therefore, the blood leaving the kidney by the renal veins must be considerably purer than the blood entering by the arteries, because, having undergone a kind of filtration in the capsules with the consequent separation of the urine from the blood as it passes through the capsules, it is apparent it must be more free from nitrogenous matter.



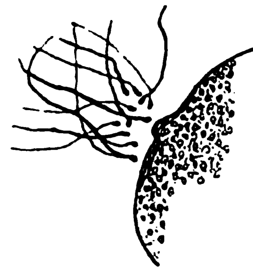
Section through a Malpighian Capsule of Kidney, showing—

1, Renal vein; 2, Renal artery; 3, Glomerulus; 4, Epithelium of glomerulus; 5, Epithelium of capsule; 6, Tubule.

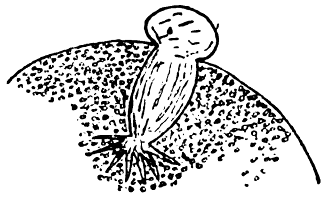
From this description the student will arrive at the conclusion that the urine is separated from the blood chiefly in the Malpighian capsules and the tubules of the kidneys. It will also be observed the blood carried away in the renal vein must be the purest in the whole body—such is, indeed, generally considered a fact. After the separation of the urine from the blood, it is carried into the pelvis, and from thence into the ureters, whence it flows constantly but slowly into the bladder. It will be seen the whole of the capsules and tubuli are covered with epithelial cells. It is also considered by some authorities that the glomeruli are lined in a like manner; but this would appear to be open to doubt.

For purposes of examination, the student should obtain a *fresh* kidney from a sheep, and having thoroughly cleansed it by carefully removing particles of adhering fat, and washing in cold water, cut thin sections, and harden the substance by immersion in bichromate of potash solution for the space of about 14 days, remove, wash in cold water, stain by placing in Beale's solution for about 36 hours, wash in spirit, mount in glycerine, and finish in the usual manner. A section treated in this manner forms an interesting and pretty object, in which the salient features may be observed. If, however, a more distinct object is desired, let the student inject fluids of various colours respectively into the renal artery, renal veins, &c. By this means each point will be the more apparent. It may be well to mention the injected staining fluid should be allowed to remain in the vessels for some little time (about twelve hours). This may be accomplished by injecting the vessels quite full and keeping the fluid in by a ligature of fine silk tied at the point of injection. After this treatment, wash in spirit and mount in glycerine, as before described. I may add I have in my possession a slide treated in this manner, mounted by myself fifteen years ago, and to-day it is as brilliant in colour and as beautiful an object as at the time of mounting.

The examination of the kidneys brings us to the consideration microscopically of the methods and appearances occurring in the reproductive organs. We saw in the previous chapters that several methods exist for the reproduction of species. In the case of Torula we found the process known as gemmation or budding chiefly apparent, whilst in the Fern we had the process known as "alternation of generation"; but in mammals we shall observe the process of "sexual generation"—that is, the sperm-cell of the male fecundates the germ-cell or ovum of the female; it is this process and its microscopical changes which it becomes our duty to study. The spermatic fluid of the male consists of an albuminoid plasma, in which exist an immense number of little tadpole-like bodies termed spermatozoa. These bodies are in adults very active—that is to say, their motility is great. The vitality of the spermatozoa must not, however, be confounded with its motility—vitality being considered to infer the power of fecundating the ovum, whilst motility refers to the activity only. It would appear that the seminal fluid is produced only at the time of emission. This theory is substantiated by the fact that it is not found in the fluid contained in the vesiculæ-seminales, nor other fluids which are ejected with it. The spermatozoa themselves are developed in the tubuli seminiferi. If exposed to an electric current they are rendered rigid, death at once taking place. If exposed to cold the motility is greatly impaired; whilst if cooled to about 50 C. death immediately results. The motion of each spermatozoon is essentially spiral. This is all that need be said concerning the male organ of generation microscopically. If the student desires a detailed account of the physiology, he is referred to works treating especially upon this subject. With regard to the female element, it is sufficient to state the ovum is set free by the Graafian follicle at the time of menstruation. At this period the whole of the generative organs are in a state of congestion: the mucous membrane of the uterus is thicker and spongy, and forms the so-called "decidua menstrualis." This decidua differs from that of the impregnated uterus by the shape of the epithelial cells. One of our leading gynæcologists is of opinion that the period of menstruation is really a process of fatty degeneration, the portions removed being replaced by growths from beneath. After the freeing of the ovum, and prior to fecundation by the spermatozoa, a process of maturation occurs. This consists in a kind of cell-division similar to that observed in the vegetable kingdom, with the eventual production of the female pronucleus. The actual process of fecundation merely consists in the spermatozoon coalescing with the maturated ovum. The ovum being prepared to receive the spermatozoon at a definite point known by an excrescency, the spermatozoon ferrets its way through the external covering of the ovum, and, having gained admittance, becomes, as it were, absorbed, and forms the male pronucleus.

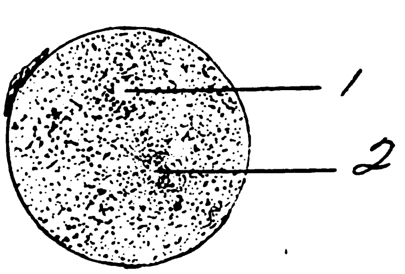


Spermatozoa Penetrating an Ovum at the Point termed the Colliculus.



Section through Female Ovum, showing Maturation and Formation of Pronucleus and Polar Cell.

Microscopically, we observe the protoplasm arranges itself in a radiating stellate manner around the sperm-cell. Eventually the female pronucleus, coming in contact with the male pronucleus, the one merges itself into the other, and the impregnation is complete. We leave the matter here, as this portion is of importance to the microscopist, the after-results being more suited to the student of physiology. The diagrams give a good idea of the changes as far as we have described this phenomenon.



Ovum containing Male and Female Pronuclei.

1, Female pronucleus; 2, Male pronucleus, with stellate radiating protoplasm around it.

In proceeding to terminate these articles upon human physiology, we must not omit the examination of the lungs; the more so because respiration is the means whereby the blood becomes arterialised in the lungs, due to the forcing or pumping action of the heart. To understand rightly the effect of the blood coming in contact with the oxygen contained in the lungs, we must trace the whole process known as the "systemic circulation." We must understand the blood does not flow in one direction at one time, and in another direction at another, but has a definite course to pursue, and cannot, without upsetting the whole arrangements of the body, deviate from that course. Assuming, then, we follow the arterial blood from the left ventricle of the heart, we find it pumped by the muscular contractions into the aorta, from thence into the systemic arteries, and from these into the systemic capillaries. Here it becomes venous blood—that is, deprived of the greater portion of its oxygen by the surrounding tissues. From hence it passes into the veins, and these in their turn pouring the contained blood into the venæ cavæ, which empty themselves into the right auricle, this completing the greater circulation. From the right auricle the blood passes into the *right* ventricle, and then commences the circulation known as the "lesser" or "pulmonary" circulation, and it is this lesser circulation which is of interest to the microscopist, as the whole of it is in connection with the lungs. The right ventricle then forces its contents into the pulmonary artery, the branches of which enter the capillaries of the lungs. It is here, therefore, the blood becomes arterialised, owing to the fact of coming in contact with the inspired air in the lungs. The blood is then received into the pulmonary veins, and poured into the left auricle, and from thence through the bicuspid or mitral valves of the heart into the left ventricle, this completing the lesser circulation. It then starts anew, upon the greater circulation previously described, the same process being again and

Section of Human Lung, showing Large Artery and Branches therefrom.

1, Large artery; 2, Branches.

again repeated. If the student desires to examine the heart physiologically and anatomically, he is referred to works treating especially on that organ. We find the lungs situated in the thoracic cavity;—indeed, the only organs in this cavity are the lungs and the heart. At the back of the mouth, just at the back of the tongue, we have an opening called the "glottis," which is protected by a little lid termed the epiglottis. Within this glottis we have the larynx, or voice-box, and immediately below this we have the trachea. This branches into two divisions, one of which serves either lung. Each division is termed a bronchial tube, or bronchus; this divides again and again, until the little tubes are not more than $\frac{1}{100}$in. in diameter, and these terminate in air vesicles. Such, then, is the structure of the lungs, and the student will understand how the blood parts with its carbonic-acid gas, and becomes arterialised by the inspired air. If the blood does not become arterialised, owing to insufficiency of oxygen in the inspired air, a state of asphyxia is the result.

The whole of the trachea and large bronchi are lined with ciliated epithelium; but the smaller canals are not so lined. The microscopist should obtain the whole of a sheep's lung, with the trachea attached, and, having examined its parts, let the substance be hardened in spirit or bichromate solution. This will require a space of about three weeks. Then cut a thin section, stain in carmine solution, and mount in Canada balsam. The student of microscopy in relation to human physiology will now have arrived at a fair knowledge of the subject; but I would not advise him to rest here, but carry his researches still further, and enjoy the pleasures which knowledge combined with the utmost care can only impart, using this knowledge not only for the benefit of mankind, but for the glory of the Creator.

ASTRONOMICAL NOTES FOR FEBRUARY, 1892.

The Sun.

Day of Month.	Souths.	At Greenwich Mean Noon.		
		Right Ascension.	Declination South.	Sidereal Time.
	h. m. s.	h. m. s.	° ′ ″	h. m. s.
1	0 13 46·14 P.M.	20 58 26	17 9 55	20 44 40·14
6	0 14 16·74 ,,	21 18 40	15 41 11	21 4 22·92
11	0 14 26·78 ,,	21 38 32	14 5 47	21 24 5·70
16	0 14 17·44 ,,	21 58 6	12 24 36	21 43 48·48
21	0 13 50·50 ,,	22 17 22	10 38 26	22 3 31·25
26	0 13 7·83 ,,	22 36 22	8 48 8	22 23 14·02

The method of finding the Sidereal time at Mean Noon at any other station will be found on page 406.

Spots, faculæ, and other indications of solar disturbance are both fine and frequent.

Towards the end of the month the Zodiacal Light may be caught in the West after sunset.

The Moon

enters her First Quarter at 9h. 39m. a.m. on the 5th, and is Full at 7h. 38m. in the evening of the 12th. She will enter her Last Quarter 14·7m. after midnight of the 20th, and be New at 3h. 47·3m. a.m. on the 28th.

Day of Month.	Moon's Age at Noon.	Souths.
	Days.	h. m.
1	2·8	2 52·2 p.m.
6	7·8	7 6·9 ,,
11	12·8	11 42·7 ,,
16	17·8	2 36·9 a.m.
21	22·8	6 8·1 ,,
26	27·8	10 48·5 ,,

The Moon will be in conjunction with Jupiter at 9 a.m. on the 1st (Jupiter 3° 43′ N.); with Saturn at 4h. p.m. on the 15th (Saturn 1° 41′ S.); with Mars at 7h. a.m. on the 22nd (Mars 2° 38′ N.); with Mercury at 3h. p.m. on the 27th (Mercury 3° 3′ N.); and once more with Jupiter at 5 a.m. on the 29th (Jupiter 3° 19′ N.)

Occultations of (and Near Approaches to) Fixed Stars by the Moon.

Day of Month.	Star's Name.	Magnitude.	Disappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.	Reappearance.	Moon's Limb.	Angle from N. Point.	Angle from Vertex.
			h. m.		°	°	h. m.		°	°
1	B. A. C. 8274	6	5 58 p.m.	Dark	32	4	6 55 p.m.	Bright	263	229
2	15 Ceti	6½	3 49 ,,	Dark	55	54	4 59 ,,	Bright	233	219
3	μ Piscium	5	3 59 ,,	Dark	22	29	4 59 ,,	Bright	268	262
6	κ¹ Tauri	4½	10 19 ,,	Dark	136	97	10 55 ,,	Bright	201	160
6	κ² Tauri	6½	†10 38 ,,	S. by E.	168	128				
6	υ¹ Tauri	4½	11 3 ,,	Dark	12	331	11 30 ,,	Bright	326	283
8	118 Tauri	6	12 46 a m.	Dark	101	57	1 45 a.m.	Bright	257	214
10	λ Cancri	6	10 45 p.m.	Dark	72	74	11 50 p.m.	Bright	322	303
16	46 Virginis	6	‡9 12 ,,	Bright	55	94	9 39 ,,	Dark	2	40
17.	θ Virginis	4½	†5 9 a.m.	S W by S	216	196				
18	B. A. C. 4591	6	†12 25 ,,	S W by S	213	243				
24	τ Sagittarii	3½	‡5 17 ,,	Bright	130	160	6 13 a.m.	Dark	236	259

† Near approaches. ‡ Moon has not yet risen. An illustrated description of the above table w be found on pp. 406 and 407.

When our notes commence the Moon is passing out of Aquarius into Pisces, through which she travels until 7h. a.m. on the 2nd, when she enters an outlier of Cetus. She remains in Cetus until 1h. a.m. on the 3rd, when she re-enters Pisces, only, however, to plunge into another outlying portion of Cetus at 4h. a.m. on the 4th. When she finally emerges from this part of Cetus five hours later she comes out in Aries. She continues in Aries until 8h. p.m. on the 5th, when she leaves it for Taurus, quitting Taurus in turn for Gemini at 2h. p.m. on the 8th. Her journey through Gemini terminates at 1h. p.m. on the 10th, and then she enters Cancer. She passes from Cancer into Leo at 3h. a.m. on the 12th, and is travelling over Leo until 2h. a.m. on the 15th, at which hour she leaves it for Virgo, in which great constellation she remains until 7h. 30m. p.m. on the 18th, when she enters Libra. Crossing Libra, she arrives at 8h. 30m. p.m. on the 5th at the western edge of the base of the northern spike of Scorpio. She traverses this in twelve hours and a half, and at nine o'clock on the next morning (that of the 21st) comes out in Ophiuchus, a constellation which at 8h. p.m. on the 22nd she leaves for Sagittarius. At 10h. a.m. on the 25th she quits Sagittarius for Capricornus, as she does Capricornus in turn for Aquarius at 2h. 30m. a.m. on the 27th. Her passage through Aquarius terminates at 1h. a.m. on the 29th, when she enters Pisces. She is obviously in Pisces at midnight on that day.

Mercury

is a morning star throughout February, and is but poorly placed for the observer. For although his South Declination diminishes as the month advances, towards the end of it he will be getting very near the Sun. Furthermore, his angular diameter shrinks from 5·6″ on the 1st to 4·8″ at the end of the month, and he becomes very nearly circular.

Day of Month.	Right Ascension.	Declination South.	Souths.
	h. m.	° ′	h. m.
1	19 29·2	22 25·8	10 44.7 a.m.
6	19 59·9	21 44·8	10 55·7 ,,
11	20 31·8	20 31·4	11 7·8 ,,
16	21 4·4	18 44·5	11 20·7 ,,
21	21 37·6	16 23·4	11 34·2 ,,
26	22 11·4	13 27·8	11 48·2 ,,

Starting thus from Sagittarius, Mercury crosses the whole width of Capricornus, and terminates his journey in Aquarius. His path is quite destitute of conspicuous stars.

Venus

is an evening star during the entire month, and is becoming a very conspicuous object after sunset, as it is nearly 8 o'clock before she sets at the beginning of February, and not until between 9h. and 10h. p.m. at the end of it. She is very perceptibly gibbous in the telescope now. Her angular diameter increases from 12·6″ on the 1st to 14·3″ by the 29th.

Day of Month.	Right Ascension.	Declination	Souths.
	h. m.	° ′	h. m.
1	23 6·0	7 10·9 S.	2 20·9 p.m.
6	23 28·3	4 37·6 ,,	2 23·6 ,,
11	23 50·4	2 1·4 ,,	2 25·9 ,,
16	0 12·3	0 36·2 N.	2 28·1 ,,
21	0 34·0	3 13·6 ,,	2 30·1 ,,
26	0 55·8	5 49·4 ,,	2 32·1 ,,

Beginning in Aquarius, the major portion of the path indicated by the above ephemeris is described in Pisces. It lies in a barren region of the sky. At 10h. a.m. on February 6th, Venus will be in conjunction with Jupiter, and only 1′ South of him. Most unfortunately this interesting phenomenon will happen in bright daylight.

Mars

souths and sets in daylight, subtends an angle which only reaches 7·7″ on the last day of the month, and has great and increasing South Declination; so that, to all intents and purposes, he is invisible.

Jupiter,

too, is now much too near the west at dusk to be fairly seen, so that we shall not resume our ephemeris of him until late in the summer, while

Uranus

will not come into view for the observer's purpose until the spring.

Saturn

rises about 9 o'clock at night on the 1st, and some two hours sooner at the end of the month. His equatorial diameter subtends an angle of 18·55″ on the 1st, and this increases imperceptibly to 19·09″ by the 29th. The major axis of his ring measures 42·74″, and the minor axis 2·53 on the 1st of February; while on the 29th, the measures of the major and minor axes are 44·02″ and 1·97″ respectively. The planet continues to present a remarkable and interesting spectacle in the telescope.

Day of month.	Right Ascension.	Declination North.	Souths.
	h. m.	° ′	h. m.
1	12 2·7	2 18·4	3 19·5 a.m.
6	12 1·9	2 24·6	2 59·1 ,,
11	12 1·0	2 31·7	2 38·5 ,,
16	12 0·0	2 39·5	2 17·8 ,,
21	11 58·9	2 47·8	1 57·0 ,,
26	11 57·7	2 56·7	1 36·1 ,,

The short retrograde arc thus indicated is described above a line joining β and η Virginis, Saturn being as it were at the obtuse angle of a very obtuse-angled triangle which he forms with the stars in question.

Approximate Times of the Greatest Eastern Elongations of Saturn's Five Inner Satellites, visible at Greenwich.

Day of Month.	Satellite.	H.	Day of Month.	Satellite.	H.	Day of Month.	Satellite.	H.
1	Dione	10·5 p.m.	13	Mimas	12·2 a.m.	25	Rhea	12·4 a.m.
2	Enceladus	1·3 a.m.	13	Enceladus	12·4 ,,	26	Mimas	4·8 ,,
6	Enceladus	4·0 ,,	13	Mimas	10·8 p.m.	27	Mimas	3·5 ,,
6	Rhea	10·9 p.m.	14	Tethys	1·2 a.m.	28	Mimas	2·1 ,,
9	Mimas	5·6 a.m.	15	Tethys	10·5 p.m.	28	Enceladus	2·1 ,,
10	Dione	3·5 ,,	15	Rhea	11·7 ,,	29	Mimas	12·8 ,,
10	Mimas	4·2 ,,	17	Enceladus	3·0 a.m.	29	Tethys	3·6 ,,
11	Mimas	2·9 ,,	20	Enceladus	5·6 ,,	29	Mimas	11·4 p.m.
12	Mimas	1·6 ,,	21	Dione	2·2 ,,			
12	Tethys	3·9 ,,	23	Enceladus	11·4 p.m.			

A description of the above table appears on p. 407.

No Eastern elongation of Titan is visible during February. Hyperion will attain its greatest elongation East of its primary at 11·1h. p.m. on the 23rd: but it is hopelessly beyond the power of any but very large telescopes. At 12·4h. a.m. on the 9th Titan's shadow will be projected on Saturn's disc, as it will be again at 11·5h. p.m. on the 24th. An Eclipse of Titan will happen at 4·4h. a.m. on the 17th.

Neptune

continues to be visible during the working hours of the ordinary amateur's night, and as his North Declination is still very considerable, is favourably situated for the observer. He is in so-called "quadrature" with the Sun at 9h. a.m. on the 15th—i.e., is 90° from him.

Day of Month.	Right Ascension.		Declination North.		Souths.	
	h.	m.	°	′	h.	m.
1	4	18·9	19	47·8	7	33·9 p.m.
6	4	18·8	19	47·8	7	13·2 ,,
11	4	18·7	19	47·9	6	53·4 ,,
16	4	18·7	19	48·1	6	33·8 ,,
21	4	18·7	19	48·5	6	14·1 ,,
26	4	18·8	19	49·1	5	54·6 ,,

So that Neptune will remain sensibly stationary a little to the north-west of ε Tauri.

Minima of the Variable Star Algol

will occur on the 2nd at 5h. 41m. p.m.; on the 14th at 4h. 57m. a.m.; on the 17th at 1h. 46m. a.m.; on the 19th at 10h. 35m. p.m.; and on the 22nd at 7h. 23m. p.m., as well as on other occasions when daylight will render the phenomenon invisible.

Shooting Stars

are neither numerous nor striking in February. The 1st, the 15th, and the 20th are supposed to be dates on which the watcher will be most likely to be rewarded.

Greenwich Mean Time of Southing of Thirteen of the Principal Fixed Stars on the Night of February 1st, 1892.

Star.	Souths. h.	m.	s.	
α Ceti	6	10	56·44	p.m.
α Persei	6	30	51·70	,,
Aldebaran	7	43	47·07	,,
Capella	8	20	40·22	,,
Rigel	8	23	18·35	,,
α Leporis	8	41	52·59	,,
α Orionis	9	3	10·54	,,
Sirius	9	54	6·20	,,
Castor	10	41	17·99	,,
Procyon	10	47	13·16	,,
Pollux	10	52	16·06	,,
α Cancri	*12	5	56·30	a.m.
α Hydræ	*12	35	33·34	,,

* Early morning of the 2nd.

The method of ascertaining the Greenwich Mean Time of Southing of either of the stars in the above list for any other night in February, as also that of determining the Local Instant of its Transit at any other station, will be found on p. 408.

NOTES ON DRILLING MACHINES.

THE following hints, extracted from a treatise on the construction and use of drilling machines, issued by the Brown and Sharpe Co., of Rhode Island, U.S.A., may be useful to many:—"The change gears having been selected, the next step in cutting spirals is to determine the position at which the spiral must be placed to being the spiral in line with the cutter as the work is being milled, for, if the spiral is not in line with the cutter the groove will not be cut to the shape of the cutter. The correct position of the spiral bed is indicated by the angle shown at A, Fig. 1, and this angle, as may be noted from that figure, as the same number of degrees as the angle B, which is termed the angle of the spiral, and is formed by the intersection of the spiral and a line parallel with the axis of the piece being milled. The reason the angles A and B are alike is that their corresponding sides are perpendicular to each other. The size of the angle of the spiral depends upon the lead of the spiral and the diameter of the piece to be milled. The greater the lead of a spiral of any given diameter, the smaller the angle, and the greater the diameter of any spiral the greater the spiral angle. The angle may be ascertained in two ways, graphically, or more conveniently, by a simple calculation and reference to the prepared tables. In determining it graphically, a right-angle triangle is drawn to scale. One of the sides which forms the right angle represents the lead of the spiral in inches; the other side represents the circumference of the piece in inches, and the hypothenuse represents the line of the spiral. The angle between the lines representing the line of the spiral and the lead of the spiral is the angle of the spiral. This angle can be transferred from the drawing to the work by a bevel protractor, or even by cutting a paper templet and winding it about the work, as shown in Fig. 2. The machine is then set so that the spiral or groove as it touches the cutter will be in line with the cutter. Or the angle may be measured and the spiral bed set to a corresponding number of degrees by the graduations on the clamp bed. The natural tangent of the angle of the spiral is the quotient of the circumference of the piece divided by the lead of the spiral. Accordingly, the second method of obtaining the angle of the spiral is to divide the circumference of the piece by the lead and note the number of degrees opposite the figures that correspond with the quotient in the tables of natural tangents. The angle having been thus obtained, the spiral bed is set by the graduations on the clamp bed.

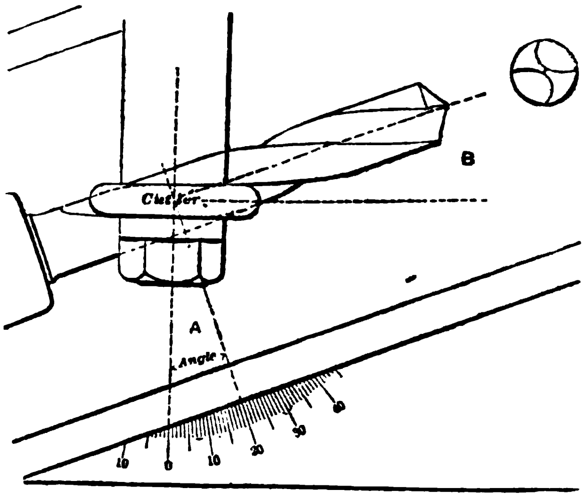
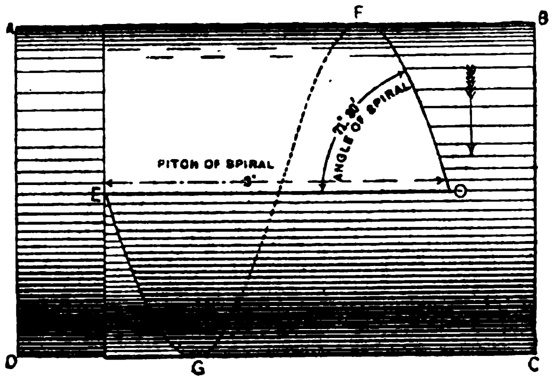


Fig 1.



THE ANALYSIS OF PEPTONES.

THE compounds obtained in the digestion of meat by acid pepsin, although similar in composition, are by no means identical in chemical properties or nutritive value. Any analytical method, therefore, which gives a tolerably accurate account of the composition of commercial peptone preparations must prove one of importance and value to the practitioner, seeing that peptones are largely employed as nutrients in cases of enfeebled digestion and in wasting diseases. At the last meeting of the Society of Public Analysts held at Burlington House, Messrs. C. W. Heaton and S. A. Vasey, of Charing Cross Hospital, contributed an interesting paper on this subject. These chemists have devoted their attention to the methods which have from time to time been proposed, and while they recognise in Denaeyer's method the best that has been devised, and one by which they have been mainly guided, yet they are led to think from their own experimental observations that the process of which the following is an outline is simpler and more satisfactory. A convenient quantity of liquid peptone is gradually dropped into strong alcohol. The precipitate, consisting of albumens, gelatine (coagulable), albumose, and peptone, is dried and weighed. The filtrate, containing meat bases, creatine, &c., and uncoagulable gelatine, is decanted and reserved for further treatment. After weighing the alcoholic precipitate, it is dissolved in water, and the insoluble albumens filtered off and weighed. An aliquot portion of the filtrate, which now contains only albumose, gelatine, and peptone, is next treated with saturated ammonium sulphate solution and the precipitated albumose and gelatine weighed on a tared filter. The adherent sulphate is estimated by means of barium chloride, and deducted, together with the filter, from the total weight. Another portion of the filtrate is treated with specially prepared copper hydrate emulsion, which, with albumose, forms an insoluble compound. The precipitate is treated for nitrogen by the Kjeldahl process. Multiplied by the factor 6·33, this gives albumose. The filtrate from the copper emulsion, now free from albumose, is concentrated, and then treated with ammonium sulphate, heated and cooled. By careful manipulation the gelatine which separates may be made to adhere to the sides of the beaker, washed with ice-cold water, and weighed. Adherent sulphate is estimated and deducted as before. The quantity of gelatine and albumose being ascertained, that of peptone may obviously be gained by difference. Part of the alcohol filtrate (*vide supra*) is evaporated to dryness, taken up with water, and treated with ammonium sulphate for the separation of uncoagulable gelatine. Another portion may be evaporated to dryness and weighed, and another taken for the estimation of nitrogen. The following data are furnished by this process: albumens coagulated by alcohol, gelatine (uncoagulable and coagulable), albumose, peptone, and substances soluble in alcohol, such as creatine, urea, &c. Total nitrogen, water, organic matter, and mineral matter are estimated in the usual way. The authors give to Denaeyer the credit of first recognising in peptones a variety of gelatine soluble in alcohol, and they also add that his process was the first to provide for the estimation of gelatine, or glue-peptone. A knowledge of the presence and amount of this body is desirable, inasmuch as it is said not to present the nutritive value of either the albumens or their peptones.—*Lancet.*

ELEMENTARY PRINCIPLES GOVERNING THE EFFICIENCY OF SPECTROSCOPES FOR ASTRONOMICAL PURPOSES.—III.[*]

By James E. Keeler.

On account of the achromatism of the nominally achromatic telescope, the collimator must have a sliding motion in the direction of its length, in order to bring the slit into the focal plane of the rays which form the part of the spectrum under examination. About 1in. is a proper allowance for a 12in. telescope of the ordinary construction, and for telescopes of different sizes the amount of motion required will be in proportion to the focal length. The position of the collimator in its slide is shown by a graduated scale. If the spectroscope is quite small it may be attached to the draw-tube of the telescope, and the whole instrument moved in or out to bring the slit into the required position.

The slit is an important part of the spectroscope, and it deserves careful attention. Very good mechanical work is required in its construction. It is convenient to have both jaws move equally in opposite directions on turning the slit screw, the centre of the slit thus remaining always in the same place. This construction is condemned by Dr. Scheiner in his textbook on celestial spectroscopy as only fit for small instruments, not intended for accurate measurements. All the devices which he describes are certainly open to objection; but the double-motion slit with jaws actuated by a right and left-handed screw, as made by Brashear and other American instrument makers, is practically free from error. Caution must be observed not to rely too implicitly on the principle of the double-motion slit, as it is only in certain positions of the prism or grating that a spectral line widens symmetrically when the slit is opened.

The arrangement of a diagonal eyepiece for viewing the slit from behind, first described (so far as I know) by Dr. Carl Braun in one of the volumes of the Haynald Observatory publications, is a very useful, and when a large telescope is employed, indispensable addition. With this eyepiece a good view of the object to which the telescope is directed can be obtained on widening the slit, and on narrowing the slit the observer can assure himself that the exact part of the image which he wishes to examine spectroscopically is within its jaws. The eyepiece should move between stops, so that when fully in the slit may be in the centre of the field, and when withdrawn the rays from the slit may pass without obstruction. An equivalent focal length of about 1in. will give a convenient magnifying power.

The positions of unknown lines in the spectrum of a heavenly body are determined by comparing them with known lines, usually furnished by a terrestrial source, such as an electric spark passing between metallic points, a spectrum tube or a flame. In order to make the comparisons reliable there must be no displacement of any kind in the comparison spectrum; that is, a line in the spectrum of light coming through the telescope must fall at precisely the same place as the same line in the spectrum of light which is reflected into the slit from the artificial source. It seems to me that this coincidence is best assured, apart from good workmanship in the instrument, by making the light from both sources traverse the instrument under identically the same conditions. In some of the earlier spectroscopes light from the electric spark was reflected from a plane mirror to a totally reflecting prism directly over the slit and thence into the collimator; but this is a bad arrangement, since the spark, being of very small dimensions and at some distance from the slit, sends light to but a small portion of the collimator lens, while the full aperture of the collimator is filled with light from a heavenly body. An *image* of the spark should be formed on the slit by a lens having a greater angular aperture than the collimator, so that the light from the spark, after being reflected through the slit in the direction of the collimator axis, will completely fill the aperture of the collimator. If the actual aperture of the collimator is greater than the effective aperture, it should be reduced by a stop until equal to the effective aperture, as recommended in the first part of this article. If very accurate comparisons are necessary, as in measures of the motions of stars in the line of sight, all the optical parts of the instrument must be perfect, and all the adjustments must be made with the greatest care. The latter condition it is, of course, the business of the observer to fulfil. In a paper on the motions of the planetary nebulæ in the line of sight, I have described briefly the arrangement of the slit and comparison apparatus of the large spectroscope of the Lick Observatory, which leaves little to be desired in the way of convenience and accuracy.

In spectroscopes for observing solar prominences the slit plate is frequently movable in a direction at right angles to the slit, as the adjustment of the slit on the limb of the solar image is a delicate one, not easily made with the slow motions of the equatorial. This construction is not to be recommended for other purposes.

When the spectrum of a star is observed, a cylindrical lens is placed in front of the slit to give the spectrum sufficient breadth. The way in which a cylindrical lens is used will appear from the following considerations:

When a convex cylindrical lens is placed in the cone of rays from the object glass two real, linear images are formed by the combined action of the the two lenses. The one nearer to the cylindrical lens is called the principal focal line. Its axis is parallel to the axis of the cylindrical surface of the lens, and its length is equal to the diameter which the cone of rays will have at that point if the cylindrical lens were removed. Its distance from the focal plane of the telescope, and from the cylindrical lens, depends upon the focal length of the latter.

The linear image farther from the cylindrical lens is called the secondary focal line. Its axis is perpendicular to the axis of the cylindrical lens, and its length depends upon the focal length and position of the cylindrical lens. The secondary focal line is always in the focal plane of the objective, and it is, therefore, the more convenient one to use. It must be made to fall precisely within the jaws of the slit, and in making this adjustment the diagonal eyepiece already described is almost indispensable. The breadth of the spectrum, which is evidently equal to the length of the line, can be varied by simply changing the distance between the lens and the slit.

The focal length of the cylindrical lens is not entirely an indifferent matter. If the rays passing through the slit are widely divergent, they will fall outside the limits of the collimator lens, and some light will be lost. Hence the cylinder lens should have a considerable focal length, say 10in. or 12in. The emergent beam from the collimator will then be elliptical in section, with the longer axis parallel to the slit, and a stop may be cut so as to just allow the passage of the beam, and placed over the collimator lens when the comparison apparatus is used. It should be noted that the *minor* axis of the emergent beam is equal to the effective aperture of the collimator; hence unless the aperture is somewhat greater, some light will be lost.[*] The advantage of a collimator aperture somewhat in excess of the requirements of the rule given in the summary A has already been mentioned. As prisms are almost invariably higher than necessary to transmit a cylindrical beam, no change in their dimensions need follow the enlargement of the objectives of the collimator and observing telescopes.

For measuring the positions of lines in the spectrum a great many devices are used, such as a graduated circle read by microscopes or verniers. and a micrometer slow-motion screw for moving the observing telescope. The illuminated scale reflected from the first surface of the prism, commonly used on small spectroscopes for analyses of minerals, is one of the roughest devices for recording the position of lines. It is not necessary that the positions should be read in terms of any determinate unit. It is not necessary, for instance, to eliminate eccentricity from the readings of a graduated circle by reading opposite verniers (unless *deviations* are required for other purposes), since the correction for eccentricity is itself a continuous function of the circle reading. I have no doubt that if an instrument of given weight and cost is to be designed so as to give the greatest accuracy of measurement, the end will best be reached by relying entirely upon the use of the comparison apparatus and eye-piece micrometer, and using a graduated circle, if at all, only as a finder. The cost and weight of all other attachments can then go into the important parts which determine the efficiency of the instrument.

No reference has yet been made to the *resolving power* of a spectroscope, or its power of separating close lines in the spectrum. Lord Rayleigh has shown that for simple prisms the resolving power depends upon the difference between the longest and shortests paths of rays in traversing the prisms. With properly constructed apparatus the extreme difference of paths will be the sum of the bases of the prisms. A single prism is therefore equal in resolving power to two prisms of half the size. Hence we see that the power of a spectroscope is by no means defined by its dispersion, for it is easy to obtain large dispersion with small resolving power. It is customary to state the optical power of an instrument in terms of the number of single prisms required to give the same dispersion, and although the statement is indefinite, yet, as prisms for astronomical spectroscopes are generally of about the same size, it is accurate enough for conveying a general idea of the efficiency of the apparatus employed.

The relation between thickness of glass and the resolving power of a prism is quite analogous to that between aperture and separating power of a telescope objective.

For compound prisms the rule for resolving power requires modification, a given thickness of the less dispersive medium (crown glass) not counting for so much as the same thickness of flint glass.

The equations of Lord Rayleigh show that a prism of dense flint glass must have a base of at least one centimètre in order to separate the *D* lines. If the student wishes to test this result by actual experiment, let him place a cardboard stop with an aperture of about $\frac{1}{10}$in. over the collimator of his spectroscrope when the telescope is directed to the sun. If not more than two simple prisms are used, he will find that with no adjustment of the apparatus can he separate the *D* lines, although there may be abundance of light. A long slit $\frac{1}{10}$in. wide may be used instead of a circular aperture, provided it is placed parallel with the refracting edge of the prism, and not crosswise.

The resolving power of a grating depends on the number of lines used on the grating and on the order of the spectrum. It is the same in all parts of the spectrum of one order, whereas the resolving power of a prism increases very rapidly toward the violet, where it is seven or eight times as great as in the red.

Professor Schuster takes as the unit of resolving power that power which is necessary to separate lines differing by the thousandth part of their own wave-length. A spectrum in which such lines can just be separated has unit purity. The resolving power of a spectroscope is numerically equal to the greatest purity of spectrum obtainable with it.

The *D* lines are very nearly one-thousandth part of their own wave-length apart. Hence the spectroscope considered above, with a prism one centimètre on the base, would have a resolving power of unity for sodium light. A grating with one thousand lines would have unit resolving power in the first spectrum.

The great advantage of a grating over a prism in regard to resolving power is apparent from the figures which have been given. A resolving power of 100, which is easily realised in large gratings of modern construction, would theoretically require a thickness of one mètre of glass if obtained by prisms, and doubtless it would actually require much more if enough light were left after passing through the prisms to make the experiment practicable.

When there is paucity of light, the full resolving power of a spectroscope cannot be realised.

For efficiency in regard to resolving power a large aperture of the spectroscope is an important condition, as we have shown it to be in most cases from another standpoint, for brightness.

Almost all our space has been devoted to a consideration of the compound spectroscope, as it is the only form with which exact comparisons of spectra are possible. For merely seeing the spectrum very simple spectroscopes suffice. The McLean star

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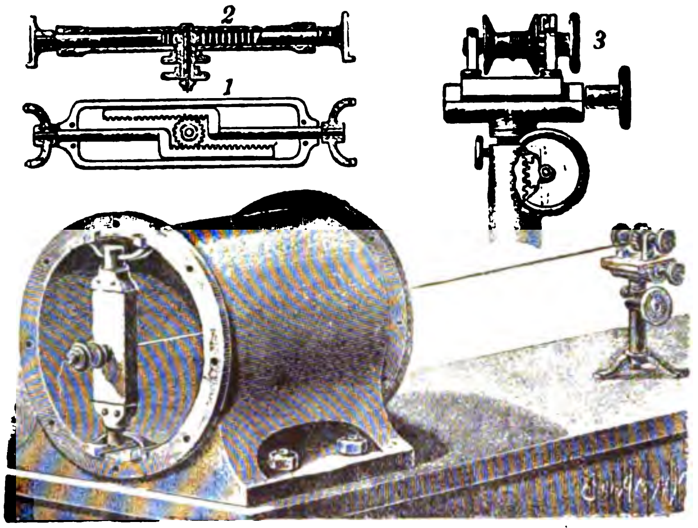
[*] From the *Sidereal Messenger.*

[*] The same remarks apply to the case when a considerable length of slit is used, as in observing any extended surface, the cylindrical lens being dispensed with.



spectroscope, which is much used for looking at the spectra of stars has no slit, and therefore cannot be used for any other purpose. In all instruments of this kind which I have seen, the spectrum is made unnecessarily wide, and correspondingly weak by using a cylindrical lens of too short focus. A somewhat similar combination of a small direct-vision prism and a cylindrical lens, placed on the eye-piece of a telescope so as to receive the emergent beam, will give good views of stellar spectra.

Such spectra are necessarily of small resolving power; but as the prisms required are very small, but little light is lost by absorption, and they give brilliant spectra.

It has been impossible to mention in this article the optical and mechanical features of the great variety of forms which have been given to the spectroscope, but a fair judgment of the efficiency of any particular form for its intended purpose may be based on the general principles which have been explained. The mechanical execution has much to do with the "efficiency" of an instrument, not in the limited sense in which we have used the term, but in its more usual application. Even mechanical defects which are apparently trivial, such as the division of a micrometer head into any number of parts but one hundred, or the marking of a scale by longer lines in any other way than by fives and tens, by causing annoyance and loss of time to the observer, possibly even mistakes, detract from the usefulness of the instrument. The mechanical appliances should be such as to afford the greatest facility for adjustment and accurate measurement, as well as to give proper support to the optical parts.

ASSEMBLING PARTS OF ENGINES.

THE apparatus shown in the figures is designed to avoid the tedious work of calipering in assembling the parts of an engine, and is patented by Messrs. Hunt and McKechnie, of New Westminster, British Columbia. Adjustable heads having central openings, and adapted to be secured in the ends of the bore of the cylinder, are shown in plan and sectional views in Figs. 1 and 2, the cord holder to be used in connection therewith being shown in Fig. 3. In the casing of each head slide racks with rods extending in opposite directions through the ends of the casing, arms at the outer ends of the rods having each a lug adapted to abut against the end of the cylinder. The racks are in mesh with a pinion having a hollow hub, on one outer end of which is a nut to lock the hub and pinion in place after adjustment of the feet, while on the extreme outer end of the hub is a knob to turn the pinion to move the racks inward or outward, there being in the end of the hub a bushing with an opening to be used for sighting, or through which may be passed a cord. The cord-holder has a hollow part in which slides a rod having on one side rack teeth, meshing with a pinion which may be turned by a hand-wheel to move the rod up or down, there being a set-screw to hold the rod in adjusted position. On the upper end of the rod is a frame with guideways in which slides a laterally adjustable plate, on top of which are standards carrying a spool, to which is attached the cord to be passed through the openings of the bushings in the heads, there being on one of the faces of the spool a ratchet-wheel engaged by a pawl, whereby the spool may be locked in place when the cord has been drawn tight. By this quickly-obtained vertical and lateral adjustment the cord can be brought to the exact axial line of the cylinder (says the *Scientific American*), and the other parts of the engine can be readily laid out or set on a frame to be in proper alignment therewith, the slides for the crosshead, the bearings for the main shaft, &c., being at once located in the proper place.

USEFUL AND SCIENTIFIC NOTES.

THE puddlers in the ironworks of Menden and Schwerte, in Westphalia, are now provided with furnace shields to protect them from the intense heat. The shield is an iron screen hung from a rail overhead, which can be pushed aside when not required. The upper edge next the furnace carries a perforated pipe from which cold water runs down the screen to a gutter formed on its lower edge, and thus keeps the screen cool.

Telephones.—By a stupid error, the name of Messrs. J. T. Gent and Co., Faraday Works, Leicester, was omitted last week from our back-page "Directory." We mention it, because we know no firm to which a reader seeking for quotations or information about telephones and other electrical appliances could apply with more reasonable certainty of good work, prompt attention, and fair charges.

A New Cure for Injured Heads.—Blows on the head, causing inflammation of the brain of the severest kind, can now be cured by lubricating all the internal membranes of the nose with glycerine. This causes water to descend by the nose and throat so abundantly that the brain is thereby relieved, and headache removed. This discovery has been made by Mr. James Johnstone, 8, Merchiston Park, Edinburgh, who has issued a small pamphlet containing details of this cure, and the results from it, entitled, "The Action of Glycerine on the Brain."

Mountains and Valleys.—In an article on mountains and valleys, interesting mechanically, but not containing any novel theory, Mr. Warren Upham, in the *Popular Science Monthly* for September, says the strata forming the upper part of the earth's crust are bent up and down in long, nearly straight or curving, wave-like ridges and troughs, and where their disturbance was greatest the successive ridged folds are closely pressed together. The waves of the rock structure are then pushed to such steepness that their sides become parallel with each other, and the entire fold is driven forward into an inclined position. The order of the strata on the lower side of the oppressed fold is thus inverted; the originally highest and last formed deposits there lie beneath older beds, in an overturned series. Sub-aërial erosion then wears down the undulations and the crests of the closely-folded strata, often planing them off until a long section, crossing mountain ranges, passes from older to newer beds, and onward from newer to older, in several alternations, having throughout the whole a nearly constant steep dip. Owing to the interbedding of hard and enduring sandstone, quartzite, gneiss, and other rock formations, with more easily eroded limestone, shales, incoherent sandstones, or schists, the erosion commonly produces a new topography, making hollows and long valleys where the more erosible beds have been removed, and leaving ridges and mountain ranges of the harder rocks. More than this, when erosion has been continued through very long periods, it tends towards the ultimate result of removing the upward curved or anticlinal portions of the great folds, and sparing the originally lower downward curved or synclinal portions, until valleys take the places which were originally occupied by the highest upheavals, while the original troughs, where the rocks were most compact by pressure, remain now as the principal mountain ridges.

SCIENTIFIC NEWS.

SOME time back Mr. E. E. Barnard observed a nebula in the Pleiades so close to Merope that it was buried in the brilliant light of that star. Mr. Burnham has recently made some measures with the great Lick telescope, and says that the nebula is one of the most singular and interesting objects in the heavens. In respect to its nearness to a bright naked-eye star, it is unique, the distance between the centres being less than 40″. Mr. Burnham says there may be other examples, but no other has ever been discovered. This close association of a faint nebula and one of the prominent stars of the Pleiades is, he says, an interesting fact, whether such association is accidental or otherwise. His measures are given in *Ast. Nach.* No. 3074.

Another small planet (No. 324) was discovered by Dr. Wolf, of Heidelberg, on Jan. 20, at 7h. 4m., Vienna time. The position was R.A. 3h. 50m 6s., N.P.D., 67° 42′ 26″, with a daily motion of + 12s. and − 2°. It was of the 11th mag. On Dec. 22 last, it will be remembered, Dr. Wolf discovered No. 323 by photographic means.

The small planet discovered by M. Charlois, of Nice, on Sept. 4th last (No. 315), has been named Constantia.

At a recent meeting of the Paris Academy of Sciences, MM. Fabre and Andoyer, of the Toulouse Observatory, exhibited some photographs of the eclipsed moon taken on Nov. 15 last, on collodio-bromide and collodio-chloride plates, treated with eosin and cyanin to make them orthochromatic. The collodio-bromide plates were found to have yielded the best results, and will be employed to photograph the red spot on Jupiter, Mars, and coloured stars, as when rendered orthochromatic they are more sensitive to red and yellow rays than the collodio-chloride plates.

Astronomy and Astro-Physics is the new name of the *Sidereal Messenger*, and in the No. for January a large amount of space is devoted to Astro-Physics, several interesting papers having been sent. That department will be under the care of Mr. G. E. Hale, Kenwood Astro-Physical Observatory, Chicago, while Mr. W. W. Payne, Goodsell Observatory, Northfield, Minnesota, U.S.A., will take charge of the department of General Astronomy and the business conduct of the publication.

The crown disc for the great 40in. refractor which is to be placed on a lofty point in Southern California, is reported by Messrs. Alvan Clark to be perhaps the finest piece of glass they have ever seen. Some delay has been experienced owing to the difficulty found by M. Mantois, of Paris, in moulding the flint disc, but as soon as that is received the Messrs. Clark will commence to grind the lenses.

The death is announced at the age of 71 of Dr. Frederic John Wood, chairman of Convocation of the University of London.

The Hon. Walter Abbott Wood, the inventor and founder of the manufactory of the harvesting machines well known all over the world, died at his residence at Hoosick Falls, New York, on the 15th inst., from the effects of influenza and pneumonia, aged 76. He was one of the earliest and largest makers of this class of machine, beginning in 1852; since which time he and the company of which he was president have made nearly a million machines. They made the first wire and string self-binders ever sold. Mr. Wood had had conferred upon him the Legion of Honour by the Emperor Napoleon III. at Paris in 1867, and the Francis Joseph Cross by the Emperor of Austria at Vienna in 1873. He represented his district in the American Congress for four years, from 1878 to 1882.

Lecturing last week at the Royal Institution, Lord Rayleigh referred to the decomposition of water and atomic weights. The investigations of chemists with respect to hydrogen and oxygen had varied, he said, but not within great limits. In 1842 Dumas thought that the weight of oxygen was 15·96 times that of hydrogen, and Regnault, in 1845, came to the same conclusion. It was, of course, not improbable that this slight deflection from the exact number, 16, arose from error of calculation. For a long time this question slumbered, and it was not for 40 years that attention was again directed to it. He had himself in 1888 arrived at the conclusion that the right proportion was 15·884 to one; and other chemists, both in Europe and America, had published the results of their inquiry, which all gave figures between 15·7 and 15·9. The real difficulty arose from the extraordinary lightness of hydrogen, which was only 1-14th as heavy as the air. The glass in which the weighing was done might be 200 grammes, whilst the hydrogen contained therein was only 1-10th of a gramme. Our brass and platinum balances were accurate enough to record infinitesimal weights; but that was not the crux. The atmospheric conditions might cause a greater disturbance than the weight of the hydrogen. To meet this difficulty Regnault had devised a method of weighing two glass vessels as similar to each other as possible against each other, so that each would be affected in like manner by any sudden changes of external conditions. The effect of moisture or change of barometric or thermometric conditions might be very different as between platinum weights and glass; but with two glass vessels constructed precisely alike the difficulty was eliminated.

At the same institution on Saturday last Prof. Fleming began a course of lectures on the "Induction Coil and Transformers," and promised at his next lecture (to-morrow) to show some experiments with the great induction coil made by Mr. Apps for the late Mr. Spottiswoode, by far the largest coil ever constructed.

The work by Mr. G. J. Romanes, F.R.S., entitled "Darwin, and after Darwin," will be divided into five parts—Evolution, Selection, Heredity, Utility, and Isolation. The first of the two volumes, comprising parts one and two, will be copiously illustrated, and sold separately as a handbook of distinctively Darwinian doctrine. The other parts will deal with various theories—notably that on Heredity, which will discuss Dr. Weismann's views. Messrs. Longmans are the publishers.

The forty-fifth annual general meeting of the Institution of Mechanical Engineers will be held on Thursday and Friday, Feb. 4 and 5, at 25, Great George-street, Westminster. The annual report will be presented on Thursday, when the officers and council will be elected. The president, Mr. Joseph Tomlinson, will retire, and will be succeeded by the president-elect, Dr. William Anderson. The following papers will then be read and discussed, as far as time permits:—"Notes on Mechanical Features of the Liverpool Waterworks, and on the Supply of Power by Pressure from the Public Mains, and by other Means," by Mr. Joseph Parry, water engineer, Liverpool—Thursday. "On the Disposal and Utilisation of Blast-Furnace Slag," by Mr. William Hawdon, of Middlesbrough; communicated through Mr. Charles Cochrane, past-president—Friday.

Mr. Angus Campbell, a native of Hamilton, Ontario, but resident for some years in the United States, has, it is said, invented a "cotton picker" which will save many millions of dollars a year. His machine, wich has been tried at Waco, Texas, will pick the ripe bolls, and leave the unripened ones and flowers for a later picking. It is stated that it costs approximately a hundred million dollars annually to pick the cotton crop of America. Mr. Campbell, it appears, occupied about seven years in working out his invention to its present degree of perfection.

Prof. S. P. Thompson calls attention to the results of the tests on the efficiency of the "electric transmission of power" from Lauffen-on-Neckar to Frankfort. For three months, he says, the result of the elaborate tests applied by the jury of experts under Prof. Weber, of Zurich, has been anxiously awaited. Now that the tests are completed, it is gratifying to know that the prophets of evil have been disappointed. To put it briefly, the final result is as follows:—When 113H.P. was taken from the river at Lauffen, the amount received 110 miles away at Frankfort through the wires was about 81H.P., showing an efficiency, in spite of all possible sources of loss, of 72 1-6 per cent.

Electric lighting has been adopted in flour-mills for very good reasons—the absence of naked flames. It is stated that some large mills now being erected at St. Louis are to be run by electricity entirely, and that if the experiment proves a success, all the immense mills at St. Paul and Minneapolis, including those of the Pillsbury English Syndicate, will be driven electrically by power transmitted from the Falls of St. Anthony. It is in this direction that electricity has a much more promising field of usefulness than it has in the way of lighting, especially when water-power can be had for the mere cost of the machinery. It is probable that at the Chicago Exhibition an effort will be made on a large scale to show what can be done in the transmission of power by electricity.

The pneumatic method of transmitting parcels is to be tried in Chicago. The Illinois Central Railroad Company has granted the Pneumatic Transit Company the right to lay tubes along its road-bed from Randolph-street to the World's Fair grounds. It is proposed to use tubes 1ft. in diameter, and the system is intended to comprise an application of electric switches to divert carriers to intermediate or way stations. It is expected to require a year to build the line, and a connection with the Post-office, for the despatching of mails, is projected.

In Hamburg it is proposed to extend the pneumatic system to a passenger service from Hamburg to Boshen, about 15 miles. The distance, it is expected, will be covered in 11 minutes. The tube will be made by the Mannesmann process, and will carry a car about 7ft. wide and 3½ft. long, capable of holding three persons.

The Council of the Royal Geographical Society have determined to give occasional courses of lectures on geography in connection with the society. Mr. H. J. Mackinder, Reader in Geography at Oxford, will deliver the first, either in the spring or next autumn.

Although Paris, unlike London, is comparatively free from influenza, the disease is raging in many parts, notably in the coal-mining department of the Pas-de-Calais. No spot seems to be free from this epidemic febrile catarrh, to which the name *la grippe* was given by Sauvages when he first described the epidemic of 1743. It is stated that a specific has been found in potassium bicarbonate administered in rather large and frequent doses; but it seems that the faculty know no more about the disease than they did a hundred years ago.

Refining Copper.—In a patent for improvements in refining copper, the patentee, Mr. J. C. Bull, of Erith, points out that in the purification of copper by the Bessemer process the heat furnished by the combustion of the impurities is not sufficient to maintain the metal at a suitably high temperature. In order to secure this high temperature, the patentee introduces an oxidising substance, such as Chili saltpetre, into the molten metal. This is effected by providing a cavity at the bottom of the converter in which the nitrate is placed, and which communicates by perforations with the body of the condenser. When the molten metal is poured into the converter, some of the metal finds its way through the perforations into the cavity beneath, and the heat from the metal decomposes the nitrate, and causes a stream of oxidising gases to rise through the metal in the converter. Or the nitrate in a fused state may be forced by air pressure into the perforated cavity. Or, lastly, an ordinary Bessemer converter may be used, the nitrate, in a powdered state, being supplied by an automatic feeding arrangement to the current of air. The converter is lined with ganister, or a mixture of sand and clay, and the metal is covered with a suitable silicious slag.

St. Paul's Cathedral Clock.—After much consideration of plans (says the *Building News*), the Dean and Chapter have just commissioned Messrs. John Smith and Sons, Derby, the well-known clockmakers, to make a new clock to replace the old one in the south-west tower of the cathedral. The old clock strikes the hours on the old "Phelps" bell, but the new one will strike upon "Great Paul," which is nearly seventeen tons weight, with a hammer weighing 680lb. The quarter-chimes will be struck much the same as before, but provision will be made in the clock so that chimes on four bells may be added at a future time. The two dials, which are 16ft. diameter, will be unaltered, except that the central part will be arranged for illumination at night. The clock movement will be a very large piece of machinery, designed by Lord Grimthorpe, and it is guaranteed by Messrs. Smith and Sons to keep time with very great accuracy. There will be special precision apparatus, whereby the first blow of the hours will fall within one second of Greenwich time, and the first blow of the three-quarters will also strike with the same accuracy. Some idea of the great size of this clock may be formed when it is known that the hammer which strikes the bell is 680lb., while the hammer which strikes "Big Ben" at the Houses of Parliament is about 450lb.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

*** In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

SIR R. S. BALL'S FALSE "CAUSE OF AN ICE-AGE."

[33106.]—THIS book, by the Irish Astronomer-Royal, is a most wondrous example of mathematical diligence misapplied to bolster up a false world, Lyell's ridiculous theory of a world without catastrophes. As we have never lived in Lyell's imaginary world, but in this actual catastrophic world, liable to cometary impacts as frequent, on the average, as above four per million years, of course, I totally disbelieve Sir R. S. Ball's "Cause of an Ice-Age." The real cause I admit to have been the earth's gradual cooling by radiation. But when this had reduced her to the most glacial condition about 50 centuries ago, in Noah's time, I hold with Halley and Sir Isaac Newton that a comet overtook her from behind and precipitated its whole substance upon her, consisting of about 15,000,000 cubic miles of water, and a smaller quantity of air. The water raised the seas to their present level, while the addition of air, raising the sea-level barometer perhaps some inches, gave us the warm climates, now cooling far more slowly than in Antediluvial times.

Sir Isaac Newton can at no time have known or guessed comets to be one-quarter so numerous as we know them to be. Yet he saw that they proved the earth's history to be catastrophic. Auguste Comte, the inventor of "Positivism," took the same evident truth. *System of Positive Polity*, Engl. tr. I. 410. "Scientific knowledge of planetary relations destroys the sense of absolute security from all possible risk of disturbance . . . . Collision with a comet, for instance, is a danger from which it can never be proved that we are really free." He shows the ethical value of this fact, and the utter mischief of ignoring it, like his present countryman Flammarion. The late C. Darwin, on the contrary, prated about "300 million years" for certain of his denudations, without a hint of how many comets the earth must pass through or pick up in that time! Present statistics would have readily shown him their number to exceed 1,200. When Sir Robert Ball then ends by saying his theory is "non-catastrophic," that is equivalent to saying it is unnatural and false.

In Sir R. S. Ball's very needless theory, however, are some questionable points. In p. 79 he says that with the eccentricity of the earth's orbit varying, "it can be demonstrated that the total quantity of heat which the earth receives during each complete revolution will be inversely proportioned to the minor axis of the ellipse." Without having seen this demonstrated, it is a point I have for many years taken for granted, but I now regard it as certain. Suppose the sun a mere point, and that the orbit were reduced to a straight line, with no minor axis at all, the receipt of heat would become infinitely great at the moment the earth and sun coincided, though but once a year. Sir R. Ball speaks of some who call the Ice Age an effect of greater heat; but, in fact, he himself holds it to be so.

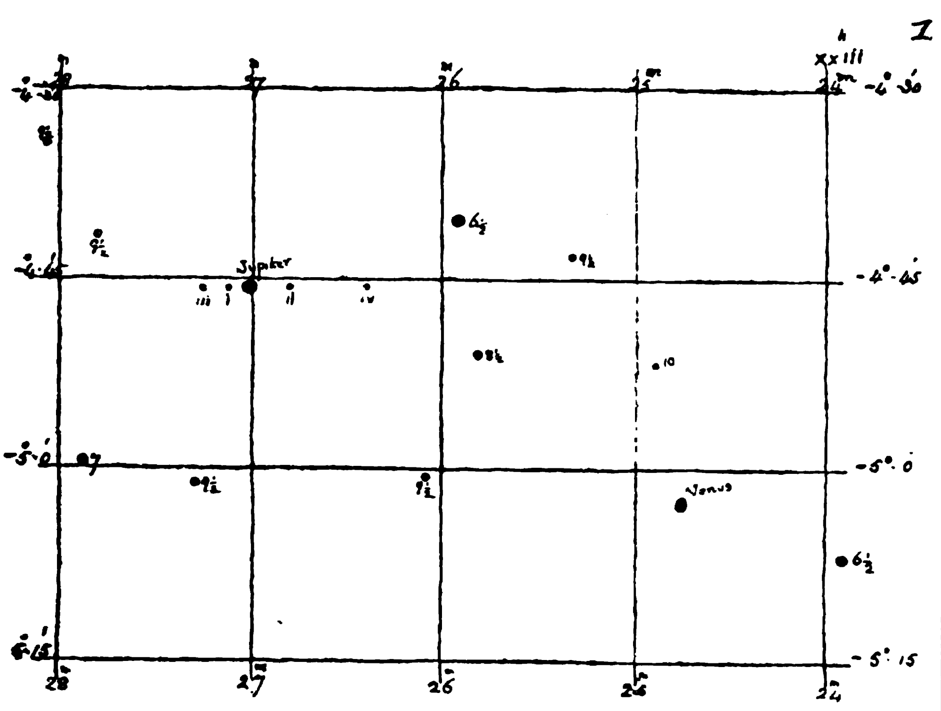
In p. 95 is one obvious error, that "with the present eccentricity of the earth's orbit, the greatest possible difference between summer and winter would amount to 33 days." With the present eccentricity it certainly could not exceed eight days, which was its amount about six centuries ago. But higher in that page he says: "The number 465, multiplied by the eccentricity, expresses the difference in days between the length of the two seasons." In Appendix, p. 177, he also says: "The maximum difference between the length of summer and winter is thus: 465 days × eccentricity."

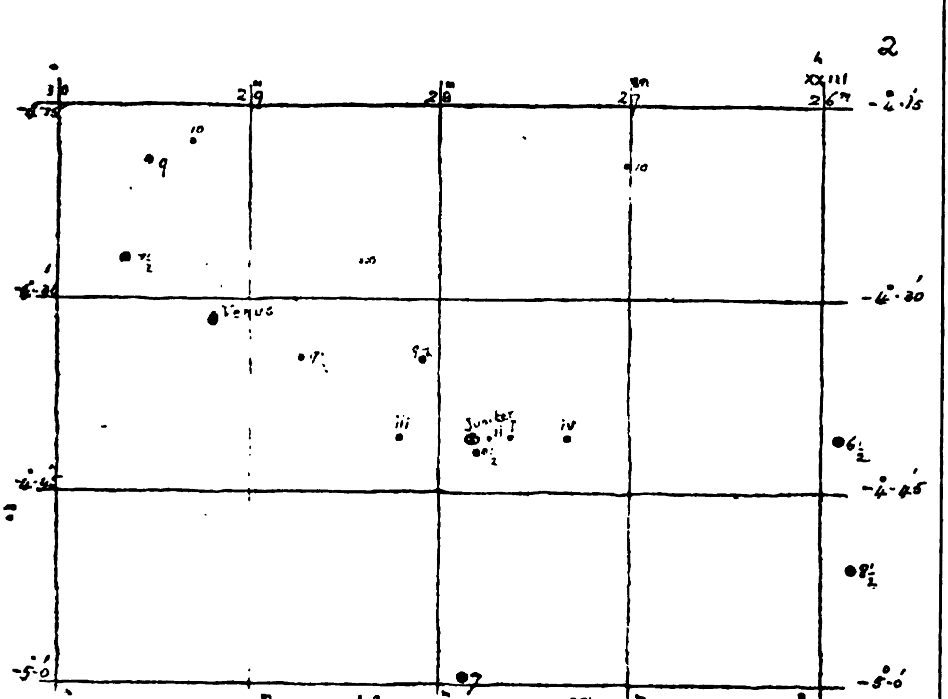
But suppose the eccentricity were 0 9. The two seasons would differ then by nine-tenths of 465 days, or more than a year. I thought at first that 465 was a misprint for 365; but this works no better.

465 × 0·0745 gives, not "33," but near 35.
365 × 0·0745 gives . . . about 27·5.

I cannot but think some application of the eccentricity, or perhaps its square, to 365 will give the true difference; but has it here been deduced?

E. L. Garbett.





CONJUNCTION OF VENUS AND JUPITER.

[33107.]—The conjunction of Venus and Jupiter, which is predicted to take place at 10h. 14m. a.m. on February 6, unfortunately occurs after sunrise in Europe; but as the planets will be close together after sunset on the evenings of the 5th and 6th, I have thought that two diagrams of the appearance of the field of view with a low power at 7h. p.m. on the evenings of the 5th and 6th (Figure 1 representing the appearance of the planets and the stars surrounding them on the 5th, and Fig. 2 on the 6th) might be of interest to some of the readers of the "E.M." Marth gives the distance of the limbs, geocentrically, at the time of nearest approach as 18·4″, the equatorial diameter of Jupiter being 34·04″, and the diameter of Venus 13·52″. The brightness of Jupiter is only about one-half of what it was in the middle of last September; and the brightness of Venus, as compared with what it will be on June 4, is as 69 to 184, $\frac{83}{100}$ of the disc being illuminated. At about 2h. 40m. p.m. on the 5th, Venus will be in conjunction with, and about 50″ South of, the 6½ magnitude star B.A.C. 8184, shown just outside the border of Fig. 1; and at 6h. 10m. p.m. on the 6th, Jupiter will be in conjunction with the 9·5 mag. star S.D. −4°, 5903, the star being about 20″ south of the planet's southern limb. The figures attached to the stars are the approximate magnitudes in the photometric scale.

H. Sadler.

THE QUADRANTIDS.

[33108.]—In reply to Mr. Booth's query, letter 33087, I regret I am unable to give the time of maximum display, the sky being overcast here from 12 till 2 a.m., local time. After this, however, they appeared steadily up to 3.30, when they apparently slacked off. I may mention I saw no quadrantids during the previous or following evenings; but on the night of the 6th I saw a large meteor from this region, which at once suggested itself to me as a straggler. I am pleased to see that Mr. Corder and I confirm each other as regards radiants that night at 181° + 20° and 210° + 19°.

Dublin, Jan. 23. **W. H. Milligan.**

RAIN WITHOUT CLOUDS—A SIDEREAL TIME WATCH—A SWARM OF SUNSPOTS.

[33109.]—On Friday night, 22nd inst., at 10.56 I went into the garden for the purpose of consulting the thermometer. A considerable haze, such as has been by no means uncommon of late, dimmed the lustre of Sirius, Rigel, and neighbouring stars; but, at a greater altitude, Castor, Pollux, Capella, Aldebaran, and their compeers shone quite brilliantly. I could detect no trace of a cloud over any portion of the visible sky, yet a brisk shower was falling. Is not this something out of the common way? I remember having read somewhere many years ago that rain did sometimes fall from a cloudless sky; but the mystery of invisible condensation of the aqueous vapour was not even noticed.

Being the possessor of a 17s. 6d. Waterbury watch for which I have no other use, I some time ago conceived the idea of regulating the same to keep sidereal time, and finding a place for it in my pocket. As it answered the purpose most admirably (Waterburys really seem to be excellent timekeepers) I decided to elaborate it a little. I consequently removed the seconds hand, and attached to the dial underneath the hour and minute hands a disc of highly glazed paper ruled with a fine pen from centre to circumference into 5° spaces. A watch in which the hour hand revolves once in 24 hours would be decidedly better; but, as it is, I have marked the first 12 hours and their corresponding higher numbers in their proper positions as follows:—$\frac{1}{13}$, $\frac{2}{14}$, and so on. Midway between centre and circumference of the disc I have described a zone $\frac{3}{16}$in. in width in which to plot down with a fine pointed soft lead pencil the planetary symbols in their respective R.A. The space between this zone and the centre of disc I have devoted to the principal stars of the N. Dec., plotted down in ink; and the space between the zone and circumference to stars of S. Dec., taking care to indicate in the case of this $\frac{12}{24}$ arrangement for both planets and stars, whether R.A. 4 or R.A. 16; R.A. 5 or R.A. 17 is meant, by attaching the number of the hour to the name or symbol. Now each of the 5° spaces above mentioned corresponds to 10m. R.A.; consequently it is an easy matter every fifth day to take from the "E.M." or *Whitaker's Almanack* the R.A. of sun, moon, and planets, and lightly pencil down the symbols of each on the disc with a close approximation to the truth, to be erased and readjusted after five days have past. The names of the Zodiacal constellations are also described in the spaces between the respective hour numbers. I find this little arrangement exceedingly useful, being all day occupied in the Strand, where it has for months past been as difficult to glimpse a bit of clear sky as it is to meet with a person who does not grumble. The hour hand of the watch corresponds to the meridian, so that one sees at a glance not only the sidereal time, but also what planet or noticeable star is thereon, or rising or setting.

At 12.30 p.m. to-day I counted no fewer than 21 spots, large and small, on the sun's disc, viewed through a 3in. refractor, power 80. Tried 150: a large spot in northern hemisphere seemed to be bridged completely over, but definition was far from good. There was a fine cluster of 12 or 14 spots, various sizes, not far from W. limb. Should like to hear something about them.

William Godden.

TELESCOPES AND TROOPSHIPS—CARBOLIC ACID AND INSECTS—FAINT STARS—PRICE OF MANUFACTURED SILVER.

[33110.]—I am greatly obliged to Mr. Sadler (letter 32941) for the trouble he has taken in making out for me a list of test stars, with latest measurements. It will be very useful to me. I must also apologise for not noticing the remarks of "F.R.A.S." (letter 32762, p. 133) and of "Sm." (letter 32769, p. 134) on the fungoid growth on lenses of my telescope. A friend in England has "first read" of my copies of the "E. M.," and forwards them to me, and, unfortunately, the number for October 2 got lost, and I have only just received it. In answer to "Sm.," I at first suspected myself that the spots were due to the cause he mentions; but as they persisted on separating the object-glass lenses, the proof of their substantial existence was manifest. Moreover, some of the spots are of eccentric form, like an acarus under the microscope. I have followed "F.R.A.S.'s" advice, and scrubbed thoroughly with pure alcohol on cotton wool, but with no effect whatever. However, they do not at all injure the definition, and obstruct little light, but I should like to know their cause and composition. This is a terrible climate for destroying instruments. My lacquered brass telescope is now an ugly tube of dull colour, spotted all over with black discs the size of a pin's head to a threepenny-bit. Nickel plate suffers in the same manner. Can "Eos," or "F.R.A.S.," or any other travelled contributor to the "E. M." explain? Is it due to flies, or cockroaches, or to damp heat?

I find that the one thing which insects will not face is the smell of carbolic acid. The powder impregnated with the acid is invaluable for putting in tins wherein to stand the legs of tables, bottles of sweets, sugar, &c. The ants are completely baffled by it, and it lasts for months without renewal.

Christmas Eve was a remarkable night for faint stars. It was a dead calm, and a heavy dew falling (a rare occurrence here). The sky was like rich black velvet, on which the stars shone like electric lamps. Definition was bad, but faint objects very strikingly visible. The zodiacal light could be traced beyond Jupiter, and was very bright towards the horizon. With my 3½in. (which with the spots on the o.g. cannot be more than equal to a 3¼in. in light-grasping power) the faint *comes* to λ Orionis was constantly held (power 80). Five stars could be seen in the Trapezium, the fifth being about midway between the two lower stars of the trapezium (in inverting telescope). To the naked eye numberless stars were visible not shown in Proctor's "Star Atlas." I tried Aldebaran, and glimpsed a *comes*, but found it much harder than either of the faint stars just mentioned. The next night definition was perfection, but not a glimpse could I get of the Trapezium star or of the *comes* of Aldebaran. Δ Orionis was just visible by averted vision. After which experience I am very sceptical of the possibility of laying down any general rule for visibility of star magnitudes in given apertures.

Some years ago I asked a question in the ENGLISH MECHANIC, to which I received no answer. There must be some jewellers and silversmiths who read this journal, and therefore I will appeal to them again to tell me why the price of manufactured silver is so high. For example, if a silversmith offers me an electro-plated teapot for the sum of £2, it appears to me that, at a most generous calculation, the price of an identical pattern silver one, weighing, say, 10oz., should be arrived at thus: Price of material, say, £2; workmanship, £2; one year's interest on outlay of £4, at 10 per cent., 8s. Total, £4 8s. It will be observed that I have allowed the whole price of the electro-plated article for the making of the silver, plate dealer's duty, &c.

Now, what I want to know is why, the electro-plated teapot being priced at £2, I should be expected to pay, say, £9 for the silver article? If anyone can explain this, I am sure many readers of the "E. M." will be interested. I am very certain that any manufacturer who will sell silver goods at a fixed cost for workmanship, profit, and interest on outlay, and so much per oz. for the metal contained in the articles themselves, would have a good sale for his wares now that the silver duty is removed. Personally, I should consider it a waste of money to buy electro-plate could silver be had on reasonable terms, and I am sure I am not the only person of such opinion. Most assuredly I am not going to pay 15s. or £1 per ounce for a teapot made of metal whose intrinsic value is somewhere between 3s. 6d. and 4s.

Can any reader give me a hint as to preserving some large, fat-bodied spiders? They will not dry up if kept in the open, but burst, and turn putrid. In spirits they also burst after a few days. Their bodies are most inordinately fat, like a plum pudding in shape. I wish to preserve them for a museum. **T. Preston Battersby,**

Barbados, Dec. 29. Capt. R.A., F.R.A.S.

SHAPING MACHINES.

[33111.]—MILLING and shaping machines should be useful tools in a small way, and I believe that some are made for use in amateurs' workshops; but I mention the matter to call attention to the following, which I find in an American paper by Mr. J. Lang, which may be useful to those who have shaping machines.

The common double-spindle shaper is a peculiar machine to keep in order, on account of the manner it is fitted up. On an ordinary shaper, to fill the requirements, the top of the spindle must be of small diameter, to receive small collars, to get into small curves, and there must be enough clearance between the knife and the spindle. This causes the top part of the spindle to be very small. We generally have two or three changes of collars—that is, in diameter. Some builders furnish with their machines one set of collars about 1½in. diameter, one set 2in., and one set of 3in. collars; while others furnish one set only about 2½in. in diameter.

Now, to accommodate the small collars the top of the spindle has to be three-fourths or seven-eighths of an inch in diameter, and one about 4½ to 6in. long, sometimes longer; and these spindles, to do anything like good work, must make 4,500 turns a minute. Suppose these spindles are a least bit out of true. They are a failure for good work. They will tremble and jar, and the work they produce will be wavy and chattered. In a new shaper, to all appearances a first-class machine, this often occurs. One of the spindles never runs true, while the other will run perfect in every particular, and never give trouble. The defective one is a continual source of trouble, jarring and always running hot, making a great deal of lost time. All upright spindles on any machine require more attention than level ones. One reason is, the oil does not remain long around the bearing before it is worked off. The top bearing wearing out of line with the bottom or step bearing when frequent taking up, causes the spindle to be a little cramped. This produces an unsteady jar and poor work. Other defects are the unsteady whipping motion of the quarter-turn belts chasing up and down on the pulleys on the spindles; rubbing against the flanges either top or bottom; sometimes not enough room for clearance of belts between the castings; continual slapping against the corners, which are always sharp, soon destroying the life of the belts; sometimes the hangers are too high on the countershaft, causing the belts to run up too high, and the frame of the shaper is raised; the table is too high for a medium-sized man, so a platform has to be built around the work end of the table to stand in a natural position while operating the machine.

I have seen an illustration showing a shaper with an improvement on the countershaft, two idle pulleys or binders inside the two driving pulleys, raising the belts up to a suitable height and preventing the flapping of the belts, causing them to run steadily and true as the side spindle belt on a flooring and ceiling machine. The drum or pulley is placed near the driving pulleys inside machine frame. It prevents the slipping of the belts, and keeps them up in place on the spindle pulley.

Some causes of spindles running unsteady are the yoke or supports being too light, and not firm or strong enough; over-speeding the machine if it be a light shaper. Another cause, when knives are narrower than others, on screwing down the collars with a large wrench and drawing one side of collar out of true, will be sufficient to spring the top or small part of the spindle, and, nine cases out of ten, trying to true up the spindle will be a failure. The cheapest way in the end when this trouble is met with is to order a new spindle. The general run of shaper spindles are about 1½in. in diameter—that is, the largest part. If shaper spindles could be as large above the top of table as they are below the table, there would be a great deal less trouble to keep them in order. To my idea, the top part of the spindle to receive the collars should be not less than 1⅝in. in diameter, the lower part the usual size.

Another reason why shaper spindles often give trouble is this: The small or top part is long and slender, and must sometimes resist a hard cut with nothing to support the top end, causing it to tremble. It can be seen by the cut it produces, which is often a little wavy. We may take, for comparison some of the small moulders with the outside support or bearing. The shaft is small, and without this support would tremble and do bad work. Of course, some will say there is a difference in the size of heads; but to my idea the principle holds good on the shaper as well as on the moulding machine. Inside moulders do better work than outside moulders, on account of a good bearing each side of the head, causing a steady, firm motion to the cutting cylinder. Would it not be an improvement on the shaper if there could be a top support to the spindle? I think I hear a great many say it would be in the way, and would not be practicable, and too much time would be consumed in changing cutters and collars. Perhaps it would be; but the time will come when the shaper in use at the present day will be greatly improved upon, and will be safer to operate.

I know this is nothing new, that all medium-sized shapers should have large collars for each spindle, about 4in. in diameter, in addition to the small ones. The collars should be about 4½in. in diameter, to suit the cut of an ordinary sticker-head. In a case of emergency the sticker-head can be put on the shaper and used for some work where there are knives to fit the sticker head, and not the shaper collars, which is very often the case. A better plan is to have a pair of heads just like the sticker, only the bore to suit the shaper spindle, which is always smaller. It will pay for itself in a short time, and a great deal of work can be done in a short time. Large shaper collars are always better than small ones for square work, such as heading pickets to a Gothic point, and other work of this kind. A good rate of speed is necessary for all shapes, large and small. The ordinary collar being small, the cutting movement in feet must be made up, and, of course, the spindles have to be speeded up to 4,500 turns to do any kind of satisfactory work; they should never be speeded less than 4,000 turns. If they are, they are more dangerous to operate, on account of the nature of the work they do.

Some mechanical experts recommend this manner of operating shapers, namely: In arranging shapers always drive them at as high a speed as the spindles and bearings will stand. The small diameter of the head requires this to attain anything like a standard speed with the cutting edges; besides, it insures greater safety to the operator. The weight and inertia of a piece will often prevent it catching at a high speed when it would be drawn in at a slow speed. This is true in some respects and in others not. To overspeed any machine is a great mistake, and is often done through a false idea that a big amount of work can be done, that cutters will work better if they are run at very high speed. It soon wears out a machine and makes it a rattle-trap, besides the extra cost of belts, frequent babbitting, hot boxes, delays in tinkering with the machine, &c., which is sure to follow. A set of spindles properly fitted up should run at 4,500 turns a minute, which, with heads or collars 2½in. in diameter, gives a cutting movement of a little less than 3,000 feet a minute, and with larger collars, which all shapers should have, a great deal more as the diameter increases in size.

The step bearings of these machines should be as long and nearly as large in diameter as the top bearings, arranged to be flooded with oil. The countershaft should set about 8ft. from the spindles, to give a good, easy-running belt; too long a distance from spindles to countershaft will cause a flapping motion to belts, and make the machine run unsteadily. Do not use knives that are of an uneven width, which causes a strain on the top part of the spindle when screwed down or secured, and will injure the shaft if continued. Use a pair of calipers and bring the cutters to an exact width when they are first made.

As to blanks for shaper cutters, have on hand several bars of best cast steel, ¼in. by 1in., ¼in. by 1½in., ¼in. by 1¾in., ¼in. by 2in., ¼in. by 2½in., and wider, in such proportion as the nature of the work may require. Cut these bars up into lengths of about 2ft. each. Send them to a machine shop to have their edges jointed and bevelled by a planing machine. This will cost but a trifle, and will insure uniform width of cutters, without which no machine can work well, as the spindle is bent to meet any variation of width between the cutters forming pairs. The cutters can be cut from the bars, shaped and tempered as needed.

There is no doubt that a shaper is a dangerous machine to operate, from the fact that the hands are constantly exposed to the cutters; but a careful and thoughtful operator will always be on the alert. The square cutters are just as dangerous as the deep cutters. Nine cases out of ten more accidents occur where square cutters are used than where long or deep cutters are used. The operator is involuntarily cautious; but with small cutters the man is independent, hence so many accidents. Accidents will occur, it is true; but if machinemen would not become so indifferent there would be less accidents. If the angles of the cutters were obtuse, there would be less danger; but they would not do as good work. An acute angle is the best on account of the nature of the work to be done on these machines. **Three-squared.**

EXPERIMENTS IN ELECTROSTATICS. —II.

[33112.] — *Experiment No.* 4. — *Electrification transferable.*—The apparatus for this experiment consists of a tin can (A, Fig. 2), on one side of which is soldered a brass hook, and which is supported on a glass stand, B. A pith ball, suspended by a thread from a metal stand, is placed so that the pith ball may hang about an inch from the can. Having arranged the apparatus as shown, excite the glass rod and draw it through the hook. It will be found that the can attracts the pith ball, both while the rod is in contact with the can and after it has been removed. On touching the can with the finger, the pith ball at once swings back to a vertical position.

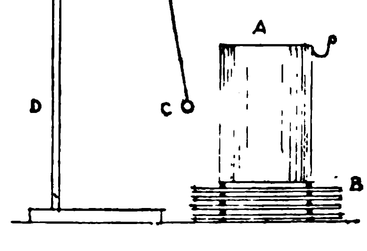


Fig 2 · Experiment 4

This experiment shows in a clearer manner how electrification may be transferred from one body to another. The steps by which this experimental result is established are worth a little further examination.

1. The divergence of the pith ball from the vertical towards the can shows that there is an attraction between them. (We say there is an attraction *between* them because it is a mechanical principle that the pith ball attracts the can with exactly the same force as the can attracts the pith ball.)

2. This mutual attraction is the mark or sign that one of the two bodies is electrified.

3. In the present instance, the can is the electri-

fied body, and it has become electrified by contact with the excited glass rod.

In addition, we further infer from this experiment:—

(i.) That the electrified conditon of a body is not permanent, for the electrification of the can disappears on touching it.

(ii.) That the possibility of a body becoming electrified is dependent in some way on the nature of the substance (in this case, glass) that supports it. When a body is supported in such a way as to be capable of acquiring the electrical state, it is said to be "insulated."

Practical Remarks.—For the above and many other experiments it is necessary to "insulate" a body—that is, to support it in such a manner as to allow it to become and to remain electrified. A body is insulated generally by placing it on an "insulating stand." The following is a very simple method of constructing such a stand. Procure a number of pieces of window-glass about 7in. square. From a piece of sheet ebonite cut out about a dozen roughly cubical fragments. Lay one of the squares of glass on the table. On it place three of the fragments of ebonite, taking care that they lie on their smooth side. Lay the second square of glass on the ebonite supports immediately over the first; then place on it three more fragments of ebonite; then lay down the third square of glass. Continue this process till all the squares of glass are used up. Four squares will generally be found sufficient. The fragments of ebonite should be kept at least an inch from the edge of the glass, and each three should be placed over the intervals between the three below. The glass should be perfectly clean, and it is best to warm it before building up the stand. It must be remembered that insulation depends chiefly on the condition of the surface of the material used to insulate. The efficiency of the stand just described depends chiefly on the ebonite. Hence it is best to cut the fragments from the sheet just before they are used, and in any case they should be perfectly clean and free from dust. One advantage of this form of insulating stand is that dust does not readily penetrate between the squares of glass. In order to keep the metal can in this and similar experiments from slipping on the smooth surface of the glass, it may be placed on a piece of sheet indiarubber, and a couple of pounds of shot put inside the can.

Cork balls may be used instead of pith balls. They should be about ½in. in diameter, and gilt or covered with Dutch metal. (Tinfoil is too heavy for the purpose.) The Dutch metal, which is used by gilders as a cheap substitute for gold leaf, may be made to adhere by first covering the cork ball with a little glue. Cork is most easily cut with a knife having a saw-like edge, such as may be produced by sharpening it on a gritty stone, or with a file. The amateur corkcutter will find a rasp useful for rounding off corners. G. J. B.

INCUBATOR REGULATORS.

[33113.]—In a recent number of the "E.M." information concerning regulators was sought, and in reply thereto several articles have recently appeared from contributors, giving sketches of regulators; but nothing new seems to have been brought out, the sketches being simply reprints from back numbers of the "E.M."

Having devoted a number of years of study and experiment to the subject of artificial incubation, and being familiar with the workings of a large number of the incubators patented in this country, as well as elsewhere, I believe I have acquired some knowledge on the subject, and to which the readers of the "E. M." are welcome.

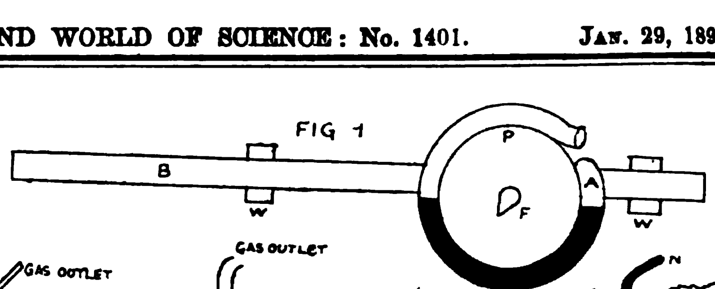
Probably more attention has been paid to the subject of artificial incubation in the United States during the last fifteen years than elsewhere. During that period upwards of 500 patents have been granted for incubators and their attachments.

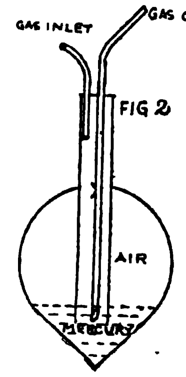
The heat of incubators is usually controlled by one or more of the following methods: The opening of a valve to allow the hot air to escape; to allow the heat of the flame to escape; by reducing the flame. This last method is usually accomplished (assuming the heat to be produced by a coal-oil lamp) by cutting off the air supply from the flame; this is done by a collar, which fits loosely around the wick tube, and when down is level with the top. It is lifted by means of a crank or lever; a ½in. rise of the collar reduces the flame more than one-half. Similar results are attained by the use of a burner such as is usually sold with hanging parlour-lamps, by simply pulling a small chain, two jaws are brought together above the flame, and the light is extinguished or reduced, according to the length of the pull.

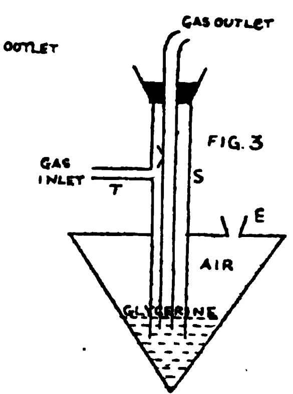
The use of any mechanism to reduce the flame has two objections. First, it requires to be disconnected from the other attachments every time the wick is trimmed. To avoid this, wicks of asbestos, being fireproof and claiming to require no trimming, have been tried; but the oil soon clogged the pores, and sufficient oil could not be supplied to the flame. The other objection is that there is a bare possibility of a few grains of charred wick dropping between the tube and collar, causing it to bind, and the flame continuing to burn overheats and destroys the eggs. The only advantage in reducing the flame is the saving of about one gallon of oil during a hatching. Are we warranted in risking an incubator full of valuable eggs for this saving? Certainly not; and the best incubators of this country are no longer regulated by this means.

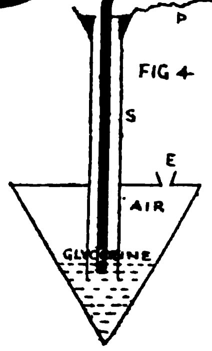
I was surprised to see in a late issue of the "E. M." an article illustrating an incubator, in which the lamp-wick was turned up or down by a gearing, so regulating the flame. Why resort to such a crude and ancient method when either of the above methods could be used, and requiring only one-fiftieth the power to effect a like result?

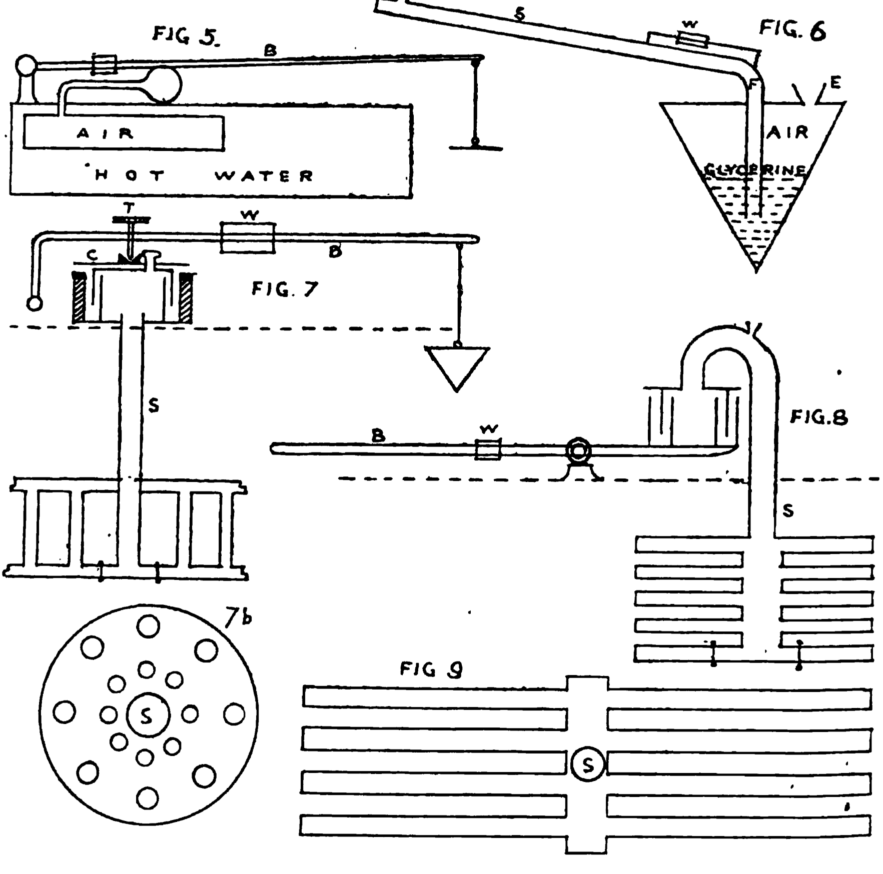
Among the various methods employed to regulate incubators, I recall the following:—A curved strip of brass, the heat expanding it and completing an electric circuit. A compound bar of brass and steel, riveted together either straight or in spiral form. The expansion of mercury in a glass tube closing an electric circuit. A system of compound levers made of compound bars, affecting a weight and clockwork mechanism. A rod of hard indiarubber or gutta-percha, similarly operated, which, unlike most other materials, contracts by heat. A capsule of metal, charged with a few drops of ether, carbon bisulphide, chloroform, alcohol, or other like substance. This form of regulator is used on Hearson's incubator, as recommended by Mr. Fraser. It is also used in this country; but three or more capsules are usually connected together.











Some years ago I made over 100 capsules of different sheet-metals, and used various substances to create expansion, and I found the capsules all unreliable, and not near so effective, sensitive, and certain as my latest regulator described further on. With capsules, the first expansion stretches or draws the metal, which never regains its former condition.

I inclose herewith a sheet of drawings of regulators which may be of interest to the many readers of the "E. M.," and will proceed to describe them.

Fig. 1. This is a balanced rod, and works by the expansion of alcohol and mercury; P is a grooved wooden pulley about 6in. in diameter; in the groove a glass tube of ½in. bere, and closed at one end, is bent and securely strapped in place as shown; F is a knife-edge bearing; B is a rod attached to the pulley; W are weights to balance the regulator; in the tube a quantity of alcohol is placed, as shown at A. Mercury is then poured in as shown; the expansion of the alcohol and mercury tip the beam. This regulator is patented in the U.S. Its objections are:—1. Being made of glass, it is easily broken. 2. All adjustments must be made inside of the incubator. 3. The quantity of mercury necessary.

Fig. 2 is a regulator working by gas; it is quite common here, and an improvement on the crude affair described by a correspondent in the "E. M." four or five numbers back. It is made of glass; the drawing explains itself. In the gas outlet tube at V a hole is drilled sufficiently large to allow just sufficient gas to pass to keep the flame lit when the gas is shut off by the mercury, thus dispensing with the necessity of a second tube and jet of gas to the main burner.

Fig. 3, as my improvement on Fig. 2, is made entirely of metal, is not liable to be broken, and is also much more sensitive to heat and cold than glass. Furthermore, the stems S, G, and E can be made long enough to extend up and through the incubator or other heating arrangement. The air-chamber is a cone 6in. in diameter and 5in. or 6in. high, made of thin sheet tin-plate or brass. The tube S is of brass, with an elbow at T. The tube *g* slips through a cork, which fits in the tube S, and, when adjusted, is sealed up with sealing-wax or gasfitter's cement. At E is a small opening, in which a small rubber cork or tight-fitting screw-cap fits. The opening is used to drop in a few drops of ether, in case rarefied air does not give sufficient pressure. The operation is the same as Fig. 2. In all regulators where gas is used, to obtain good results it must be of a uniform pressure, necessitating a reliable governor at the meter.

Fig. 4 is an electrical regulator of my own design. *s*, *e*, and the air-chamber are the same as Fig. 3; N is a piece of guttapercha-covered wire, slipping tightly through a hole in a cork, which fits in *s*. The cold glycerine is loaded with as much sal-ammoniac or common salt as it will dissolve. This makes it a good conductor, one pole of the battery being attached to any part of the regulator, the other to the insulated wire N. In operation, the heat expands the air, forces the glycerine up the stem S, until it touches the exposed end of the wire, which completes the circuit.

Fig. 5 is an air cylinder surrounded by hot water, heated by a lamp. From the air cylinder a tube rises to the top of the incubator, and to its end is attached a hollow rubber ball, upon which a weighted lever rests. The expansion of the air in the cylinder is supposed to expand the ball and lift the lever. The arrangement is patented in the United States. I do not think it is reliable, or that it would work well for any length of time, owing to the effect of heat and cold on the rubber.

Fig. 6 is a balanced regulator of my own design. S, E, and the air-chamber are the same as Figs. 3 and 4; the stem *s* is bent and closed at the end, with the exception of a small hole, *v*, to allow the air to escape should it expand in the tube. F is a knife-edge bearing; W is a weight sliding on a wire rod soldered to the tube S. The play of the upper end of this tube should be limited, so as to keep it always on an incline. This allows the glycerine to flow back to its place. In operation, the glycerine is forced up and along the tube S, tipping it and giving the movement, Fig. 7. This regulator is also of my own design, and, I think, is the best, simplest, and most sensitive regulator ever invented. When properly made and adjusted, it will maintain a given temperature with a variation of not more than one-half of a degree. The air-chamber is composed of two thin sheet-tin plate or brass capsules about 9in. in diameter, the edges of each plate being turned up ½in., one fitting within the other, and soldered at the edges. These two capsules are connected by a number of 1in. sheet-brass or tin-plate pipes 4in. or 5in. long. The arrangement of the pipes and the punching of the two inside plates of both capsules is shown in Fig. 7 B. The object of making it this way is to expose a given amount of air to the largest possible heating and cooling surfaces. Through the lower capsule three or four rivets are soldered, which prevent the lower plate from bulging down by the expansion of the air within. S is the stem which rises through to the top of the incubator. To this a cup, 6in. diameter and 3in. high, is soldered. Inside of this cup a ring, 4in. high, is soldered, leaving an inch space all around, which is filled to within ½in. of the top with cotton or wool. On top of this plaster of Paris is poured and smoothed level with the top ring. Another ring, 3in. in diameter and 3in. high, is then soldered within the cup, which leaves a centre space of 3in., into which the stem S extends, ½in. being soldered thereto. Outside of the 3in. ring there will then be an annular space of ½in., which is nearly filled with glycerine into which the cup *c* dips, and is sealed. T a disc 6in. in diameter is soldered a coller 3in. high, and 3½in. in diameter. This is the inverted cup *c* shown in the figure. Inside of this cup 1in. of cotton is packed, against which a disc of tin is soldered. This and the other filling is intended to prevent the external air from cooling the heated air within. Through the top of the cup is soldered a small tube, to which is soldered a small screw tap, such as is used on perfumery bottles: it must be screwed on air-tight; it acts as a vent to put the cup in place. In the centre of the top of the cup is soldered a small piece of brass, having a conical recess into which the conical point of the thumb-screw T sets. The rod B, bent as shown, is of ⅜in. square wrought iron, which gives weight and steadiness. The bearing is the same as used on telegraph instruments. The weight W is a piece of lead bent to fit the rod, and slides back and forth to balance the air pressure. In operation the air expands, forces up the cup, which lifts the rod B

Fig. 8.—This is another form of my regulator. The air-chamber consists of a number of capsules 9in. in diameter, and ½in. high soldered together as shown, the knife-edge bearing stem S, vent V. Glycerine seal and other parts will be readily understood by the drawing.

Fig. 9 is another form of air-chamber which occupies very little space above the eggs. It is made entirely of thin sheet tin plate or brass; the centre is a box of 1½in. square by 6in. long. On the two sides are punched four 1in. holes, into these tubes are soldered, the outer ends of which are capped, or otherwise securely closed. These should be as long as the incubator space admits of: in the centre of the top of the box is a hole, *s*, into which the tube S is soldered.

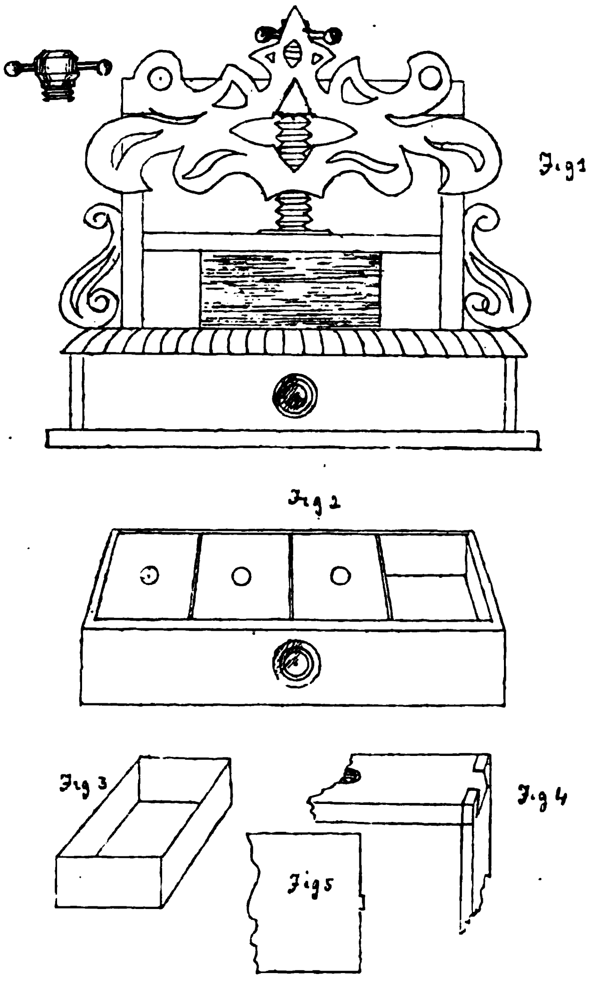
Other forms of air-chambers may be used, but these here given are simple, have a very large metal surface, and occupy little space. In all cases where air-chambers are used, the colder or more dense the air is when it is sealed in by the cup and glycerine seal, the greater will be the expansion when heated; but if in any case sufficient expansion, or power, cannot be had from air alone, the addition, when cold, of a few drops of any of the fluids before mentioned in connection with capsules, will accomplish the purpose.

Having already occupied more valuable space in the "E.M." than I intended, I will bring this article to a close, saying, in conclusion, that should any question be asked me on this subject, it must come through the columns of the "E.M.," and not by mail.

In the near future, should it be acceptable to the Editor of the "E.M.," I will prepare an article on incubators, giving improved heaters, and systems of heating; also improved hot-water incubators, and incubators heated by moistened hot air alone,—a method extensively adopted here, with the best results, and upon which I have devoted much time, study, and experiment. **J. A. Buffer.**

San Francisco, Calif. U.S.A., Jan. 2.

An Old Card Press



ANTIQUE PRESS FOR PLAYING-CARDS.

[33114.]—A few evenings ago I came across a little ornamental card press, and as it was to me a novelty, I conclude it will be so to many of our readers. It appears to have been in possession of the same family for two or three generations, at least, but is still in fairly good order, though the screw will no longer do its work. The wood is oak, now black with age; but the entire workmanship is excellent, all parts still fitting with the utmost accuracy.

As far as was possible under the circumstances, I took the measurement, but it is not of very great importance. The stand in which the drawer works is 7in. long, or thereabouts, and the width 4in., which is also about the height of the press frame, including the foliated scroll work which surmounts and partly conceals it in front. The general character of this I have endeavoured to reproduce, but to a great extent it has to be drawn from memory.

The idea of a press wherein to place the pack of cards after use would probably not have occurred to any one in these days, when cards are cheap and the duty small or none. But in old days cards were far more expensive, and it was not then the custom in a club to use them but a single night and replace them on the following evening with new ones. Hence a press to restore them to flatness and keep them clean was a very capital suggestion.

Fig. 1 represents the press complete in a front view, with a pack of cards *in situ;* Fig. 2 the drawer, with four divisions, in each of which lies a little cedar tray holding ivory counters. On the cover of each of these is a small shield of ivory, upon which is engraved either an ace of hearts, diamonds, clubs, or spades. The counters are narrow strips of thin ivory, about half an inch in length, rounded off at the corners. Fig. 4 shows the construction of the press. The side is dovetailed to the top in the usual manner, so as to resist the strain of the screw. The top is thicker than the side, being about ⅜, as it has to receive the hole tapped with a screw-thread. The screw itself is apparently of beech, as is also the top-piece, as being better suited than oak for tapping. Fig. 5 shows in plan one end of the pressure-board. It has a small fillet at each end, which slides in a groove made in the inside of the two upright pieces of the press. From the fact that the covers of the little counter-boxes are each labelled with a different suit, and that the counters have been stained in different colours, it would appear as if the press was specially devoted to some card game in which four players took each a different suit. I do not profess to know much about card-playing myself, and cannot therefore suggest any game suitable to such a deal; but some other reader may be able to do so. O. J. L.

VIOLIN MATTERS.

[33115.]—I CAN assure "J." (letter 33074) that it is *not* too much trouble for me to give him or any other reader of the "E. M." whatever information I can to enable him to meet the difficulties which may, and indeed must, be encountered. To prescribe, however, for a sick fiddle without being able to overhaul it, would be something like expecting a doctor to diagnose a complaint without an opportunity of getting at the symptoms. In this case one of the symptoms appears to be "tubbiness," which may arise from various causes—e.g., a too thick G string, the back or the belly, or both, being too thin, or the bar being too short or too heavy, &c. There are subtleties about fiddles which no man has ever fathomed, and, perhaps, never will, and there is great diversity of opinion, and treatment of fiddle diseases by fiddle doctors; but "J." has no doubt read the excellent letter of "Lancastrian," which immediately followed his own in last week's "E.M." This specially treats of "regulation," on which so very, very much depends. It is truly, as he says, "a long, exhausting, and anxious business"; but it will, in nine cases out of ten, amply repay for the time bestowed. I would recommend all amateur violinists to learn to regulate their own instruments as far as they possibly can by the ordinary means, such as stringing, bridging, and soundpost adjustment. It is unfair to expect the professional repairer to devote much time to such a matter. If he charges, for instance, a couple of shillings or half-a-crown for fitting a bridge, one may think it is plenty of money; but he would not be adequately remunerated if it were less, as there is skill as well as time to be paid for. Would it not be more in the style of the "E.M." reader to expend the 2s. or 2s. 6d. in the purchase of half a dozen new bridges and fit them himself, and take a note of the experience gained? He would begin by slackening the strings, and getting the feet of bridge to fit accurately to the contour of the belly. When this is accomplished, and if the feet are still thick, they should be thinned at the top by scooping out the semicircle with a very narrow-bladed penknife, or filing with a rat-tail file. Then the height should be determined, and, lastly, the thickness adjusted. There is no rule as to this: a thick bridge will suit some instruments, and be death to others; but a very interesting experience may be gained by cutting up half a dozen bridges, as it will be found that, though apparently all exactly alike, each bridge, owing to differences of density, will give a different character to the tone. It is only by devoting considerable time, as "Lancastrian" says, that the best results can be obtained.

I hope to reply to a few other correspondents next week.

The careful and painstaking experiments recorded by "Grinder" (33090) eminently confirm the last paragraph of "Vio" (33036, Jan. 1st) that "gauging does not guarantee satisfaction," and which I also had in back numbers ventured to insist upon. A curious fact which I have just reached seems to clench this assertion. A few days ago I was offered, and purchased, an odd-looking instrument of the long and narrow pattern, with a fine Swiss pine belly, and the back and ribs of Hungarian ash—a wood, by the way, which was introduced into England some years ago in the chair-making trade, but abandoned owing to its want of strength. The only attraction the fiddle had was its excellent tone. There was some writing in ink across the back, inside, which I could not completely decipher, and I therefore took the belly off. Imagine my surprise at finding that the back and ribs had been scooped out of one solid piece, the ribs being nearly ¼in. thick all round, and, where they sprang from the back, were not cut at right angles to its plane, but rounded. Outside a sham edge had been carved. The instrument is almost guitar-shaped, there being the merest apology for corners. The inscription stated it to have been "made by Morriseau, Paris, 1856." If it had a vile tone, no one would be astonished, and it would probably be put down to its unnatural build; but having a voice of an excellence which surprises all who try it, and the belly and back, which I calipered, showing no sort of regularity, it may be asked—Where does accurate gauging come in, in the matter of tone?

The "rule given by Stradivarius," says "Grinder," in the same letter, that the *f*-hole notches should be 7½in. to 7⅝in. from the top edge of the instrument where it joins the neck, of a 14in. body, I had not previously heard of, and at once took an opportunity of measuring a "Strad.," and found the distance to be full 7¾, and the body of the instrument $\frac{1}{16}$ *less* than 14in. So that "Strad." did not adhere to his own rule. I at the same time took the opportunity of measuring a "Guarnerius del Jesu," and a "Carlo Bergonzi," and found both give 7½in., and both instruments are $\frac{1}{16}$ under 14in. I also measured the distance between the *f*-holes in each instrument, with reference to the "recognised position" which some writers insist upon. The "Strad.," immediately at and under the inner notch, showed 2⅞in., the Guarnerius 2½in., and the Bergonzi $3\frac{3}{16}$, or a difference of ⅜ between the Strad. and Guarnerius, and *nearly three-quarters of an inch* between the Guarnerius and the Bergonzi.

To Mr. C. H. Austin (letter 33091). Following are dimensions asked for of the "Alard" Strad.:—Length, 14in.; upper width, 6⅝in.; waist, 4½in.; lower width, $8\frac{3}{16}$in. This celebrated "Strad.," which belongs to Mr. David Laurie, of Glasgow, is by far the finest specimen of that maker that I have ever seen. Its preservation is perfect, and in freshness it looks as if only a few months old. The tone is grand and voluminous. Two other "Strads." which have been in my possession measured:—Length, 14in.; upper, 6⅝in.; waist, 4½in.; lower, 8¼in.—length, 14in.; upper, 6⅝in.; waist, 4⅝in.; lower, 8⅛in. The last mentioned was a "late" one, probably near 1730, and in which the age of the maker had been written on the ticket; but some ignoramus had partially obliterated the interesting figures.

It would be difficult now to ascertain the dimensions of a "Strad." bass-bar, the original bars having long since been removed and replaced by those of greater length and strength, ostensibly to meet the additional pressure resulting from the rise of the musical pitch.

With regard to the model rising gradually from the edge, I suggested this in my instructions, as they were supposed to be addressed to those who had not previously made a violin; but as you have already passed that initial stage, you will find it will look somewhat more elegant to leave the edging, or "maccaroni," as the Italians call it, standing up a little, and let the rise commence from a slight distance within the purfling.

As to "baked wood," it was tried years ago by Vuillaume, who thereby spoiled numbers of what would otherwise have been splendid copies of the old masters. It is a customary thing among experts, whenever a "Vuillaume" turns up, to put it to the nose, in order to ascertain if it is a baked one. During his latter period, Vuillaume wisely abandoned the practice of cooking the wood.

W. Pickering.

[33116.]—I NOTICE that in my reply (33092) an error has crept in somehow, which I would correct. In the fourth line 6¾ should read 6¼ from the bottom of the belly.

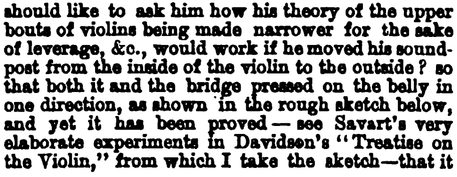
In reply to Mr. Rae (letter 33039), regarding the influence of shape on the tone of a violin, I would say that the mere shape has little or no influence whatever on the tone. The body of the violin is a simple resonance box, and the cubic capacity of that box is what regulates tone. The quality of tone, however, is greatly influenced by the nature of the wood employed in its construction: old wood, being freer in its vibrations than new, gives a rounder and softer tone.

In reply to "Grinder" (letter 33090), I would say that I am also sorry that, owing to the turn which matters concerning violin-construction have taken, I do not see my way clear to send in the promised articles.

Glasgow. **Scio.**

VIOLIN-MAKING.

[33117.]—I AM afraid Mr. Schucht (letter 33037) has not mastered the duty or the functions of all the various parts of the violin, or he would hardly have written the letter as numbered above. I should like to ask him how his theory of the upper bouts of violins being made narrower for the sake of leverage, &c., would work if he moved his soundpost from the inside of the violin to the outside? so that both it and the bridge pressed on the belly in one direction, as shown in the rough sketch below, and yet it has been proved — see Savart's very elaborate experiments in Davidson's "Treatise on the Violin," from which I take the sketch—that it would answer its purpose just as well outside, as shown, as it would inside.



I say its purpose, because there are so few who understand or recognise this purpose, many having the idea that it is a support to the belly to assist it in bearing the strain of the strings, &c., and how Mr. Schucht makes it do duty for his lever, whereas its only duty and purpose, "as proved by the above experiment of Savart's, who fixed a cross-piece over the instrument to the side blocks, and thus put his soundpost outside, as shown," is to check excessive vibration on the treble side of the belly, which is the soundboard of the instrument, and bring its vibrations into harmony with those of the bass side, which is loaded with the bass bar, and, consequently, more sluggish or slow in vibrating, and so by this check bring the vibrations of the belly into one harmonious whole. If the post is too long, and fitted in too tightly, so as to force the back and belly to spring a little apart, it would be checked too much; if too short, or stood in the wrong place away from the foot of the bridge, it would not check it enough; and in either of these cases the result would be bad: hence great care is necessary in its being properly adjusted.

I see your writers are very divided as to whether it should be hard or soft. They have been made and tried of a great variety of substances, even glass, which I should say was about as hard as could be, and even this gave a very good result; and so, I think, would anything, "hard or soft," if properly fixed to carry out the above-mentioned function; so that getting it the right length, and stood in the right place, is all that is important.

And now, Sir, I think my original question as to the reason "Why the upper bouts in some instruments are narrower than in others?" still stands open; or shall I say that it is only satisfactorily answered when you say that it is a most convenient method for a maker to reduce the air-mass of his instrument if too large?

There are many things connected with violins which I should like to see discussed in your paper. For instance, I was asked by a maker about a fortnight since What I thought of using walnut or some such wood for linings? And I saw yesterday in an eminent maker's window in the west of London an instrument with the belly off, which had linings of walnut in it, or what I should judge was walnut from its appearance, as I stood outside the window. Now, with all due deference to this maker, I think it is a great mistake, for many reasons. As nearly as I have been able to estimate, and I have weighed several sets, the twelve linings of a violin, when made of pine, say off the belly, weigh ¾oz., and pine is the best conductor of sound of any known wood. I do not know the difference in specific gravity between walnut or pine; but as it is a dense heavy wood I suppose it to be as five to three, and to me it seems very much against reason to think that 1¼oz. of walnut would give as good result as ¾oz. of pine, leaving out of the question the conductibility of sound, which is much in favour of pine, as I would show, thus:—Pine would tend to make the ribs vibrate more in unison with the belly instead of tending to check it, for the sound would travel round the linings at the same speed as it did through the belly, whereas I should think walnut would be a decided drag on the tone, if I may so express it; but I think my meaning is clear. Now the only benefit I can think of in favour of walnut is that it is a wood which is not liable to become worm-eaten. It is, in fact, one of the few woods which they do not tackle; but then, if they will not touch these linings, there are all the other parts of these instruments which they will go for given a favourable opportunity, and the linings will hardly hold these together to be of much use after they become rotten. Altogether, I think the advantage is in favour of pine, and if only a little it is worth utilising; for, given a little benefit in one part, and a little in another, and again in a third, and probably a fourth part of such a multiplex instrument as a violin, and it becomes when finished, with all these little differences added together and taken advantage of, an immeasurably better instrument than it would have been had they been let slip.

In conclusion, I should like hear what Mr. P. and some of your other writers have to say about walnut linings. **T. K. Monk.**

INFLUENZA.

[33118.]—I DO not suppose that there is much value in the statistics of one medical man in the matter of the treatment of any disease; yet I will venture to send a short personal record of my own results with what is so curiously styled "influenza" up to this date.

First, let me call attention to the symptoms caused by gelsemium, when taken by a healthy man for the purpose of experimental observation. (The doctor, not the patient, performs this experiment.)

First symptoms are: pain over the top of head and eyes, general giddiness, and then pain all over head; eyesight affected, giving dazzling sensation, then pains worse in eyeball, followed by shooting pains, with soreness and heaviness in the legs and back; face flushed, pains in loins increase, and there are cramps and twitchings of various muscles, short spasmodic pains en drawing breath, and specially severe over the breasts in females (experiment by a volunteer lady); very nasty, sickly taste in mouth; tongue has a dirty yellowish coating; great loathing for food; shivering, followed by fever; sometimes a very plain rash like measles over the whole body. After the experiments, great languor, and joints stiff and painful, with great feebleness in walking, want of appetite, and continued mawkish taste in mouth; nasal catarrh, rough, hoarse voice and sore throat, with continued bad cough, and mucus flowing from nose and throat.

Let any genuine "influenza" patient read this series of symptoms, and see if they do not call to his memory the happy period of his illness! I have now treated close on 300 cases with symptoms as above, such as are regarded as typical cases of this disorder, and, so far, I have lost only one patient by death, he being an old man. I have used gelsemium as the first medicine in all these cases, and I have had pneumonia follow in only 20 cases, all the pneumonia cases going no further than the early stages (this being the more usual course of that disorder under unorthodox treatment). In about 100 other cases of "influenza" of other types, such as the now prevalent attacks of purging, vomiting, &c., followed by the fever and muscular rheumatism of the more common type, I have also lost no cases through death, having fitted each case with such medicines as most closely resembled the attack in its symptoms.

I have had the usual proportion of severe cases. I do not claim that these figures are any proof of the superiority of my own treatment, because, for all I know, the more respectable, orthodox practitioners may have still better results to report; but it seems that my humble record, added to those of some 80 other men of my way of practice, is of some little value—1,500 cases with only 73 deaths (this does not count the present epidemic), and, of the 80 men, 58 having treated between them 6,982 cases without one death. These seem results worth looking at, though they be disreputably unorthodox. So far as I can learn, the recent advances in medical science—the catching of many bacilli—have not yet reduced the usual mortality from epidemics, yet there are many more doctors. Why is this thus?

Heretic.

INFLUENZA AND HOMŒOPATHY.

[33119.]—Reading as we do in the daily papers the alarming number of deaths resulting from influenza all over the country, would it not be well to recall to the public mind the words spoken on the subject of this epidemic by the President of the Homœpathic Conference in his address to that body in July last?

With a view of gaining some statistics from his medical colleagues, he had sent circulars to all whose names appeared in the Homœopathic Directory, and had received over a hundred replies, thus being enabled to give the following figures.

He stated, "In 1890 the total number of cases was 6,839, and the mortality 17. In 1891 the total number of cases was 8,146, and the mortality 56. So that taking the two years together, we find a total of cases 14,985, with a mortality of 73, or at the rate of one death to every 205 cases, and of these losses 15 are stated to be over 70 years of age." And further on he said, "58 practitioners were fortunate enough to treat 6,982 without a death."

The important fact that under homœopathic treatment the deaths from influenza are at the rate of less than half per cent. cannot be too widely known, and should surely make us pause to consider whether there is not something that ought to be altered in the mode of treating those suffering from this disease, and so reduce this increasing death-rate, which fills us with sorrow and indignation.

E. E. B.

THE BEST FORTY BOOKS.

[33120.]—I have read "Vehmgericht's" list of the best forty books, and am surprised to find Bastian's "Evolution and Origin of Species" mentioned amongst them. Bastian's views on this subject have long been known to be as erroneous as his observations; both having been overthrown by no less a person than Pasteur some twenty years ago. "Vehmgericht" mentions Cooley's Encyclopædia as a work "containing all known receipts." This surely is a slip. I have the last edition of Cooley's invaluable work, but it is far from containing all known receipts. I have often to turn to my back vols. of the "E.M." to find something which is not in Cooley.

Lancastrian.

FLORA MEDICA.

[33121.]—The valuable natural order of *Gentianæ* contains nearly 300 species, scattered over the four quarters of the world.

Prof. Lindley has remarked: "The intense bitterness of the Gentian is a characteristic of the whole order. It resides both in the stems and roots, rendering them tonic, stomachic, and febrifugal; and it is very remarkable that there are no exceptions to these properties in the whole order as it is now limited."

Of the Indian species, the well-known Agathotes chirayta has three representatives, only varying in the quantity of bitter principles they contain and an emetic resin of much power, indissoluble in cold water; hence infusion only is the proper preparation.

On searching the pages of old botanical books, I find *Halonia* mentioned as a native of India, and conclude that the *Halonia*, regarding which there have been many queries of late, must be the same plant; however, I have never gathered it, nor are its properties mentioned in my medical literature. Don named this species, which is nearly allied to Swertia (so called by Linnæus, after a Dutch florist). S. perennis is a delicate little aquatic with purple flowers, ¾in. high, growing in British marshes, and is worthy of investigation. A Gentian called *Kurroo* (Pneumonanthe of Don) is a favourite bitter drug in Northern India, the roots only being used. Cheronia centauroides is another popular plant, with the same properties, vernacularly known as *Nye*. Exacum hyssopefolium is another favourite tonic, being also laxative.

The Gentians proper of Europe supply the apothecary's stores. Old experiments decided that the gentisic acid is devoid of any active properties, —the bitter principle had not been isolated. The roots contain a proportion of sugar, of which the inhabitants of Switzerland have taken advantage. The sliced roots are fermented with water, alcohol being generated by the process, and by distillation a bitter liqueur is the result. This distilled water is a strong narcotic; a tablespoonful suffices to occasion giddiness. I do not think it is generally known that the beautiful menyanthes, buck bean, or fringed water lily, of North British bogs, in this same order, contains a powerful bitter tonic and febrifuge, and has been used, instead of hops, in the manufacture of beer! This plant has its representative type in India.

Nearly all the Gentians I collected in the Himalayas and South Africa grew at a great elevation. About three-quarters of them are natives of high mountains, to which the herbalists and drug collectors proceed, late in the autumn, when the growth has attained its full vigour, and the sap is concentrated by the fall of the flowers.

Eos.

DIALLING.

[33122.]—In the example given on p. 467 of a declining dial, it was supposed that in addition to its declination it reclined; but, it might be asked, how should we proceed if it had inclined? If we imagine that it inclines by the same angle that the one we worked out reclined, then the first part of the process would have been identically the same; but the angle D W F (Fig. 1, page 467) would have to be *added* to Q W D, and the rest of the working continued as before, with the new value so obtained for the angle R W F. The result would have been that the longitude of the place F would have worked out 31° 2′, and the latitude of the same 50° 8′. Computing with these values, quite a different arrangement of hour-lines would have resulted. But we now have to deal with the difficulty that in consequence of there being no line upon the dial that is vertical, there seems nothing to set it by. We might, it is true, fix it by a watch showing local apparent time; but that is not altogether a workmanlike proceeding, especially as we should probably find, when it was fixed, that the bottom edge was not horizontal, and the whole affair would present an awkward appearance. A way out of the difficulty may be found thus: Consider for a moment that we have to provide an erect dial, having the same declination as the reclining one proposed. This would have the noon-line vertical, and angular distance of this line from the substile is easily found, the tan. of this angle being equal to the sin. of the dial's declination × co. tan. latitude. In the example given this would be 15°13′. If we mark off this angle on the dial by a temporary line (shown on the sketch, Fig. 2, p. 468, by a dotted line just before hour-line XI), we can square off the top and bottom edges from this line, and make the sides parallel to it. Now the only difference, so far as mere position is concerned, between an erect declining dial and one that reclines in addition, is that the latter is, as it were, hinged back on the bottom edge, which, we may suppose, remains in the same position in either case. If, therefore, the edges have been made symmetrical with the line above referred to, the reclining dial can be set by level just as easily as the erect one.

A word or two on setting out dials generally. There are, as a certain eminent statesman once remarked, three courses that may be adopted. The trigonometrical part of the work may be performed on a globe, which is a quick and easy method, but rather rough and inexact. The second plan is to adopt some graphical method of computation, of which there have been more than one fully described in these columns. To assist those who constructed dials this way, there used to be made special dialling scales, which were sold at the mathematical instrument makers. If the scales are correct, and a certain amount of skill be forthcoming, the simpler dials can be set out fairly well by that method; but those who are not very deft with the drawing-board had probably better do all they can by figure calculation, leaving the drawing of the final lines the only part of the work dependent upon draughtsman's skill. This brings us to the final, and, to my thinking, far the best plan of setting out dials,—viz., that of computing all the required angles by logarithmic calculation. As seen in the example given, which is probably as awkward a one as is likely to occur, the calculations are really very simple, and such as anyone who possesses a table of logarithms can easily perform.

In plotting the values finally found upon the dial, the only appliances required are a straight-edge and a scale, which should of course be decimally divided. If the angles are laid off by tangents, as suggested, care should be taken to get the line truly at right angles with the sub-stile. When the angles get much beyond 45° the tangents become of unmanageable length. But that is easily got over, for if the log. tan. be taken from unity, it gives the log. co-tan., which, taken out in natural numbers, can be plotted on the co-tan. line V U in the diagram. This avoids entirely lines of excessive length. With regard to the half-hours, quarters, &c., I do not quite agree with those who say they are unnecessary. They may be unobtrusive, but it is a distinct advantage to have them marked. If the variations in the hours, too, are great, they ought to be computed, as mere bi-section of the intervals does not give the positions accurately. Much might be said on the practical side of dialling, the best materials to use, and the methods of working them to obtain good results; but as most readers of the "E.M." are capable of using a few tools, this side of the matter may be well left to their ingenuity.

W. J. R.

61, Fairholt-road, Stamford-hill, N.

DR. ROBERT BRYANT.

[33123.]—From several inquiries which have been recently addressed to my client, Dr. Robert Bryant, it appears that he has been identified with another correspondent of that name. To prevent confusion, therefore, will you allow me to state, on behalf of my client, that (1) he is the only Fellow of the Royal Astronomical Society of that name; (2) his London addresses are: Wightman-road, Harringay, N., and The London Institution, Finsbury-circus, E.C.; (3) he has no connection with the medical profession; (4) he is unacquainted with anyone of name similar to his own who is engaged in astronomical pursuits.

Arthur E. Barfield,
Solicitor to Dr. Bryant.

Moorgate-chambers, 72, Finsbury-pavement,
E.C., Jan. 22.

LATHE MATTERS—CONE FITTINGS FOR CENTRES, &c.

[33124.]—Among the many matters connected with the lathe which have been discussed in your valuable paper there is one which has hardly received the attention which its importance entitles it to. I refer to the cone or taper fittings of lathe-centres and small chucks.

If our good friends "O. J. L.," "J. K. P.," or "F. A. M." would each give us a full reply to only one of the following questions they would be conferring a great benefit on many of your readers, and might possibly start a movement tending to evolve something like order out of what is now chaos. As examples of what I mean, I may mention that I have come across:—three lathes by the same firm: not one centre would fit any lathe but its own, and that not too well. An expensive lathe made to order by a maker who would like to be classed as A1: both centres a bad fit, and not interchangeable, though evidently intended to be so. A lathe by a so-called "practical man": dead-centre very shaky fit; live centre fitted to a driver chuck, the hole in which was $\frac{1}{16}$in. out of true; hole in nose a different taper. I could add other examples to this list, and have no doubt other of your readers have come across similar cases.

1. What is the *best possible angle* for cone fittings of centres, theoretically and practically.
2. What are the best possible ways of obtaining that angle internally and externally, and concentrically with other parts of lathe?
3. Are any of the taper reamers, cock reamers, &c., obtainable at the tool-shops, suitable for adoption as a standard taper for cone fittings. Can a sufficiently true internal cone be obtained by their use, and can the reamers themselves be depended on to be all of the same angle?

Walmer, Jan. 23, 1892. **A. H. S.**

STAR FLUTING AND BUMPTIOUSNESS.

[33125.]—Something must have disturbed the mind of your peaceful correspondent, "F.R.A.S.," or he must have been very badly off for matter to write about, that he should have had to rake up a discussion that occurred last May to furnish him material for his vindictive note regarding Mr. Taylor and myself. Everyone who reads the English Mechanic knows that the word "Kensington" has the same effect on "F.R.A.S." as a red rag has on a bull. It makes him mad, and he loses the calm dignity which characterises him in his normal condition. I have previously pointed out that the words used by me at the meeting of the Royal Astronomical Society, in May, were to the effect that Prof. Keeler's results favoured the magnesium origin of the chief nebula line more than the nitrogen origin. This is merely a statement of fact which "F.R.A.S." can easily verify by comparing the wave-lengths of the nitrogen double, the chief nebula line, and the edge of the magnesium fluting. If I had stated that the nebula line was due to magnesium, I should have said what I do not believe, and I should have richly deserved the word "bumptious," which "F.R.A.S." has applied to me; for I am fully alive to the fact that my personal opinion counts for very little.

With regard to Prof. Keeler's work, I have been working at spectroscopy sufficiently long to know the difficulties and the labour involved in his investigations. And when "F.R.A.S." insinuates that I spoke of his work in derogatory terms, he does me wrong. Here I place on record, for all to read whom it may interest, that, in my opinion, Prof. Keeler's spectroscopic researches are of the highest value. Of his other work I know very little. I cannot, therefore, presume to have an opinion upon it.

"F.R.A.S." has seen proper to make an odious comparison between Prof. Keeler and myself. He seems to object to my age, or rather, youthfulness. Space will not permit me to vindicate this affliction, but I would refer "F.R.A.S." to Pitt's memorable reply when taunted in the same manner. It may be worth remarking, however, that I am older than Prof. Keeler, so it is absurd to apply the word "youth" to one and not to the other.

In conclusion, let me beg "F.R.A.S." in future to confine himself to facts, and by no means to try to stir up ill-feeling among workers in the same field—fellow seekers after truth. The scientific man should be above such trivial bickerings.

Richard A. Gregory.

11, Southey-road, Wimbledon.

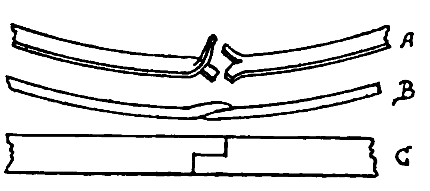
WELDING TIRES.

[33126.]—On page 460 of Friday's issue of the "E. M." I read under the heading of "Welding Tires" the instructions given by "Vulcan," with which I, being a practical man, do not agree.

The method of scarfing and riveting is all right; but when he says you should begin pounding at F and working up to H, that is where he would lose a good heat, for by the time he had worked to H, the thin edge being in contact with the anvil, would be too cold to weld; but would simply be hammered into the thick part.

Now, if the smith started pounding at H, he would thus get the thin edge welded underneath, and the end at F not being in contact with anything, excepting the heat from the thick part of the tire, would, of course, keep hot the longest.

Another good method of welding thin tires is to scarf them down, and then cut with a thin sale a nick about 1in. to 1½in. in the length of the hoop, and on both ends; then by bending one end down and the other up, and placing one within the other, and working the same way as the other method, a good job can be made of a light tire, and also of a broad one, when he has to weld one side at one heat, and take another heat for the other side.



This small sketch will show what I mean by cutting them. A shows the ends of hoop to be put together, B being the edge view, and C the inside (and outside also) view, when ready for welding.

New Subscriber.

SILVERING MIRRORS.

[33127.]—If Mr. Skelton gets on very well with the large pad, I have no interest in saying anything against its use.

Mr. Skelton asks: "is it *necessary* to press evenly the large polisher?" I should say yes. With the large polisher you are supposed to make it the same true and parabolic curve of the mirror. Can this be done?—if not, then the large polisher acts *locally*, that is to say, it acts as if it were a small polisher.

Mr. Booth's advice to warm the bath with the mirror immersed is very good with a small article, but you are almost sure not to get so even a film as with the way I advise, that is, to use nothing warmed up, but let everything used remain in a warm room till they are the same temperature as the air.

In Mr. Booth's plan the dish must get warmed first, and of course *most*, and thus get most of the silver, the glass receives the warmth slowly, and so gets least silver.

Mr. Booth asks me to try this plan, as it might be expected. I have tried everything to get out of these occasional failures, including warming, and have seen the mirror come out without being silvered at all. A far better way to use warmth is to keep the mirror for some hours in distilled warm water of a *known* temperature, warm the distilled water to be used to the same degree (about 60°), add the solutions to it, and immerse at once in the disc that the mirror has been in; the mirror will then be slightly the warmest and take the silver kindly.

As to "roasting" the mirror, that is both unwise and unnecessary; the blotting-paper will do the drying in an instant, without any risk of any kind. Surely such a plan ought to commend itself, and save Mr. Booth's mirror from further "roasting." Take a pocket-handkerchief in each hand: one to press down the paper so as not to slip about on the silver, the other to press it and "blot" every part of the surface; avoid the paper sliding, for fear there is grit, and if the paper does slip, and it is clean, no possible harm can be done. If you have but one or two thicknesses of paper, and you press it down with the warm hand, using no pocket-handkerchief, the heat from hand or fingers will drive the silver. The great advantage of the blotting is that the surface is dried instantly, and there is no time for dust to get on the wet face of mirror.

Mr. Booth's advice, "not to throw the baths down the sink," reminds me that I thought it too much trouble at one time to save the waste, the mud, &c., but I am wiser now. I sent my waste to a London refiner a few months ago, and he got from it 65oz. of pure solid silver—about £12 worth—so don't feed the sink with silver.

I thank "Mistral" for his very interesting and useful letter on the chemical combinations of the substances used in silvering.

G. Calver.

Violin Matters.—Erratum.—In col. 1, p. 488, 19th line, for "Pannona bass," read Panorma bass.

Grinder.

Photography has made great strides of late years, and now we find a *Photographic Review of Reviews*, a new illustrated monthly issued by Mr. Walter D. Welford, of Birmingham. It is well got up, and gives the pith of the serials.

Four surface railway companies in Brooklyn have recently obtained from the Board of Aldermen the right to substitute electric traction, by the single overhead trolley system, for animal traction upon all the street railways operated by them in that city. The measure, says the *Engineering Record*, awaits the approval of Mayor Chapin. It is said that the change to electricity, as a motive power, will cost over 8,000,000dols.

By a new invention the services of the driving-cords or belts now generally in use for driving spinning spindles are absolutely dispensed with, the amount of the product increased, and a more regular and uniform and much greater speed is obtained. Regarding the regularity and equality of the twist of the strands, the product is far superior to that usually secured. A valuable feature of the new idea is that by it any individual spin may be removed without stopping the whole frame. Altogether, it is a most ingenious and practical arrangement, and is something that will prove successful by its own merits. A patent has been granted the inventor, and it will soon be on the market.

Ice Cream Diet.—Dr. Herstey reports, in the *American Medical News*, three cases of gastric ulcer in which recovery had followed the use of a diet of ice cream. This novel method of treatment was suggested to him by the experience of a patient, a woman of thirty-five, who had for three months suffered from symptoms of gastric ulcer. She had hæmatemesis and severe pain, and could retain nothing, until by chance she one day took a small quantity of ice cream. She had lost 25lb. in weight. As all ordinary methods of dieting had failed, and digested food administered by the rectum was rejected, the patient, at her own desire, was allowed ice cream, and told to take as much of it as she could. Her severe symptoms at once began to subside, and at the end of two months, during which from one to three quarts of ice cream were taken daily, she had gained 24lb. in weight. Solid nourishment was gradually added to her diet, and she made a complete recovery. Dr. Herstey had a similar experience with two other patients, in one of whom there were symptoms of perforation and local peritonitis, and he is naturally inclined to think highly of the mode of treatment, and to recommend its use in similar cases. He believes that the ice cream in those cases is beneficial because of the local anæsthetic action of the cold permitting digestion to go on without pain, while at the same time sufficient material for digestion and nourishment is supplied in the cream. But he insists that every care must be taken to insure the absolute purity and freshness of the ice cream, and for this purpose he recommends that only that which is made at home should be used in such cases.

REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75180.]—**Cement for Lamps.**—For cementing brass collars and sockets to the glass fonts of lamps plaster of Paris is generally used. Get the best quality, such as is used by dentists and rubber stamp manufacturers, make into a stiffish cream with hot water, and apply; it sets quickly. Another cement which is said to be insoluble in petroleum, and highly recomended for this purpose, is made as follows: Rosin 12 parts, strong lye 16 parts, water 20 parts, plaster of Paris 20 parts. The rosin is boiled with the lye until it is entirely dissolved, and, when cold, forms a tenacious, solid mass; this is sufficiently diluted by adding the water, and the plaster of Paris is then carefully worked in to bring it to the proper consistency, and applied. Much difficulty is sometimes experienced in removing the old plaster from collars and sockets that have become detached from lamps. In this connection I recently discovered a little wrinkle which may be of use to many of the readers of the "E. M." Wishing to clean out an old collar in order to recement it to a lamp, I found the plaster to be so hard that it could not be picked, and only barely scratched, with a pocket-knife; tapping around the collar to break the plaster, and digging at it with the sharpened end of a file were also unsuccessful. I then thought to try the effect of expansion by heat and sudden contraction by cold. Slipping the collar on a wire rod, I suspended it over an alcohol flame for about a minute, slowly rotating the collar so as to heat it uniformly, then quickly plunged it in water. Taking it out, I found the plaster to be cracked into thousands of little grains, and of a mushy consistency, exactly like a lump of quicklime which has been wet, and crumbles to pieces. With my finger I washed out the plaster, leaving the collar as clean as when new. I have tried this process a number of times, and always with the same result.

J. A. Buffer.

San Francisco, California, U.S.A.

[76003.]—**Aluminium.**—A reply has certainly been sent to this query by "A. E. B.," but I cannot say I consider the same to be an answer. At the time I sent this query I had already made an attempt to anneal aluminium, but without success. I have since made another attempt, and have this time succeeded, as I think the samples sent herewith will prove. The springiness in the unannealed sheet-metal is probably caused by its having been passed through a rolling mill, and unless I am much mistaken the metal has to be annealed during the process of manufacture each time it passes the rollers, as the sheet is being reduced thinner and thinner in substance. Having succeeded in effecting the desired end, I now reply to this query myself in the hope that it may prove useful to others of your subscribers. Thin sheet aluminium can be annealed and rendered soft by simply moving the same to and fro in the flame of a spirit-lamp, care being taken not to overheat and burn the metal. The better plan is to proceed tentatively heating the metal only moderately at first, and trying whether it be annealed by simply drawing it between the fingers and thumb. If not sufficiently softened, use a little more heat and try again. The touch is quite sufficient to tell when the operation is finished.

Metal.

[76042.]—**Wheel-Valve.**—The reply of "R.S." on page 491 is, I believe, in accordance with what is generally considered correct practice; but I would point out to the querist that it is often of great value to be able to shut the pressure off from the stuffing-box in order to repack a leaky steam-valve. Admitting the steam below instead of above the valve also makes the latter more responsive, and capable of more easy regulation. This is important in cases where a very small jet of steam only has to be turned on.

Qwerty.

[76114.]—**Press Tools.**—I do not think there is any work on the subject of making press tools, but some information might be gained from the catalogues of makers. The tools are well known and well used in such places as Birmingham.

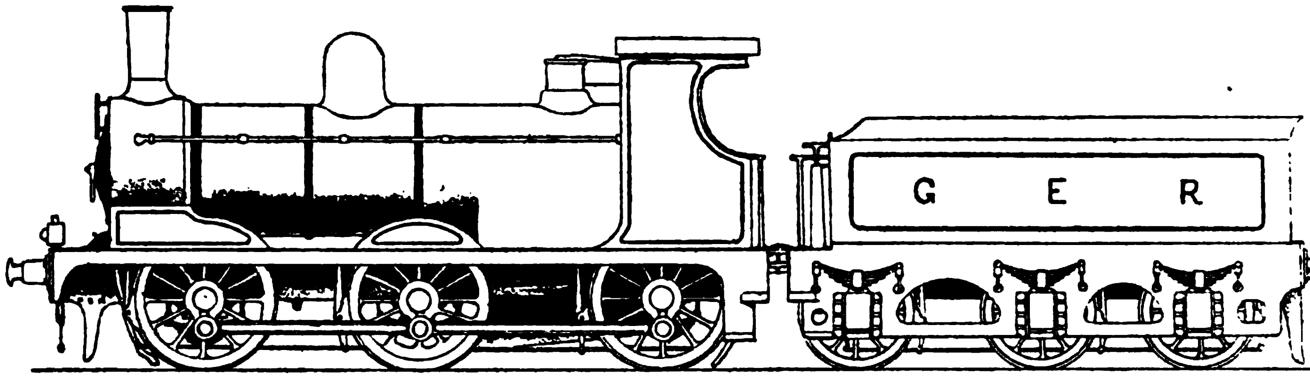
R. S.

[76119.]—**Fixative.**—A good fixative for most drawings is skim-milk sprayed on, or the drawings may be floated—face downwards—on the fixing mixture. A solution of gum in alcohol is more of a varnish than a fixative. I am sure there are several recommended in back volumes.

T. D.

[76122.]—**Marble Slab.**—Use a small saw and plenty of water for cutting the marble to shape. Don't attempt to chip it. If suitable grinding appliances are available, that is the best and safest method of working, leaving a little surplus to be rubbed down by means of a bit of sandstone or emery until the exact size required is obtained.

S. M.



[76127.] — **Gas Photometer.** — The ordinary photometers described in the textbooks would appear to suit this querist's requirements; but as he says he is acquainted with the elaborate apparatus used in gas-houses, he is also probably familiar with the ordinary forms. Has he tried the Letheby method, illustrated and described on p. 85, Sept. 19, 1890? That appears to answer his requirements.

M. T.

[76135.]—**Pocket Medical Coil.**—How can anyone answer such a question as this? The size of the case must be given before that of the coil it will take can be stated; but there are many hints on these medical coils in back numbers, and the querist can adopt one of those previously described which will suit his case. A medical coil, "complete except the coil," seems to be in a rather incomplete state.

T. C. L.

[76143.]—**Hot-Air Engine.**—"J. B." will find a good many designs in back volumes, but perhaps that on p. 103, Vol. XLVI. Sept. 30, 1887, will give him the idea of what he requires. There is also a diagram on p. 204, Nov. 1, 1889. Perhaps if some reader were to give full details of a small hot-air engine, it might be of interest to those who have the appliances for making it from castings, which ought to be a profitable speculation on the part of those who lay themselves out for that kind of business.

N. D.

[76147.]—**Organ-Reeds.**—It is not clear from this query whether it is a pipe-organ or an American organ that is meant, though from the expression "rows of reeds," it would seem to be an American organ. In that the upper octaves of the 16ft. would be generally left with the reedy tone of the clarionet purposely. The querist must call in a skilled voicer if he cannot attempt the work himself from the few directions I gave recently on reed voicing. Rub the case over with a rag just moistened with paraffin oil, and clean the keys with the same, or preferably, a little alcohol, after removing the grease.

ORGANON.

[76148.]—**Front-Slide Lathe.**—There was a good deal about the front-slide lathe in comparatively recent volumes—XLV., XLVI., for instance. In the number for Nov. 25, 1887, there are full detailed drawings of a front-slide lathe which may just suit the querist, as it is 6in. which he asks for; but he should read up the long and interesting discussion on the front-slide lathe in earlier numbers.

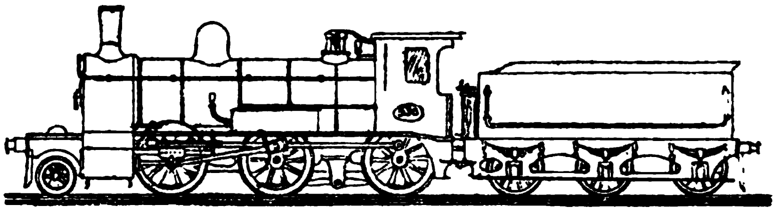
L. M.

[76168.]—**Great Eastern Railway.**—As requested, I herewith beg to send description of two classes of goods engines on the above—viz., Mr. T. W. Worsdell's six-coupled goods engines and the old "Mogul" engines, built in 1879. I inclose a sketch of the former class of engines, the dimensions being as follows:—Cylinders (inside), 7½in. by 24in.; six-coupled wheels, 4ft. 10in. diam.; single frames, inside bearings; total wheel base, 16ft. 1in., divided thus: centre of leading axle to centre of driving ditto, 7ft. 7in., and centre of driving to centre of trailing axle, 8ft. 6in.; total length of frames, 24ft. 10in. The boiler is 4ft. 4in., outside diam., by 10ft. in length, and contains 223 tubes, 1⅞in. outside diam. Firebox casing is 6ft. in length; centre of boiler from rails, 6ft. 10in.; height of funnel from rails, 12ft. 11in. Heating surface: Firebox, 105·5sq.ft.; tubes, 1,055sq.ft.; total, 1,160·5sq.ft.. Weight of engine: Empty, 33 tons 8cwt.; full, 36 tons 10cwt. Tender: Diam. of six wheels, 4ft.; centres apart, first pair to second pair, 6ft. 6in.; and second pair to third pair of wheels, 5ft. 6in.; total wheel base, 12ft.; total length of frames, 18ft. 3in.; capacity of tank, 2,755 gallons; weight of tender, empty, 16 tons 6cwt. 2qr.; ditto, full, 32 tons 8cwt. 3qr.; weight of engine and tender in working order, 68 tons 18cwt. 3qr. Locos. of this class were built from 1883 to 1886. The following are the particulars of the Mogul goods engines. Cylinders (outside) 19in. diam. by 26in. stroke. Six-coupled wheels of 4ft. 10in. diam. with inside bearings. The small leading-wheels are 2ft. 10in. diam. Wheel base, centres apart: Leading-wheel to first pair of coupled wheels, 7ft. 5in.; first pair of coupled wheels to driving-wheels, 7ft. 3in.; and driving-wheels to trailing do., 8ft. 6in.; total wheel base, 23ft. 2in. The boiler barrel is 11ft. 5in. long, and firebox casing is 6ft. long; total heating surface, 1,323sq.ft.; weight of engine in working order, 47 tons 17cwt. Tender: Six wheels, 4ft. diam., 5ft. 8½in. centres apart; capacity of tank, 2,500gals.; weight of tender, full, 32 tons; weight of tender, full, 79 tons 17cwt. The sand-box for the leading-wheels is placed on the boiler between the funnel and the steam dome.

JAMES F. VICKERY.

[76168.]—**G.E.R. Engines.**—I give sketch of the "Mogul" goods locos on the above line. They were designed by Mr. W. Adams while superintendent of G.E.R., but were placed on the line by Mr. Massey Bromley, and were built by Messrs. Neilson and Co., Glasgow. The chief dimensions are:—Diameter of driving-wheels (six-coupled), 4ft. 10in.; pony truck wheels, 2ft. 10in.; cylinders, 19in. × 26in. Boiler: Length (barrel), 11ft. 5in.; diameter (outside), 4ft. 6⅝in.; No. of tubes, 240; diameter of tubes (outside), 1¾in.; length of firebox casing, 6ft.; boiler pressure, 140lb. per square inch. Heating surface: Firebox 102sq.ft., tubes 1,291sq.ft.—total 1,393sq.ft.; grate area, 17·8sq.ft. Weight (in working order): On pony truck, 8 tons 10 cwt.; on leading driver, 12 tons 11 cwt.; on driving-wheel, 13 tons; on trailing, 12 tons 11 cwt.—Total, 42 tons 12 cwt. Wheel-base, &c., of engine: From centre of truck-wheel to front coupled wheel, 7ft. 5in.; from front coupled wheel to driver, 7ft. 3in.; from driving to trailing, 8ft. 6in.—Total, 23ft. 2in. Total length of frame, 27ft. 9in. Height from rail to top of chimney, 13ft. The engines are fitted with steam brakes.

A. J. BREWER.

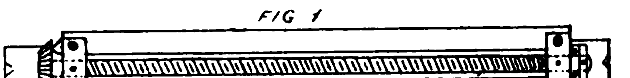


[76184.] — **Boring and Turning Engine Cylinders.**—I send rough sketch of boring bar and rest for facing. Fig. 1 shows the bar without tool rest or driver on. Fig. 2 is a cross-bar, keyed on end of bar to drive it by, and also to fit bevel wheels in to self-act the tool along the bar. The reason I have shown a cross-bar for driving—you can get two catch-pins in, and therefore take a lot of strain from the centre. Fig. 3 is a compound slide-rest for facing and turning flanges. It is not necessary to have compound slide-rest for cylinder work, because you can self-act from the screw in the bar; but for, say, turning propeller blades, it would be found useful. Fig. 4 is a block for boring purposes. The dotted lines show where tool fits in, and slots in between are for knocking pieces of wood in.

J. T. BLACKETT.

Ivy House, Guisbro', Yorks.

FIG 1



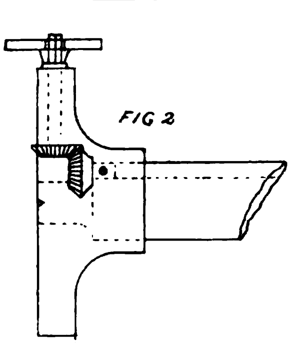
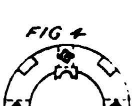


FIG 2

FIG 4



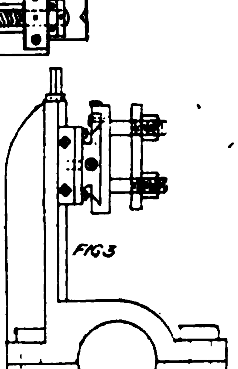


FIG 3

[76210.]—**Torsion Balance.**—"Student" has not properly understood the reply of "Iota Dash," which is correct and complete. "Student" should see that the torsion balance measures the moment of the force. If the earth's magnetic force always acted at the same angle on the magnet then its moment would be constant, and his second mode of computation would be the correct one; but the moment varies in this case as the sine of the angle, becoming a max. at 90°.

Swansea. A. R. MOLISON.

[76210.] — **Torsion Balance.**—"Student" is confounding two sets of conditions. In the question he quotes he must bear in mind that it is the magnet's moment he is dealing with, and not a single pole, as in the case of Coulomb's experiment. In his original question (Jan. 1), "Student" says, "Since three times as much force must be required to deflect the needle through 90° as is required to deflect it through 30°." Now, that is not the case, when we consider the action of the earth's field acting on a suspended magnet. Here the torsion necessary to keep the magnet in any position is proportional to the sine of displacement from the meridian—for the direction of the force is not always at right angles to the magnet's axis. In Coulomb's torsion experiment the force was considered between two points, and as acting in a straight line between them. Curiously enough, Coulomb himself made a strange slip, for he found that the movable disc at the top had to be turned 35° to move the needle through 1°, i.e., the earth's action was equal to a torsion of 35°, whereas there is evidently but a torsion corresponding to 34°, because though the top disc was moved through 35°, the needle has followed it through 1°, so that the true angle of torsion = 35° – 1° = 34°. It may interest "Student" and other readers to learn that as far back as 1771 Cavendish enunciated a definite proof of the law of inverse squares, though he was never credited with the discovery until Clark-Maxwell edited Cavendish's unpublished papers in 1879.

IOTA DASH.

[76220.]—**Electro-Motor.**—To MR. BOTTONE.—Ten quart Bunsens. TRAVELLER.

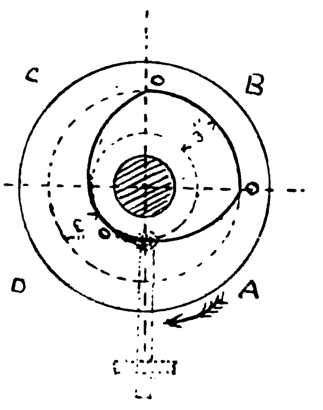
[76226.]—**Induction Coil.**—I am obliged to Mr. Bottone for his kind remarks respecting my forthcoming book on induction coils. Whilst writing this book, I read all I could get access to respecting induction coils, and found a mine of information in the back volumes of the ENGLISH MECHANIC. I know of no better book than the "E.M." on this subject, but the information is scattered throughout several volumes, and takes up very much time in collecting. My aim has been in my book to condense much of this information, and present it to my readers within the covers of a handy cheap volume. I am afraid my friend has led "ours" to expect too much from it, for I do not consider it "to be the most complete work on the subject in the English language." It is not so complete as I would have wished to make a book on this subject, for a moderately complete book on induction coils should command a price above that which an amateur would be prepared to give. I endorse much of what Mr. Bottone says respecting the Pyke-Barnet coil, but think its contact-breaker the best part of the instrument. I consider the design adopted by Mr. Apps for his famous induction coils to be the best possible, always avoiding excessive thickness in the ebonite tube between the primary and secondary coils. Over-insulation here tends to a diminution of inductive effects in the secondary coil, which can only be remedied by an increase of battery power. The method adopted by Mr. Apps is fully described in my book, which will be ready for publication by Messrs. Whittaker and Co. in the course of a few weeks. G. E. BONNEY.

[76260.] — **Diabetes.** — A little book called "Cookery for the Diabetic," published by Longmans, would probably prove of use to the inquirer. It is principally the production of a sufferer from the complaint in question, and the fact that the preface is written by Dr. Pavy, is a guarantee of the trustworthy nature of the information it conveys. E. D.

[76269.]—**Gas.**—The best substance for passing atmospheric air charged with benzoline so as to obtain the greatest illuminating power, is cotton and ordinary lump-sugar. The generator should be made in three separate parts—viz., the reservoir for benzoline, air tank, and gas holder. The reservoir is connected to the tank by a pipe, a ball-valve being fitted inside this tank so as to keep the liquid at a constant level. A number of small tubes connected to a main air-tube at the top should pass into the liquid. The gas-holder is connected to the air-tank by a pipe with a downward bend into the holder. The top part of the holder should have two perforated chambers—the top one filled with cotton, and the bottom one with lump-sugar or charcoal (sugar is the best). The outlet pipe is fitted at the top of the holder. I have found that by adding a little sulphuric ether and camphor the brilliancy of the light is increased. The ether should be put in the reservoir, and the camphor in air tank.

DRAUGHTSMAN, The Patent Light Co.

[76278.]—**Mechanical Motion.**—Let "Neros" cut a groove in A of his diagram, to the contour of line O, O, O, in Fig. Revolving to the left, he



will find A, B, C, D, fourths of circular motion to correspond to his wants.

WALTER STRAFFORD.

100, Balaam-street, Plaistow, E.

[76274.]—**Rendering Iron Hot by Electricity.**—I guess our electrical friends smiled on reading this query. I should advise the querist to ask what size dynamo he would require for his purpose? WALTER STRAFFORD.

100, Balaam-street, Plaistow, E.

[76278.] — **Mechanical Motion.**— "Neros" will not be able to get desired result with an eccentric, as the motion would be continual. I

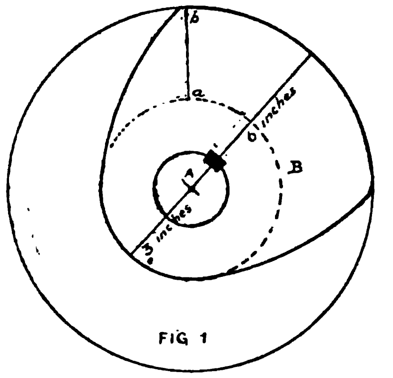


FIG 1

would advise "Neros" to use a cam, shaped as in illustration, Fig. 1. A is the shaft, B is the cam. In Fig. 2 C is the rod, with roller D to run round the face of the cam; E is a spiral spring to give

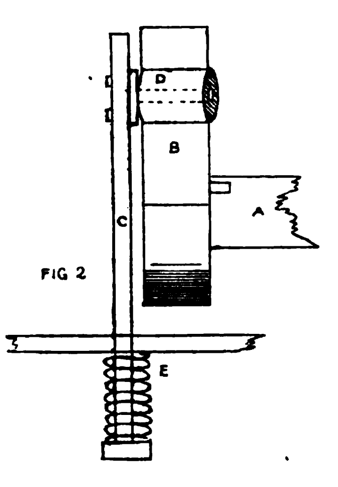
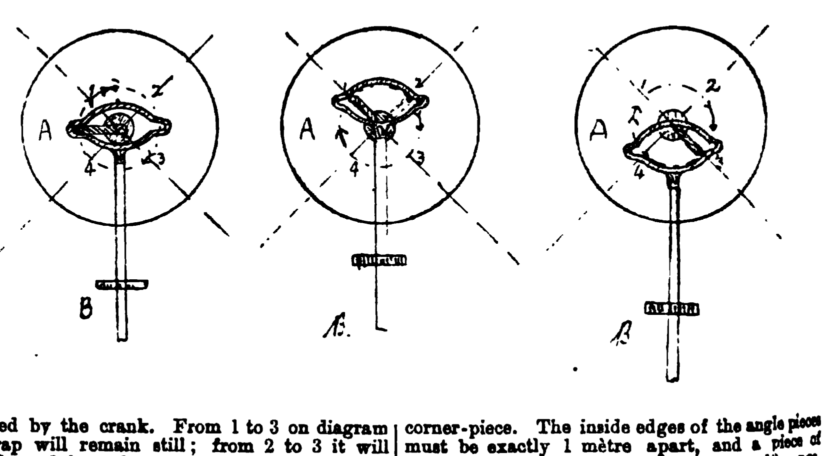


FIG 2

motion to the rod one way, the one in which the least pressure is required. Thus it will be seen that the rod will be lifted from *a* to *b*.

ALPHA.

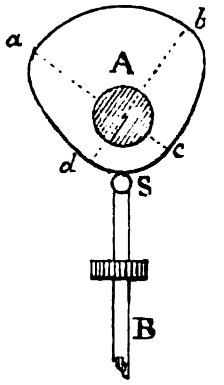
[76278.]—**Mechanical Motion.**—An arrangement such as my sketch would, I think, suit your correspondent. It consists of a crank and a strap. The strap is composed of two segments of the circle



described by the crank. From 1 to 3 on diagram the strap will remain still; from 2 to 3 it will descend; and from 3 to 4 will again remain stationary; and from 4 to 1 will ascend.

A. J. BREWER.

[76278.]—**Mechanical Motion.**—The required motion of the rod B, which is constrained to move vertically, is most easily obtained by means of a cam (mounted on the shaft), the periphery of which consists of four arcs, one in each quadrant. The arcs *a b* and *c d* are portions of circles struck from the centre line of the shaft A, the radius of *a b* being 3in. greater than that of *c d*. The motion of the rod is derived from that of the intervening arcs *b c* and *d a*. These ought to be nearly straight lines for the greater part of their lengths, but curved towards the ends where they run into the circular arcs, so that there shall be no jerks in the movement. The rod, as I have drawn it, terminates in



a projecting stud, S, or it may be a fork embracing the edge of the cam, and made to bear against the cam, either by a spring, or by a weighted lever applied to the lower end of the rod. In place of a stud, however, the top of the rod may carry two cross-bars, having the shaft with its cam between them, the action being between the cam and the upper bar, the lower bar being clear of the cam—at least, during the intervals of motion in the rod. Another practical arrangement, which, like the last, involves no spring or weighted lever, consists of a circular plate mounted on the shaft, and having a groove, shaped like the edge of the cam, cut in its face. This groove forms a guide for the stud S.

Charing. J. R. C.

[76284.]—**Skàtes.**—Use a 4in. emery wheel about 1in. wide running about 1,500 revs. a minute (to you, of course); start at the heel of blade and run straight across to the toe, or vice versâ, holding it firmly to the wheel all the cut. As the blades get warm it is best to grind them in the skates, then you have something to hold them by. If the wheel wears out of true (as they often do), true it with an old file, or you will never grind hollow; of course, the larger the stone the less hollow the blades are. As I have ground between 20 and 30 pairs a day during the late frost, I think that is a little experience. I. L. M.

[76289.]—**Telephone.**—Your case is similar to my own. A Leclanché cell will certainly improve your telephone; but turn up "E.M." for Sep. 18, 1891—I think this is the correct date—and you will find a description of a microphone by F. C. Allsop. Make a pair like it, and you will have no further trouble. Use a No. 2 Leclanché at each end of the line. TRAVELLER.

[76293.]—**Wheatstone Bridge.**—More properly a mètre bridge. The lengths of the three pieces are of little moment. Lightning-conductor tape, 1in. by ⅛in. would do well. You want five terminals,—three on centre length, and one on each corner-piece. The inside edges of the angle pieces must be exactly 1 mètre apart, and a piece of German silver, or platinoid wire, 18 or 19 gauge, stretched across and soldered, with a boxwood mètre scale, divided into centi- and millimètres, running parallel with the wire, so that you can read off,—by means of a pointer on your jockey. If you have any difficulty in buying materials, I will forward to you.

153, South-street, Sheffield. J. T. S.

[76296.]—**Prolapsus Ani.**—The mode of treatment altogether depends upon the exact nature of your complaint. If you have consulted a specialist in this matter, act upon his advice, and do not be led away by advice given to you without a proper examination. If you cannot replace the protrusion by the forefinger anointed with ointment, an operation is your only chance of permanent relief. In my own case, I found gall ointment made me worse, and cold water applied to the part still more so. An operation was the only remedy which was successful for a year or two. Since then I have had a return of the old complaint; but by taking medicine every night, and replacing the protrusion, I manage to put off the next operation until I can find time to lay up. Any support applied to the part has a tendency to irritate. Sympathy.

[76296.] — **Prolapsus Ani.** — An intimate acquaintance of mine has suffered from prolapsus ani for more than thirteen years. This weakness followed on a severe attack of bleeding piles, brought on by the use of purgative drugs. He has tried various remedies with only partial success. The doctors appear to be helpless in curing this distressing complaint. It appears to be a kind of paralysis or loss of muscular power in the parts affected. One doctor prescribed a mixture of sulphate of quinine and sulphate of magnesia, a teaspoonful to be taken in a tumbler of cold water every morning. This promoted a daily evacuation of excreta, but was the cause of much flatulence in the stomach. Another doctor prescribed local application of a solution of glycerine and tannin. This caused a small amount of constriction in the parts, but did not restore their strength. Another recommended a douche of cold water after evacuation. This has been persevered in up to the present time, as it is a simple mode of relief easily applied. The patient tried the whole-meal bread and vegetable diet recommended by Dr. Allinson, combined with the cold douche, but has had to abandon the use of whole-meal bread, because of the irritation caused by the particles of bran. This irritation promoted a frequent desire to dischage excreta, and an almost constant state of protrusion, which was very painful and annoying. After leaving off the whole-meal bread, this irritable condition was lessened. He is now trying an ordinary mixed diet and the use of a mild aperient pill on alternate days, but would be glad to know how to get cured of this distressing complaint. A pessary may afford some relief, but may also irritate and inflame the parts. How can their muscular tone be restored? Will some of "Ours" who have been cured, or who know of a case cured, kindly communicate their experience? G. E. B.

[76298.]—**Bisulphite of Lime.**—This is, I believe, used as an antiseptic, but sulphite of soda is better. It might be prepared by passing sulphurous acid gas into milk of lime, the gas being prepared by heating sulphuric acid and pounded charcoal together in a retort, when a mixture of this gas and carbonic acid are given off. A. E. B.

[76305.]—**Dynamo.**—My query should read that I want to get about 40 candles. At present get nothing. Is amount and sizes of wire correct? If not, what is, as I should like to know this before sending it to be tested. J. B.

[76312.]—**Steam Pump.**—1. One column will answer the purpose of three if large enough. 2. The diameter of one pipe to replace two 6in. and one 4½in. should be 10in., which would be rather over the mark. 3. There would be less friction in the one than in the three, in the proportion of about 5 : 8. A back-pressure valve is requisite for each delivery into the main. A. E. B.

[76312.]—**Steam Pump.** — (1) Yes. (2) This cannot be told without knowing quantity of water required to be delivered, or if present pipes are large enough—diameter of each pipe; but "Water" can easily work this out for himself: Square the diameter of each delivery-pipe, multiply by ·7854, and the sum will be the area. Then his new pipe must have an equal area. Example: Suppose he has three ·3in. pipes; then $3 \times 3 = 9 \times {\cdot}7854 = 7{\cdot}0686 \times 3$ (number of pipes) $= 21{\cdot}2056$; the nearest diameter to equal this would be 5¼in., but no pipes are made this size, so a 6in. pipe would be required. I would advise "Water" to have his pipe large enough; he cannot err much in this respect. I have a little practical experience in this matter, having under my superintendence works where from 200,000 to 300,000 gallons are pumped daily to a height of 220ft. If his present pipes are a little cramped in size, and he substitutes one of larger area, he will imagine he has got different pumps, they will work so much easier. (3) Yes. (4) Yes, or he will imagine his pumps and pipes are going to pieces by the concussion of the valves. I have given the above answers as plain as I could; if "Water" does not understand them, or is in doubt, let him write again, giving sizes of his pipes, the amount of water required to be delivered, &c., and I will endeavour to assist him. Borderer.

[76318.]—**House Warming.**—There can be no question that the most economical way of warming a house is by means of a closed stove, with fluted radiators: the stove standing a few inches from the fireplace, which must be closed, and the stove-pipe carried either through the iron plate closing the fireplace, or upwards to a higher part of the chimney. What is best must be decided not only from this, but also other considerations; some people, for instance, prefer to see the open grate. Your mention of a cellar seems to indicate a preference for hot-water pipes; these, however, I should not recommend all over a house, for the apparatus is expensive, and apt to get out of repair; it is difficult to regulate, and, when always on, is enervating. To some people, this heat, too, is very depressing, giving the sensation of a weight upon the crown of the head. A. E. B.

[76320.]—**Turbine for Electric Light.**—If the water in the mains is of sufficient pressure, a water-motor might answer for a small installation. On a larger scale, and under suitable conditions, a turbine can, and is, used for the electric light, as in the Keswick Electric-Light Co. This interesting station is worked by a "Victor" (mixed-flow type) at 273 revolutions per minute; head of water, 20ft.; alternator gives 16 amps. at 2,000 volts, which is, of course, transformed. A 50H.P. Westinghouse engine is employed when there is a partial failure of water, as in summer. Unless of general interest, it would take up too much space to give details. "Engineer" will find useful drawings and formula in Molesworth. A. D. Southam.

[76322.]—**Testing Internal Resistance of Battery.**—I think if you read your textbook carefully, you will find that it not only tells you to join two cells in opposition, but two equal cells. By this arrangement, the counter-motive forces will be equalised, and without effect upon the galvanometer. A definite current now being sent through the two with a galvanometer in circuit, the falling-off of current will indicate the resistance of the two cells, half of which is the resistance of each. A. E. B.

[76325.]—**Sodium Amalgam, &c.** — Sodium amalgam Na_2Hg (?) in excess of Hg cannot be a fixed amount, as then it is only a mixture. It is influenced by the air, and is generally prepared first when wanted on the small scale. It is used for the extraction of gold from quartzose rock, and for the chemist is a most useful reducing agent. A potassium amalgam is also known, being the compound K_2Hg, according to E. de Souza. The so-called potassic cyanide is *not* a cyanide at all, but a sulpho-cyanate—i.e., a compound analogous to potassic cyanate, in which the O atom has been displaced by an S atom. Thus—

$$N\left\{\begin{matrix}CO\\K\end{matrix}\right. \text{ Cyanate} \qquad N\left\{\begin{matrix}CS\\K\end{matrix}\right. \text{ Sulpho-cyanate.}$$

In the latter the metallic radical is not joined directly to the group CN, but *through* S. Thus, K – 3 – CN, and it is seen that when such a body is acted on by an acid, HCN is not formed, but but HSCN, which latter has not the poisonous properties of HCN (prussic acid). Iota Dash.

[76326.]—**To Mr. Bottone.**—Perhaps some of your paste has fallen away, and you have a short circuit. See to this; then charge away for a long time. I have no doubt that long charging, with short intervals of discharge, will remedy this. Your cells should run 20 lamps for 5 hours. S. Bottone.

[76328.]—**Modified Fuller Battery.**—To Mr. Bottone.—Each cell will give very nearly two volts when it has been working some little time; but owing to the presence of the porous cell and the small quantity of acid used, the internal resistance will be rather high. Hence, although your 12 cells may give as much as 20 to 24 volts, yet you cannot expect to get more than two to three ampères on the short circuit. You might expect to light well an 8c.p. lamp of about 20 volts. S. Bottone.

[76329.]—**Heating Bedroom.**—There is no method so satisfactory as a gas fire or gas stove, provided there is a reliable flue. If there is not a good flue with a steady upward draught, do not attempt to heat it, but remove into another and more satisfactory room. Thos. Fletcher.

[76330.] — **Bichromate Battery.** — To Mr. Bottone.—25 cells will give 50 volts. If the plates are immersed so that 16 square inches of carbon surface are in the liquid, and the distance does not exceed ⅛ of an inch from the zinc plate, the internal resistance will be about 0·08 of an ohm, so that you will get about 25 ampères on the short circuit. This you can reduce to 6 ampères by proportioning the resistance of the outer circuit so that the formula may come out $\frac{50}{8{\cdot}3} = 6$. The resistance of 65 yards of commercial copper wire, No 16, is about 0·6 of an ohm. S. Bottone.

[76331.]—**Coil Dimensions.**—To Mr. Bottone.—Coil heads square, 6in. × 6in., ebonite ⅜in. thick. Iron core 1½in. diameter, made of No. 18 wire; length, 14in.; paraffined cartridge paper tube $\frac{1}{16}$ thick, between iron core and primary; ebonite tube $\frac{1}{32}$ thick, between primary and secondary. Three sections, separated by ¼in. ebonite partitions—the two end ones of 1lb. each, the centre one of 4lb. Condenser, 200 sheets of tinfoil (interleaved with carefully-insulated paraffined paper) 10 × 12. Probable length of spark, with six good cells, 4in. S. Bottone.

[76333.]—**Microphone.**—To Mr. Bottone.—Possibly the movable carbon has too much play, or else there is dust between them. It may also be that the telephone diaphragm is not nicely adjusted, or that you are using too much battery power. S. Bottone.

[76334.]—**Armature Speed to get 50 Volts.**—Provided your dynamo is well made in other respects, you would need to drive at about 600 to 700 revs. per minute to get 50 volts. If the machine is compound-wound, there will be no necessity to use a resistance-board. S. Bottone.

[76337.]—**Electrical Indicator Improvement.**—You might modify Wheatstone's A.B.C., or Bréguet's dial instrument to serve your purpose, if perfect isochronism is required. You will find description and cuts illustrative of both these in Cassell's "Electricity in the Service of Man," pp. 804-5. If perfect isochronism is not necessary, two light motors would act well. S. Bottone.

[76339.]—**Curve.**—If the curve is circular—i.e., an arc of a circle, you can find the centre of the circle by drawing two or three chords, and erecting from the centres of these perpendiculars, which at the point of intersection will indicate the centre; length and height of arc, or of chord and versed sine, or of radius and number of degrees are essential to an equation. L.

[76342.]—**Steam Gauge.**—Taking the value of one kilogramme as 2·205lb., and one square centimètre as ·155sq.in., the pressure in pounds per square inch for every kilo. indicated would be $2{\cdot}205 \div {\cdot}155 = 14{\cdot}2$, so that the highest pressure, 6 kilos would be 85lb. per square inch. Halite.

[76342.]—**Steam Gauge.**—Kilogrammètres per square centimètre are very nearly equivalent to English atmospheres per square inch, being 14·2228lb. as against 14·7; and as all boilers for metric-using countries have this gauge, it is generally read here as, roughly, English atmospheres, should the usual English pressure-gauge not be affixed.

Liverpool. W. S.

[76342.] — **Steam Gauge.** — A kilogramme is equal to a little more than 2¼lb. A square inch contains about 6½ centimètres. When your dial registers 1 kilomètre, the pressure will be 14¼lb. as near as possible; but if you are going to put your gauge to any practical use, I should advise you to borrow a correct English gauge and fix both on same pipe, and then you could mark your dial to correspond. In this way you would "kill two birds" by testing your gauge, as all gauges are liable to get out of order. Borderer.

[76346.]—**Portable Electric Lamp.**—This is probably a Schanschieff battery. The charging solution is mercuric sulphate solution prepared in a special manner frequently described in these pages. S. Bottone.

[76347.] — **Coating Iron with Copper.**—Thoroughly wash the iron instrument with clean water, to which is added one part in twenty of nitric acid. Then rinse in clean water, and cover with a solution of sulphate of copper (blue vitriol), and a covering of copper will be deposited. Cost nominal. L.

[76349.]—**Ginger-Beer Plant.**—I have given full details of my experience with this plant (which I have now lost) at pp. 67 and 144 of Vol. XLVI. of the "E.M." for 1887, to which I beg to refer you. S. Bottone.

[76349.]—**Ginger-Beer Plant.**—This is very peculiar in its habits. I have never heard of any way of originating it; as to cultivating it, the very sweetened infusion of ginger which it is fermenting also acts as its food. I do not know where it is to be obtained. I never heard of it being a marketable commodity, though I know not why, for it is very useful in hot weather. It is revived from the torpid state only by use. I have never, to my memory, read anything about it except in "E. R. W.'s" query. A. E. B.

[76351.]—**Cycling.**—I do not know how the mathematician arrived at the conclusion he came to; but I know from practical experience that I would rather ride 30 miles on my bicycle than walk seven miles. I have often ridden close on 30 miles (correctly 28½) to a seaside resort, which is that distance from our place, and I have walked seven miles to a town, and I know that I am not near so tired after riding the long distance as I am after walking the shorter distance. My theory of the case is that in walking the muscles of the legs have to support the weight of the body as well as propelling it, while in riding the weight of the body is carried by the machine, and the leg muscles have only to propel the machine. In these days of ball bearings the friction counts for very little. [illegible] E. B.

[76351.]—**Cycling.**—It is true that the weight of the machine and the friction of the bearings would retard progress, but there are other facts to consider. In walking, the body is alternately raised and lowered at every step, while on the machine the motion is straightforward. Then there is a kind of accelerative motion in cycling: the first thrust makes the next more easily taken, and so on. The momentum of the body and of the machine is brought into use, but this is not so in walking. Theoretically, too, walking down a hill should not cause any muscular effort: nay, on Joule's theory they might almost expect an accumulation of force. How different is this from the case! In cycling such an accumulation exists, and its utilisation may be seen in numberless cases by those who know little of Newton, and nothing at all of Joule, great and worthy though they be. The cyclist's body is, in descending, quite still and free from effort worth mentioning, *facilis descensus* (sometimes Averni), while the pedestrian arrests himself, so to speak, at every step. A. E. B.

[76351.]—**Cycling.**—I think in this case the mathematicians are more likely to be right. In the first place, the pedestrian has to carry the whole weight of his body all the time, while the cyclist gets carried without this constant strain. I think there can be but one answer to the question: which is easier, to carry another man on your back or to pull him along in a go-cart? To my mind, the labour of propulsion is the very least part of the total exertion of walking. Men who rise much in their step incur the perfectly useless labour of lifting their bodies some 15ft. or 20ft. a minute, or, in other words, spend all their time in climbing Ludgate-hill. With regard to cycles, some are much better planned than others. to diminish labour. Those which approach nearest to maintaining the standing position, while supporting the weight and allowing the work to be done by a straight thrust with the leg, seem to me to come the nearest to solving the problem. Some makers, however, seem to imagine that since sitting is an easier position than standing, therefore it must be an easier one in which to take active exercise. This is a mistake. The best way of applying the power (and I doubt if any make of machine completely solves the problem) would be by a short, sharp pressure of the foot, delivered vertically, and with the full weight of the body, at intervals of time corresponding with the steps in walking, say, two per second when high speed was desired. These impulses, being taken off by suitable mechanical means and converted into rotary motion, would, in my estimation, give a result certainly equal, and probably superior, to that quoted by the querist, namely, five times the distance for the same exertion. Qwerty.

[76352.]—**Polishing Celluloid.**—This is a secret of the trade; but a very good polish can be obtained by the use of wax, which is well rubbed in; after smoothing the celluloid, finish off with powdered chalk. S. A. M.

[76354.]—**Reagents.**—Weigh both the reagent and the distilled water. L.

[76354.]—**Reagents.**—Parts in chemistry are always parts by weight, unless specially stated otherwise. Qwerty.

[76354.]—**Reagents.**—In answer to "Water Analysis," if he understands the metric system, the plan is the following:—One part of salt to 10 of water means 1 gram of the salt in 10 grams, i.e., 10cc.'s of pure water. Thus, to make up a 10 per cent. solution of $BaCl_2$, weigh out, say, 100 grams of $BaCl_2$ and dissolve in 1 litre (= 1,000 grams) of water. In fact, parts by weight in both cases, only it is not necessary to weigh, but to measure the volume of the water. Iota Dash.

[76354.]—**Reagents.**—The figures 1 part of salt to 10 parts of water should refer really to weight; but it is easier to measure the water. The decimal system renders this simple, for 1 cubic centimètre of water weighs 1 gramme. Thus, by weighing out 1 gramme of salt, and measuring 10 cubic centimètres of water in a graduated vessel, you have 1 gramme of salt to 10 grammes of water. I suppose your "Practical Chemistry," which you do not name, employs the decimal system, which is now used in all scientific manuals of chemistry; if not, if you will state the name of your book, or what weights and measures you wish to employ, I will give you what information I can. Chem.

[76356.]—**Electro-Bronzing.**—For a large quantity of work I should advise a dynamo; but if you have only a few small jobs, it is not worth while to go to the expense of a dynamo. I have done bronzing both by battery and dynamos, giving different voltage and ampèrage; a deep bronze by a dynamo capable of giving out 40 ampères at 8 volts; the bronze has been varied by shifting position of brushes at commutator, having a good resistance board in circuit. But the best dynamo for bronzing that I have tried is one capable of giving 6 ampères at 10 volts. This machine was designed for very light work—such as tinsel filigree—and did its work very well indeed. A good deal depends on the solution, which can be made and worked by an experienced person to give any desired colour bronze by variation of current. There are various solutions for bronzing containing copper, zinc, tin, &c.; a full account of these is given in Watt's book on "Electro-Deposition," price 9s., or "The Electro-Plater's Handbook," price 3s., post free.

S. Robert Bonney, Electro-plater, &c.
Lewisham.

[76358.]—**Dynamo, 200c.p.**—To Mr. Bottone.—Armature 6in. diam., 6in. deep, wound with 6lb. No. 18. Field-magnet cores 7in. high, 3in. diam., wound with 30lb. No. 22 shunt connected. Will take about 1H.P. to drive if well made, more if indifferently wound. S. Bottone.

[76359.]—**Dynamo 150c p.**—Armature 4½ diameter 5in. deep, wound with 4½ No. 18; field magnet cores, 2½ diameter 6in. high, wound with 20lb. No. 22. You will need 125 punchings $\frac{1}{32}$in. thick for the armature; power required to drive, about ¾H.P. S. Bottone.

[76361.]—**Velocity of Dynamos.**—1st. By increasing the circumference of armature in the same proportion that you diminish the speed—that is, as 1·5 is to 1; or, 2nd, by winding the armature with half as much wire again—that is, 1·5 times as much as is on at present. This would probably necessitate using finer wire. S. Bottone.

[76363.]—**Noise of Steam.**—This is due to the steam partially dividing the mass of cold water, and creating what might be termed temporary vacua in it. The rapid condensation of the steam allows the walls of these vacua to again contract, and, crashing together, they produce the result respecting the cause of which "A. E. B." inquires. L.

[76363.]—**Noise of Steam.**—The rattling noise is caused by the sudden change of the gaseous steam to liquid water—i.e., its condensation. The liquid water rushing in to fill the vacuum caused by such change of state, is the cause of the vibrations which make themselves evident to us by sound. In the same way we can account for the "singing" of a kettle. Here, before the water begins to boil, the bubbles of steam rising from the bottom of the vessel have at first to pass through a cooler layer of water above them, and are gradually condensed.

Iota Dash.

[76363.]—**Noise of Steam.**—The rattling and banging noise made by steam discharging into cold water is probably occasioned by the strong vibration set up in the pipe and the water. This may be plainly made visible by leading the steam into the water through a leaden, or other somewhat flexible and elastic pipe, which will be thrown into very evident vibration. This is caused by the alternate gaining of the steam on the water, and the water on the steam, through condensation. The actual surface of the water opposed to the steam is not in one constant place, but fluctuates rapidly and violently, causing the vibration which we hear as sound, and can feel by applying the hand to the vessel containing the water. Qwerty.

[76364.]—**Albo-Carbon.**—I always understood that this was principally, if not entirely, naphthaline—a substance that is formed in the making of gas, and frequently deposits in mains and pipes through which the gas passes. It is also one of the products of the distillation of coal-tar. For its chemical characteristics, see any work on organic chemistry. Qwerty.

[76364.]—**Albo-Carbon** is the commercial name for compressed naphthalin or naphthalene, a beautiful and important dydrocarbon of the composition $C_{10}H_8$, and which, therefore, contains nearly 94 per cent. by weight of carbon, so the name Albo-carbon is not so inappropriate as at first sight appears. It may be obtained from coal-tar by fractional distillation, those portions which distil over between 180° and 200° C. giving a crop of crystals, which can be squeezed out, resublimed, and crystallised from their solution in alcohol. Pure naphthalin forms colourless, transparent, pearly, tabular crystals, very volatile, and having an odour between that of the jonquil and coal-tar. Many beautiful dyes are derivatives from naphthalin. S. Bottone.

[76364.]—**Albo-Carbon.**—The white substance used here termed "albo-carbon" is naphthalin, $C_{10}H_8$. It is prepared from coal-tar, which is distilled; the first portion of the distillate consists of naphthas, &c., whereas the second portion is rich in phenols, &c. This second portion being again distilled, the residue left contains naphthalin, which, on standing, separates out, collecting as a cake on the top of the oil. This is still very impure, and has to be purified. To do so when separated, it has to be washed with dilute alkali, strong sulphuric acid, and water, in turn. It is finally distilled and cast in moulds. By means of it the illuminating power of coal-gas can be increased over 50 per cent.; and as it can be obtained for less than 3d. per lb., the process is a very satisfactory one.

Iota Dash.

[76365.]—**Oxychloride and Other Cements.**—This is indeed a large order. Your correspondent wishes for some cement for an unknown purpose, to stand an unknown temperature. If he would say plainly and clearly what he wants, no doubt I could give him a simple, clear reply; but instead of this, he asks me to write a general treatise on the obscure, and little-known basic compounds of the metallic oxides—a subject which he is evidently aware I made a special study of for many years. To write what he asks would take at least a whole issue of the "E. M.," advertisement pages included. If this were done, that special number would have a circulation of one copy, which no doubt "W. M." would buy, and perhaps half-a-dozen others would go to different parts of the world. The subject is one of interest only to specialists, except so far as general facts are concerned, and the more striking of these are the following:—A strong solution of chloride of zinc, mixed with oxide of zinc to make a thick paste, sets into a hard cement, which resists in a singular manner the action of acids. The same compound of magnesia has the same property and expands in setting. Phosphoric acid and oxide of zinc form a much harder cement than either of the above; but the relative hardness depends on the density of the oxide used, and the addition of similar basic compounds of alumina in small quantities increases the resistance to acids enormously. Similar cements can be made with phosphoric acid and tin oxide, when the latter is in a form which is hydrated, and also with zinc oxide and its sulphate, the tin compound being as translucent as the finest Chinese porcelain. Thos. Fletcher.

[76366.]—**Cleaning Wiped Joints.**—Have you tried rubbing up with wet silver-sand? H.

[76366.]—**Cleaning Wiped Solder-Joints.**—If "Young Plumber" would touch his joints with a piece of tallow as soon as they are wiped, letting tallow flow all over and then wiping off with clean rag, he will find they keep bright much longer. I used to tie a piece of paper over mine until in place. Soiling again gives them a clean appearance; but let your soil be nice and black, and put on level.

Brand.

[76367.]—**Kellner Eyepiece.**—This form of eyepiece is specially adapted for observations in which a large field of view is desirable. L.

[76369.]—**Phonograph.**—The object of the brass shoe *d* on the "repeating-lever," Fig. 15, is to prevent the spectacle-frame from being lifted too far off the wax cylinder. For instance, when about to repeat a record, the handle *b* is raised until the shoe *d* touches the under surface of the guide rod, and in this position is moved back to the point of starting. If it were not for the shoe there would be nothing to prevent everything mounted on the sliding tubes from turning completely over if by chance the instrument were tilted on one side. It is also much more convenient, when sliding the spectacle-frame back, to know when the stylus is quite clear of the cylinder, without looking underneath the frame; and this we know is the case when the shoe presses against the guide-rod. The small lever *f* in the same figure, with the help of the spring *g*, holds the threaded half-nut on the "motion lever" down in the thread on the main shaft, thus compelling the shaft, when revolved, to carry along all the parts connected to the sliding tubes. If it were not for this small lever and its spring, the motion lever would sometimes be lifted up out of thread, and so be incapable of travelling laterally. Especially would this be the case when using the turning tool, on account of the greater resistance presented. W. Gillett.

[76371.]—**Subtraction Puzzle.**—The following answer is, I believe, right:—

	Miles.	Fur.	Poles.	Yds.	Feet.	Inches.
From..	1	0	0	0	0	0
Take..		7	39	5	1	5
Answer			− 1	+ 5	+ 1	+ 7 = 1in.

Two poles must be "borrowed" in order to subtract the 6yds., 39 + 2 = 41, and as we cannot borrow more than 1 furlong = 40 poles, we get 40 − 41 = − 1 pole. Therefore, 5yds. 1ft. 7in. minus 1 pole (i.e., 5yds. 1ft. 6in.) gives an answer of 1in. A. D. Southam.

[76371.—**Subtraction Puzzle: an Ingenious "Catch."**—The difference is 1in. exactly. The remainder, as far as the yards, is 1ft. 7in., but we can get no further, seemingly, without taking 1ft. 6in. (equal half a yard) of this, and so making the 5 yards in the minuend 5½ yards only (instead of 6 yards) to be taken from the borrowed "pole." This helps us out of the difficulty at once very neatly, the remainder being just 1in., as above stated. There seems to be no other way than this, except the inadmissible one of reducing all to inches, a much longer and quite unnecessary method.

Autolycus.

[76371.]—**Subtraction Puzzle.**—Thanks "Glatton" for this problem with a moral. The moral is, "The less you borrow the easier you will find to pay it back, and if you borrow too much you may be unable to pay it at all." The only way solve this problem legitimately is to "borrow" the first place half a foot, giving a first remainder one inch; then borrow half a yard, from which u have to take a foot and a half, leaving nothing; n five and a half yards from the next higher mination leaves nothing, and so on to the end. r American cousins laugh at our "nineteen and ven three-farthings" style of money, but they ll follow the antiquated tables of weights and measures, all of which are at least as awkward as the money table. *Nicht wahr*, "E. L. G."?

Gwerty.

[76372.]—**Mounting Parasites.** — The best plan, in my opinion, when they have been allowed to become dry and brittle, is to place them upon a slide, put cover-glass on them, allow clean carbolic acid to run under the cover. Allow the acid to remain till the parasite is perfectly clear. Warming the slide may be necessary. Run off the acid (by means of blotting-paper put to edge of cover-glass) and run in fresh acid once or twice to clean the preparation. Draw off the acid and run in benzole. Allow it to soak in well, and change two or three times. As soon as all appearance of the oily discs of the carbolic acid has passed off, replace the benzole by solution of Canada balsam in benzole. Use heat or air-pump to get rid of bubbles.

R. O. H.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

75872. Sleep Disease, p. 294.
75886. Dissecting Leaves, 295.
75897. Stove, 295.
75898. Plane Mirror in a Newtonian, 295.
75906. Spongy Gold, 295.
75917. Pressure-Gauge and Thermometer for Hot Air, 295.
75918. Hot-Air Back Pressure Valve, 295.

76101. Balance Swell Pedals, p. 380.
76104. Condensers for Biunial, 380.
76108. Series Dynamo, 381.
76123. Greater Britain, 381.
76139. Air Compressors, 381.
76140. Great Western (N.G.) and North Stafford Locos.

USEFUL AND SCIENTIFIC NOTES.

It is intended shortly to cover with a glass roof the Central Court of the South Kensington Museum, and devote the hall thus gained to the reception of articles in which the Circulation Department is concerned.

The "moving sidewalk," as it is called, at the Chicago World's Fair grounds, was recently opened to the public. This contrivance is practically composed of a ring-shaped platform of considerable diameter mounted upon trucks which are kept moving at the rate of about three miles per hour, on rails, fixed to the ground.

Artificial Teeth from a Hygienic Point of View.—It is common experience amongst dentists that a very large majority of artificial dentures worn are discoloured and by no means devoid of unpleasant odour. This lack of cleanliness, which arises sometimes from neglect, but often from want of instruction on the part of the dentist as to the necessary *modus operandi*, is a fruitful cause of inflammatory conditions. Débris of food mixed with saliva and mucus accumulating on a plate rapidly undergo decomposition, with the result of irritating the mucous membrane and producing a general inflammation of the oral cavity. The oral secretions become altered and vitiated, so as to cause dyspepsia, and caries of the remaining natural teeth is set up, which proceeds with great rapidity, especially in "clasp" dentures, not from the friction, but because the inside of the clasps most generally escape the brush. The materials used in the construction of artificial dentures differ widely in their effect upon the tissues with which they come in contact. A larger number of cases of inflammation of the oral tissues occur where vulcanite is used as a basis than with gold or other metals, and so prevalent is this inflammation in the case of vulcanite that it has received the distinctive appellation of "rubber sore-mouth." Several reasons have been assigned for the effects produced by vulcanite. Nearly all this material is coloured with mercuric sulphide (vermilion), which ingredient has been accused of being the cause of trouble; but an exhaustive investigation did not substantiate this view, one particular point being that "rubber sore-mouth" often occurred where black rubber was used, which contains no vermilion. The porosity of vulcanite, especially when not sufficiently vulcanised, renders it liable to retain deleterious material if not kept scrupulously clean.—*Lancet*.

QUERIES.

[76376.]—**Arc Lighting.**—To Mr. Bottone.—I wish to light an arc lamp of 1,000c.p. What size and pattern dynamo should I require, and what size engine to work it? Which is the best arc lamp? I require a very bright and steady light.—H.

[76377.]—**Cutting Mounts, &c.**—Will anyone tell me the best way to cut bevel openings in mounts, and best knife to use? Also are the ornamental corners on mitres of gilt frames applied ready gilded, and how are they fixed?—Moufra.

[76378.]—**Phonograph.**—To Mr. S. Bottone.—I am constructing an electric motor for a phonograph like the one described by Mr. W. Gillett, but wish to wind it for two large bottle chromic batteries instead of four, as described by him. Kindly say what quantity and size of wire to be laid on field-magnets and armature, and how many layers it will be? Also how to connect up in series—if to divide the current between the field-magnets or not?—S. G. B.

[76379.]—**Water-Motor.**—Could Mr. Bottone, or others, tell me what power a water-motor is that I have got by this description? The turbine is fitted with small cups to catch the water that is forced through a small hole from the branch in a house. The turbine is about 8in. diameter, and is fitted in a wood case about 11in. by 10in. by 2½in. inside the box. Would this be any good for experimenting with electric light? If so, what size dynamo would it run, and what type would be best? I am told there is 60lb. pressure of water, which turns the motor at a high speed.—New Subscriber.

[76380.]—**Gravity Escapement.**—To "G. T. C."—I have made a Denison's three-legged gravity escapement, which works well, except that the arms are lifted by the pins with a jerk. I think the fault lies in the shape of the pieces that encounter the lifting pins. Could you oblige by giving me directions for setting out this escapement? Legs of 'scape-wheel 2in. long. A sketch would oblige.—R. C.

[76381.]—**Electric Light.**—I have three Edison-Swan incandescent lamps of 8 and 16-candle power that I wish to use for photographic purposes. Would someone kindly tell me whether a bichromate battery would be the best to fit up for them, and how many cells I should want; how to charge and manage them, and what kind of wire I should require; how to connect to battery, &c., and how to make two switches? I would be grateful for full information and sketch, if possible.—Tyro.

[76382.]—**Heating House.**—I am about to heat my house both up and down stairs with hot water on the high-pressure system, using 1 5-16in. pipes with a ¾in. bore, also a coil of 1 5-16in. pipe. Would some reader assist by informing me as to the diameter of the coil and the number of rings necessary to heat about 359ft. of pipe? Also as to the best method of conveying it from one room to another? There are three rooms up and three downstairs. Any other information would be esteemed.—Reader.

[76383.]—**Magnetism.**—Two equal bars of steel, having been equally magnetised, are kept for a number of years in a vertical position, one with its north-seeking pole upwards, the other with its south-seeking pole upwards. The bars are so far apart that they do not act on one another Would one bar be found to have retained its magnetism any better than the other? If so, why?—Student.

[76384.]—**Gas-Fire.**—What is wrong with a gas-fire I have had put up, and which I cannot use on account of the fearful smell of the burnt gas which is emitted when the wind is in some directions? I have tried to stop this by closing the register completely, and also partially, but without success.—C. E. Lester.

[76385.]—**Rain-Gauge Measuring Glasses.**—In Dr. Scoffern's "Meteorology" (Orr's "Circle of the Sciences"), he says: A glass exactly 4in. deep, and 4in. internal diameter, would hold 1in. of rain caught by a rain-gauge 8in. diameter. Would the corresponding receptacle, 2¼in. deep and same internal diameter, be correct for a 6in. rain-gauge? If so, will "F.R.A.S." kindly say how the contents are calculated in relation to the size of the rain-gauge, and much oblige—Non-Mathematical.

[76386.]—**Petroleum-Oil Engine.** — Would some kind reader help me in the following? I have been lighting my house by electricity, the dynamo driven by a steam-engine of my manufacture; but I find the constant attention required, and the trouble of lighting the fire and stoking takes all the pleasure out of the electric light. I have no gas, being in the country. Which is the most economical and best carburetted air or petroleum engine? What length of cartridge, and cylinder, and diameter to give one effective horse-power — that is, capable of driving a 100c.p. dynamo? What is the best mode of ignition, and how are the patterns made to get the water jacket? A sketch of the best, with sizes of same and cost of working per hour, with petroleum and benzoline, both at 1½d. per pint, will be most thankfully received. I have learnt the theory of action from books.—A First Class Workman.

[76387.]—**Gibraltar Rock.**—I have a piece of rock (which came from one of the caves of Gibraltar), in the shape of a large icicle, 18in. long, 1½in. round one end, and ½in. round the other end, which is broken in three pieces. Can any kind reader tell me how I can join it together again? Have tried plaster of Paris and glue; but that is no use.—W. J. H.

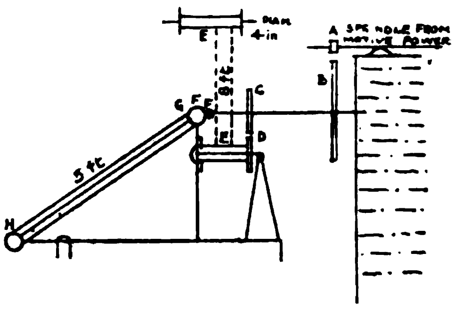
[76388.]—**Force and Pressure.**—Does a unit velocity of a unit mass represent the same amount of force as half the mass at double velocity? Also what would be the pressure on a flat side of a cubic inch of steel falling on a solid substance from a height of 16ft.?—Doubtful.

[76389.]—**Crystal Cavern.**—How can I give a crystallised appearance to a Portland-cement stalactite cavern in miniature for aquarium?—a deposition of a crystalline nature to withstand water being what is desired.—Stalagmite.

[76390.]—**Charging Accumulator.**—Will any electrical reader give me full instructions how to charge a small accumulator, which has never been used before, from a lamp circuit of 115 volts, particulars of what resistance will be required, and also amount of current? A small drawing showing position of accumulator, &c., in circuit will oblige.—Resistance.

[76391.]—**To Mr. Bottone.**—I have an ammeter with permanent magnet which does not register correctly. Would you kindly give me particulars how to recalibre same? On trying the magnet, I find it is very weak. I mention this as I thought perhaps strengthening the magnet would make the instruments more sensitive.—Ampere.

[76392.]—**Pulleys.**—Supposing that spindle (2⅜in. diam.) from motive power goes at the rate of about 200 revolutions per minute, I wish to know the size of pulleys A B and bevel-wheels F F to work strap on pulleys G H—diameter of pulleys, say, 4in. This strap to go at the rate of 1 rev. per minute; distance from G to H, 5ft. What size cogwheels, C D, to work strap on pulley E (diam. 4in.) to pulley E (distance between 8ft.) at five times the rate of strap G H? I may say that there is but very little power required to work the above, so the wheels and pulleys may be as light as possible; but the diam. of spindle from motive power would be 2⅜in. to 2¼in.—Count.



[76393.]—**Accumulators.**—Will Mr. Bottone or Mr. Allsop kindly tell me the cheapest and simplest way to construct a battery of accumulators to light twelve 16c.p. 50-volt lamps for about six hours per day?—Old Subscriber.

[76394.]—**Cutting Lathe Thread.**—Would any reader tell me how to cut a thread upright in the back of a wood-turning headstock to bring it upright with the bearings? Can I fit a small screw-cutting tool in a boring bar, or is there any simpler method?—New Reader.

[76395.]—**Cattle Shanks and Hoofs.**—Would any reader inform me what I could make of shanks and hoofs of cattle after boiling by steam to extract the oil? I sell the bones for 2s. per cwt. Could I sell the shanks to the cutlers, as the price I have for them at present does not pay me to buy them?—One in a Fix.

[76396.]—**Paint for Patterns.**—Will someone give good recipes for making red and black paint for painting wood patterns?—A. G. W. Baxter.

[76397.]—**Size of Water Pipe.**—Please say size of pipe necessary for supply (in London) of 300c.ft. per hour, and of 150 ditto? Also quantity of water from 6ft. elevation that would flow through ½in. pipe per hour, and ¾in.—Ramchullunder.

[76398.]—**Hand Polishing.**—Can any kind reader tell me the difference between hand-polishing wood and French polishing? Have heard that the former is by far the best, so would be very grateful for instructions as to doing it.—Lennox.

[76399.]—**Reservoir.**—Can any reader tell me what size reservoir I shall need for 18H.P. condensing engine, and cheapest way for making same? The land consists of stiff clay.—A rough sketch will oblige.—Agnew.

[76400.] — **Trigonometrical Distance.**—Will "F.R.A.S." or other correspondents kindly give me the *rationale* of the following solution of a question in Rosser's "Navigation"? Question: A lighthouse bore N.N.W. at 2 p.m., and at 4 p.m. it bore N.E. by N.; in the interval the course was W., and the distance run 12 miles. Find the distance of the lighthouse when the second bearing was taken. Solution:

Angle between N.N.W. and N.E. by N. = 5 points.
Do. „ 1st bearing and course = 6 points.
(point = 11° 15′).
Then— 5 points cosec. 0·0802
6 „ sin. 9·9656
Distance run 12 miles 1·0792
Distance of lighthouse log. 1·1250
= 13·3 mile.

13·3 miles from lighthouse when last bearing was taken.—L.

[76401.]—**Moon and Tide.**—Will some of your readers kindly explain the following difficulty? The R.A. of the new and full moons differ very much in each succeeding month. Thus there is a difference between the R.A. of the moon when new on July 5th and August 4th of about 163°. They are respectively, at the time of new moon, in the zenith to places on the earth's surface about this far apart. I should be glad to know what law governs this difference, and what effect it has on the tides. On July 5th, 1891, the tide was high at London Bridge at 13h. 48m., and about 1h. 47m. after the moon's transit of the meridian. On August 4th, about 2h. 5m. after the meridian. Why this difference, and why is the time of high water at p. 475 given at 1h. 48m.; while, on p. 473 of the *N.A.* it is always either more or less than 1h. 48m.? Seeing that the R.A. of the new moon is different every month, it follows, as the tide due to new moon follows the moon, it has to be pulled round 163° further to the west since July 5th, and apart from the priming and lagging of the tides, causes some difference in the extent of the tide, and in the distance it is behind the moon's transit of the meridian. I confine my attention to the tide following the new moon only. If the moon were new or full when in the zenith to the meridian of Greenwich, I suppose the tide following would be higher than if she were full 90° to east or west; but wherever her R.A. may be at new or full, the difference in longitude between succeeding months must make some difference in the time and extent of the tides during the whole interval. W. W.

[76402.]—**Electric Lighting.**—Two houses 1,000 yards apart; midway between the two I have a water-pressure 150ft. high. I want to light the two houses with one 40 and three 10 candle-power electric lights in each house. Will some reader tell me what plant I would require, including water-motor? I want to work with accumulators, but don't know how. Being dense jungle, I could not trust to night running of the dynamo.—Western Ghat.

[76403.]—**Size of Crucible.**—Would any of our correspondents tell me the amount of brass I should require to cast a cylinder of 2½in. bore, 2½in. stroke (slide valve), and where I could obtain crucible for same?—G. Stanbrook.

[76404.]—**Plumbous Oxide.**—There is a plumbous oxide (Pb_2O) of a black colour. Could any reader tell me how to obtain it?—W. G.

[76405.]—**Lunar Photography.**—Can any of the readers of the "E. M." who are interested in this say if successful photos. of the moon have been made with a small 3½in. telescope, mounted on a simple equatorial stand (with slow motion). A friend and I have attempted this, and by keeping the eye at the finder, thereby keeping the object in the field, we have succeeded in getting plates that give the limb of the moon sharp and well-defined, therefore leading us to think that the object was held steadily on the plate; but from lack of knowledge or experience, cannot get detail. There being so many amateur photographers, as well as astronomers, nowadays, I should think this matter has been fully tested, therefore I write to the readers of the "E.M." to learn whether our failure is from lack of experience, or appliance, instrument, and apparatus?—Jas. L. Park, Braddock, Pa.

[76406.]—**Vacuum Tubes.**—Many thanks to "E. E. B." for his articles on the above subject, on which it is difficult to get any reliable information. Would that gentleman kindly mention the approximate degrees of exhaustion at which the various phenomena occur? I have tried to pass a spark from a coil giving ½in. spark at ordinary pressure through a small tube exhausted to ·0015mm. (measured by home-made McLeod's gauge), and did not get any phosphorescent effect. The tube was of lead glass. Would that account for it? I have got the usual phenomena at ·5mm. pressure. Also, is there any definite connection between the lengths of tube which can be illuminated at, say, 5mm. pressure and the length of spark in air—e.g., How long a vacuum tube could be well illuminated by the before-mentioned coil?—H. G. D.

[76407.]—**Lubricant for Turning, &c.**—Will any reader inform me how to prepare properly the liquid usually termed "soap-and-water" (used in turning, drilling and milling, &c., iron and steel), so that it positively won't rust either the work or machine. I have been using soft-soap and soda dissolved in boiling water; but find this only partially protects from rust. The preparation used at the Enfield Gun Factory I noticed was in appearance like milk, and no sign of rust was perceptible about either their work or machines. I should like their recipe, if any readers could give it.—Cyclo.

[76408.]—**Portable Stoves.**—Can anyone oblige with a description of Chouberaky's portable stove, and what it burns? I am told it is extensively used on the Continent, particularly in France. Does it require piping?—L.A.I.E.E.

[76409.]—**To Mr. S. R. Bottone.**—What size core, coil, and condenser, also what primary and secondary wires, must be used for ½in. spark coil? How many bottle bichromates to be used to give full effect?—R. S. Cotton.

[76410.]—**To Mr. Bottone.**—I have a pair of magnets made from steel 12in. long, 2in. wide, by ⅜in. thick, and wish to use one or both for motor; so should be glad to know best arrangement of F.M. and armature, size and quantity of wire to get best results. They are now very weak. A sketch, if convenient, would be a great favour.—Hopeful.

[76411.]—**To Mr. Bottone.**—I want to make a small Manchester dynamo to give 15c.p. I shall be much obliged if you will kindly say size of cores and armature (should prefer using a Siemens H), amount and size of wire on each F.M. and armature. About what power (volts and ampères) should I get, and what speed should I drive to obtain same? A reply will much oblige.—Manchester Dynamo.

[76412.]—**Dynamos and Batteries.**—I have, I believe, seen it stated that a dynamo, say, giving 20 volts and 4 ampères, would light four 20-volt lamps taking 1 ampère each; but 10 cells of a battery would only light one 20-volt lamp. Do batteries only give 1 ampère; as why should not the 10 cells also light four of the same lamp? Also, what is the reason that plating dynamos give so many more ampères than lighting machines? An explanation will greatly oblige?—J. C. S.

[76413.]—**Chromic-Acid Cell.**—Will a reader of "Ours" please give instructions for making a double-fluid chromic-acid cell—i.e., what liquid in porous cell, and what in outer cell; also strength of solutions?—Doxy.

[76414.]—**Gas or Steam.**—Will some reader tell one who is perplexed whether gas or steam would be best to adopt, on the score of economy and convenience, for driving mill and machinery requiring 100 to 150H.P? In either case it will be requisite to have several engines working intermittently in different parts of the premises. I shall have to erect a gas plant on a fairly large scale to supply gas for manufacturing purposes independently of lighting, and shall be in a good district for coal. Water-gas I should not like, because of danger.—T. H. S.

[76415.]—**Water Indication.**—How may I be able to know at the surface the level of water in a well 120 yards below the surface, the water constantly varying? Please to explain, with a sketch of apparatus.—Perplexed.

[76416.]—**Motor, Electro.**—To Mr. Bottone.—It has occurred to me that some useful purpose might be served by placing a secondary coil on the top of the other coil of the electro-magnet of a motor or dynamo. Can you say if this has been tried? An induced current of greater or less intensity could be obtained.—Traveller.

[76417.]—**Motor or Dynamo.**—In designing the iron carcase of a motor or dynamo, how is the proportion of iron regulated to the amount of wire used, and what would be the effect of using too much iron in the carcase for the amount of wire put on?—Traveller.

[76418.]—**Razors.**—I should feel extremely obliged if some readers would instruct me how to set about grinding and setting my own razors. Some hints on choosing, &c., would also be of service.—Gaunman.

[76419.]—**Pedals.**—Can any reader give the measurements, and diagrams if possible, of a set of organ pedals (30) to be put to an old cottage piano by Broadwood? I want them to be made removable, as I have not much space in my room. Would a roller-board be necessary, or would backfalls alone do the work?—Norvicensian.

[76420.]—**Image of Sun.**—How is it possible to produce on a screen an image of the sun sufficiently large to see the mottled surface? The image formed by the object-glass of a hand telescope is very small. How is it enlarged?—No Sig.

[76421.]—**Gas-Burner for Lantern.**—It is required, for a certain purpose, to have a small picture shown by a lantern, but it is necessary to be as bright as possible. Unfortunately, there are reasons that prevent the limelight being used, and mineral oil is prohibited; so that coal-gas is the only possible light to be used. Under these circumstances, can any of "ours" kindly inform me which form of burner will give the most light? The Argand burner gives but poor light, and not sufficiently concentrated. Is there any form of burner that gives a small but bright light, as the large flames spoil the definition? Has any form of "mantle" been tried in the lantern? Consumption of gas is of no importance.—A. Bosquet.

[76422.]—**Electric Bells.**—To Mr. Bottone.—I have looked all my back numbers up, but cannot find anything in reference to the six bells I wish to fix in connection with my lift, which I mentioned to you in query 76819. If not asking too much, a sketch will greatly oblige.—W. Taylor.

[76423.]—**Steam Injector.**—Will someone kindly explain above? My difficulty is this: There must, I suppose, be one opening in the boiler, wherefrom the steam escapes to propel the water, and another to allow the water to enter. Why does not the steam press as hardly from the latter opening as from the first? I have no doubt my premises are wrong, and "there's the rub."—A. E. B.

[76424.]—**The Bumping of Railway Trains.**—What is the cause of this? The rhythmatical order of the movements perceived when one is in the train would seem to denote irregularities in the wheels, or beds of the carriages; but, standing on the platform when a train is running through, the beats seem to proceed regularly from definite positions in the permanent way. It would be interesting to hear expressions of opinion as to this. My own opinion is that it is caused by irregularities in the wheels, caused by friction when the brakes are applied.—A. E. B.

[76425.]—**Stain.**—How can I get iron out of wood that has been stained? It works out in a whitish powder, although repeatedly varnished.—H.

[76426.]—**Fuller Battery.**—How is this battery made up, and whether it is suitable for small jobs (plating and gilding) occasionally—say, once a week? Cannot find anything suitable in back numbers.—H.

[76427.]—**Photographic Studio.**—I have a plot of ground facing north, large enough for building a studio 22ft. by 12½ft., and would much like to have advice as to how to build it, and how high to make it, giving best possible results for portraiture? I wish it to be as light and rigid as possible, and to be made without stone. What size ought the panes of glass to be, and should it be frosted glass? I should be very much obliged to anyone who would kindly give me their help on the subject, and any further details they may think necessary, as I wish to have it as first-rate as possible.—H. B. A.

[76428.]—**To Mr. Bottone.**—I have a dynamo, bought secondhand, and want to know the voltage and strength in ampères. The size of the field-magnet coils is (outside dimensions) 1⅝in. by 6in. by 5¾in., with No. 16 wire. The armature has two separate coils end to end, wound at right angles to each other, each being 3¼in. by 2in., making the armature coils 7in. long; No. 22 wire; H laminated type; the commutator divided into four; ordinary Siemens two-pole type; shunt-wound, and weighs altogether with mahogany base 44lb. 2. Also, could you tell me the advantage of chromic-acid solution over the ordinary bichromate of potash and water and sulphuric-acid solution for bichromate cells.—Novice.

[76429.]—**Accumulators.**—To Mr. Bottone.—I am going to make a dynamo, 50 volts 10 ampères, for lighting. I shall want to charge cells. How many may I charge? Also, what will be the number of ampères that I shall be able to get in each cell, the cells being 9in. by 5in. diameter?—F. T.

[76430.]—**Indicating Gas-Engine.**—Will some kind reader inform me whether there is a standard size of a rope for indicating gas-engine, &c.? and how is it done to get the exact brake horse-power? A sketch will oblige.—R. B. W.

[76431.]—**Silvering Specula.**—I wish to make a mirror with a non-tarnishable surface, and for this purpose require to deposit on the concave surface of a glass a thin coating of platinum or gold, much in the same way as silver is deposited from an ammonio-nitrate solution by the addition of sodic potassic tartrate. This latter I can do easily; but have failed over platinum and gold. Muller, page 842, Part II., says:—"By using a solution of auric ammonic citrate, it is easy to gild upon glass, and in a similar way the surface may be platinised if a solution of sodic platinic tartrate be employed." A [illegible] description how to do this would oblige, especially [illegible] the platinum, for I only get this thrown down as platinum dust, and not as a coherent deposit like in the silver process.—Onoma.

[76432.]—**Brass Castings.**—Will some kind reader help one in trouble? I do some brass casting. Lately I received an old gunmetal bush-plate for hydraulic pneumatic gunpowder machine. I made hot, and broke it, used with other good old gunmetal and small quantity of tin, but cannot get any work sound. Have melted many castings over and over again, yet cannot get sound castings that have same metal in them. Also I have large quantity of the borings. What can I put with them for sound engineering castings? I use yellow soap as flux. I find, by cutting with chisel, the bush-plate is like sponge, yet the surface and hex-holes are dead smooth.—One in Trouble.

[76433.]—**Testing Internal Resistance of Battery.**—Many thanks to "J. T. S." for reply to my query. May I trouble him for a little more information? How can I get my data for solving the equation $\frac{E}{C} = R$, considering I have neither voltmeter, ammeter, nor tangent galvanometer, and that is the reason why I wanted to perform the experiment by the method I mentioned. I have only a Wheatstone bridge + resistance coils. Could the internal resistance of a battery cell be measured in this way? Place the cell in one arm of the bridge making the connections to the two carbons (it is a double-carbon bichromate), and leaving the zinc disconnected to anything, so that the current from the standard cells has to pass from one carbon through the liquid to the zinc, and from the zinc through the liquid to the other carbon. Measure as an ordinary resistance. In your reply, you say that if two cells joined in opposition give a current, it shows that the E.M.F. of one is greater than that of the other. Might not the resistance of one be more than the other?—Walter Herbert.

[76434.]—**Bending Violin Sides.**—Will "Violin Maker" or some other reader kindly say how to bend violin sides to shape?—Violin.

[76435.]—**Pianoforte out of Order.**—I have a trichord piano which was tuned a few weeks ago; but lately one or two of the notes, when played, sound as if there were something touching the vibrating wires, causing them to give forth an imperfect sound. I have examined the wires, but can find nothing about them to cause this grating sound. Is it caused by the three wires not being equal in tone, or by some other wire vibrating? Further, I would like to know which is the best material for making the pads fixed on the ends of the keys upon which the upright rods rest? These pads in my instrument have become quite hard, and cause the keys to rattle disagreeably.—P. C.

[76436.]—**Wimshurst Machine.**—I am about to make a Wimshurst machine, say of 18in. diameter. In "Lectures on Electricity," by Forbes, p. 22, there is given a representation of a double-plate machine of this kind, but it shows three Leyden jars, and I expect another one is supposed to be hidden by the plates. I am a pretty good amateur mechanic, and am anxious to follow the urgent request of "J. W." in your issue of Nov. 27, [illegible] and make a really useful machine, in accordance with the directions of the inventor, and I think I can do so if I once clearly understand them. Will "J. W." or Mr. Bottone tell me (*a*) if two or more Leyden jars are generally fitted to a double-plate machine? (*b*) As Mr. Forbes speaks of "connecting the outside of the Leyden jars," what are the arrangements to effect this? (*c*) I have a large collection of the usual instruments to illustrate frictional electricity (now, it seems, a thing of the past), such as large diamond jar, very large battery of Leyden jars, Cuthbertson, Harris, and Universal dischargers; electric egg, spangled tube, frightened head of hair, &c. Can I make these available in experiments with the Wimshurst show? (*d*) Can I depend on the method described by Mr. Bottone of fixing the bosses on the glass discs with "bichromate paste" and "acetic glue," and does he mean by "glacial acid" the ordinary fluid glacial acid of commerce, or crystal glacial acid? The former, I am told, contains only 30 per cent. of the latter. (*e*) Where is the thin brass which some recommend to make sectors of instead of using tinfoil, to be had?—W. E.

Artificial Oyster Cultivation in France.

The United States Consul at Bordeaux in a recent report describes the artificial cultivation of oysters in France. He says that in 1872 the increased [illegible] of oysters led to official investigation, and subsequently to the introduction of cultivation by artificial means. The modes of providing artificial beds vary with the nature of the bottom and the violence of the wind and waves. Tiles covered with cement and immersed along the sea-beach are found the most advantageous, for they present a surface to which the oyster can readily attach itself, and from which it can afterwards be easily removed. The tiles can also be transferred from place to place without difficulty, which is a matter of some importance, as the processes of breeding and fattening may require different temperatures. The Bay of Arcachon, one of the centres of oyster cultivation, was at one time crowded with natural beds, but owing to excessive dredging they became exhausted. The industry has revived there owing to artificial culture. The whole of the sea bottom that can be dredged, to the extent of 12,600 [illegible] is staked off into inclosures. In some instances nets are attached to the stakes to keep out lobsters and other fish. It is inside these parks, as they are called, that the tiles are immersed. These are usually firebricks covered with mortar, with a surface of 2sq.ft., and accommodate from [illegible] to 600 oysters. The latter grow so rapidly that the owner of the park has frequently to raise the tiles to the surface in order to scrape off the oysters for which there is no room, while he sinks more tiles to give them a home.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, FEBRUARY 5, 1892.

PRACTICAL ELECTRIC-LIGHT FITTING.—XII.

By F. C. Allsop.

Author of "Practical Electric-Bell Fitting," "Telephones: their Construction and Fitting," "Electric-Bell Construction," &c.

Arranging the Circuits.

THERE are several methods of connecting up the lamps to the dynamo or other source of supply, the more prominent of which are the "series," the "parallel," the "multiple-series," the "series-parallel," and the "three-wire" systems. Of these, the only one that has an extended application, or is suitable for all-round purposes, is the "parallel," which is also frequently called the "multiple-arc" system. The following diagrams show these different systems of connecting up lamps, the source of supply being a dynamo, and the lamps being indicated by the black circles. It is needless here to go into a detailed description of the action and construction of a dynamo, as this will be familiar to most of the readers of the "E. M." It suffices to say that when the armature is revolved, a difference of potential or difference of electric pressure is set up between the two terminals seen at the top of the machine. The one with the higher pressure is termed the positive, and the other the negative terminal; in the diagrams the right-hand side one is assumed to be the positive. When we join these two terminals with a conductor we have a "flow" of electricity from the positive terminal to the negative, the amount of this flow being governed directly by the resistance of the conductor and indirectly by the winding and construction of the dynamo.

It is customary in electrical work to speak of this flow as if there was some such transference, as is the case with gas or water passing through a pipe, though, strictly speaking, the exact action that takes place is not known. For practical purposes, however, it will be sufficient if it is borne in mind that we have the two terminals of a dynamo, battery, &c., or it may be the two wires from an electric-supply station, the one of which (called the positive) is raised to a higher electric potential than the other, and that if we connect these two wires or terminals with a conductor, a current of electricity, as it is called (or, for short, a current), flows from the positive wire to the negative, so long as the difference of electrical pressure between the ends of the circuit is maintained. The current is always trying to pass from the positive wire to the negative: hence the necessity of well insulating the wires, and if a number of paths be provided, it passes through all these paths in proportion to their respective resistances; those with a high resistance allowing only a little to pass, and those with a low resistance a large amount. If a path of very low resistance, in comparison with the other paths, is provided, almost all the current will be diverted through it, and the two wires or terminals, as the case may be, are said to be "short-circuited."

There being a difference of potential between the two wires or terminals, there is, therefore, a tendency for a flow of electricity to take place, and this tendency to produce a flow or current is called "electro-motive force," or for short E.M.F. A machine with a certain difference of potential between its terminals is said to have such-and-such an E.M.F. The wires, lamps, &c., between the terminals of the machine are called the "circuit" which has a certain resistance, according to the size of the wires and the arrangement of the lamps. If the dynamo is large enough to supply all the current we require, as we vary the resistance of the circuit, so we vary the flow or amount of current passing.

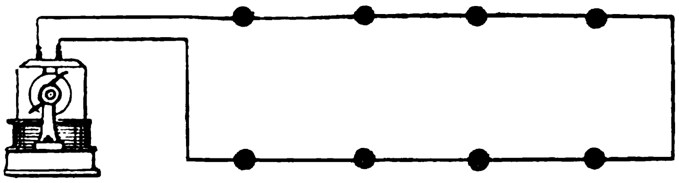


Fig. 105.

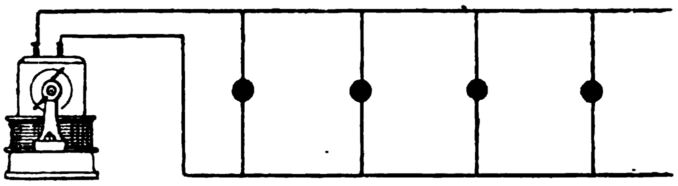


Fig. 106.

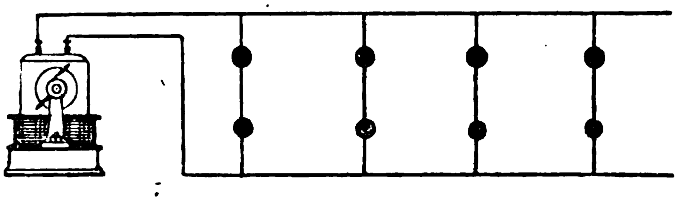


Fig. 107.

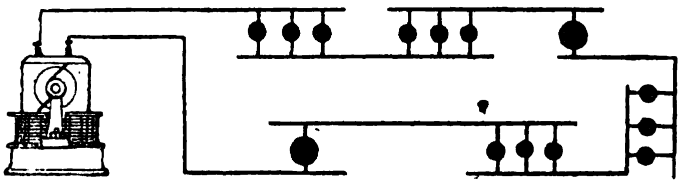


Fig. 108.

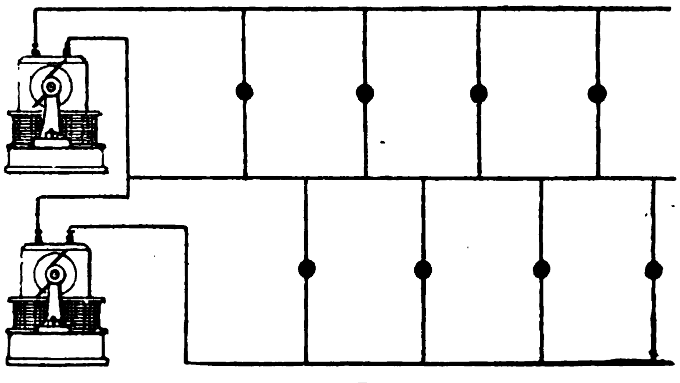


Fig. 109.

In a circuit, then, we have three things: 1st, resistance; 2nd, the strength of the current passing; and 3rd, the E.M.F. at which the current is supplied. The unit of measurement of E.M.F. is the "volt," of current strength the "ampère," and of resistance the "ohm." Ohm's law, "that the strength of the current varies directly as the E.M.F., and inversely as the resistance of the circuit," enables us, if we have two of the factors, to find the third. Thus, if we know the E.M.F. and resistance, we can find the current; or if we know the current and resistance, we can find the E.M.F.; and likewise, if we have the E.M.F. and current, we know at once the resistance. The law can be expressed as an equation thus: $E = C \times R$ or $C = \frac{E}{R}$ or $R = \frac{E}{C}$; where E = the E.M.F., C = the current, and R = the resistance. Thus, if a dynamo has an E.M.F. of 50 volts, and we know the total resistance of the circuit to be 5 ohms, then $C = \frac{50}{5}$, C = 10 ampères. Or, to find the E.M.F.: $E = 5 \times 10$, E = 50 volts. Or, again, to ascertain the resistance, $R = \frac{50}{10}$, R = 5 ohms. We will now pass on to a description of the different ways of arranging the lamps, the first of which is

The Series System.

Fig. 105 shows this method of arranging the lamps. The current starting from the positive terminal of the dynamo, passes from one lamp to the other right round the circuit back to the negative terminal. This is a favourite way of arranging arc lamps, but is not suitable for incandescent lamps, as the extinction of one puts out all the others, unless, of course, there is some electro-magnetic shunting device, the action of which devices are, at the best, very uncertain. Arc lamps designed for series working are, of course, fitted with an automatic arrangement that short-circuits them when the carbons are burnt out, or anything goes wrong with the lamp. A dynamo working lamps in series requires to have a high E.M.F., and the object to be obtained is to keep the current in the circuit constant. For the eight lamps shown in the figure the dynamo would require to have an E.M.F. of about 400 volts, and the current in the circuit would be about 10 ampères. The resistance of circuits with lamps in series is the resistance of one lamp multiplied by the number of lamps or $R \times n$, where n equals the number of lamps. Of course, to find the total resistance of the circuit, the resistance of the wires passing from one lamp to the other requires to be added to this amount. The difference of potential at the terminals of the dynamo would be 400 volts, which gets less and less by 50 volts as we pass each lamp going round to the negative terminal. A switch placed close to either of the terminals, or, in fact, anywhere in the circuit would cut off all the lamps, so in extinguishing arc lamps in series the switch to each lamp does not break the circuit, but merely short-circuits the lamp.

The Parallel System.

This system is shown in Fig. 106, and differs considerably from the preceding one. Each lamp is, it will be seen, arranged on a separate wire, which is a bridge across the positive and negative wires. Each lamp can then be lighted or extinguished without affecting any of the others on that circuit. Here the object to be obtained in keeping a steady light is to keep the E.M.F. constant, and the current should vary only with the number of lamps alight at one time. Supposing the lamps in the figure to be 50-volt 16c.p. lamps, taking approximately 1·3 ampères, then the E.M.F. of the machine would be 50 volts, and the current in the circuit four times 1·3 ampères = 5·2 ampères. As there would probably be a slight loss in the conducting wires, the speed of the dynamo might have to be slightly increased so as to raise the E.M.F. to 51 or 52 volts, to get the required current through the lamps. A switch in the main wire just by the positive or negative terminal of the dynamo would control the whole of the lamps; but a switch inserted in each bridge close to each lamp would only affect that lamp corresponding to the bridge in which the switch is placed. The amount of current passing along each bridge depends entirely on its resistance, for if we substitute a 32c.p. lamp (which takes double the current) for either of the 16c.p. lamps, the lamp would burn equally well, and the only difference in the circuit would be that the dynamo would have to supply an increased amount of current. It will thus be seen that the parallel system is eminently suited for incandescent lighting, owing to each lamp being entirely independent of the others on the circuit.

The "resistance" of a wire is the amount of opposition that it offers to the passage of a current, while the "conductivity," on the other hand, is its capability of conducting one. *Conductivity* is, it will thus be seen, the reciprocal of *resistance*. In parallel or divided circuits, the amount of current passing in each branch is proportional to their conductivities, and the total current passing in the "mains" will be the sum of the different currents in each branch. The total resistance of the circuit will, of course, be considerably less than that of any one single branch, because of the numerous paths for the current to travel by. The joint conductivity of the circuit, in fact, will be the sum of the conductivities of the separate branches. For example, suppose in Fig. 106 the resistance of each of the four bridges to be 20 ohms, then the joint conductivity of the circuit will be $\frac{1}{20}+\frac{1}{20}+\frac{1}{20}+\frac{1}{20}=\frac{4}{20}$. Taking the reciprocal of $\frac{4}{20}$ we have $\frac{20}{4} = 5$ ohms, which will be the total resistance.

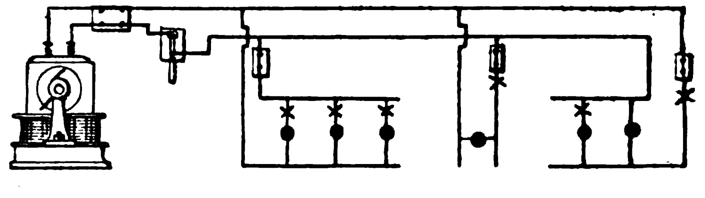


Fig. 110.

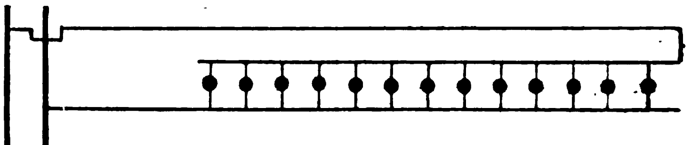


Fig. 111.

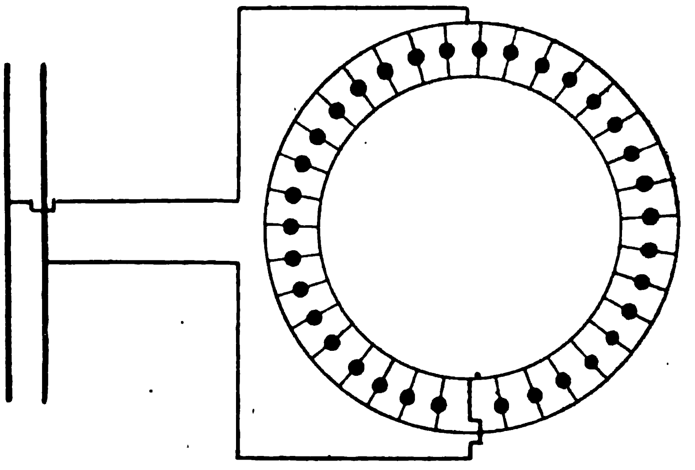


Fig. 112.

With lamp in *series*, the current will, as we have seen, be always constant, whatever the number of lamps, and the size of the wire need not be altered, the E.M.F. only having to be increased as the number of lamps increases. In parallel circuits, however, the reverse is the case, the E.M.F. being constant and the current varying with the number of lamps. Thus the greater the number, the larger will have to be the feeding mains, and *vice ver â*. The remaining systems are more or less combinations of the parallel and series methods of arranging lamps. We have, first—

The Multiple-Series System.

This system (Fig. 107) very much resembles that just described, the difference being that we have two, three, or four lamps, as the case may be, in each branch. In the figure there are two in each branch, and if the lamps were 50-volt the dynamo would require to have an E.M.F. of 100 volts, as the lamps in each branch are in series. The conductors in Fig. 107 would require to be only of one-half the sectional area of those in Fig. 106; so there is thus saving in copper in arranging lamps on the multiple-series system; but it has the disadvantage that if one light is extinguished all the others in that particular branch are put out. It is chiefly employed in very large buildings, or where it is required to subdivide the lights up in one portion of the circuit.

The Series-Parallel System.

This system is shown in Fig. 108, and is chiefly employed for running arc lamps and incandescent on one circuit. Since the advent of transformers it has been but little used; but was in use in Brighton, Hastings, and several towns some few years ago, as a means of supplying both arc and incandescent lamps on one circuit from the central station. The method of working was as follows:—A 2,000c.p. arc lamp requires a current of 10 ampères, which is also about the current required for eight or ten 50-volt 16c.p. lamps in parallel. When incandescent lamps were required, then they were placed in groups of ten in parallel in the house or shop requiring them, these groups being in series with the arc lamps. It was only necessary, therefore, to keep a constant current of 10 ampères in the circuit to run both the arc and incandescent lamps. Special regulating devices were placed at the central station to automatically keep the current constant. In the figure the arcs are represented by the large black circles, and the groups of incandescent lamps by the smaller ones, only three lamps being shown in each group. It is necessary to provide in each group an auxiliary lamp that is cut into circuit automatically by the extinction of any lamp in that group, to prevent the remaining lamps being burnt up by the increased current pending the renewal of the broken one.

The Three-Wire System.

Fig. 109 shows this system, which is chiefly employed for street mains. As will be seen from the figure, two dynamos are employed, these dynamos being coupled in series, and joined to the three conductors, as shown. If the dynamos have an E.M.F. of 100 volts, the difference of potential between the two outside mains will be 200 volts, and between either of the outside and the centre one 100 volts. This system has been very successfully applied in London by the St. James and Pall Mall Electric Supply Co., the different houses where current is required being connected alternately to the top and centre, and bottom and centre mains. Thus, though the mains carry a current at 200 volts, the E.M.F., or pressure, on each consumer's house-mains is only 100 volts. It will be seen that a large saving of copper is effected by arranging the mains in this way over an ordinary parallel 100-volt circuit.

Arranging the Wires to Equalise the Fall of Potential.

Fig. 110 shows the usual manner of arranging lamps on the parallel system, with switches and cut-outs. The main cut-out is marked *a*, the main switch *b*, the small, or branch, cut-outs c^1, c^2, c^3, and the branch switches thus X. The cut-out *a* should be a double-pole one, as it protects the whole of circuit, and the main switch *b* will switch on and off all the lamps. The cut-out and main switch should be as close to the terminals of the dynamo as possible. It will be seen that a cut-out is placed at the root of each branch as it leaves the mains, and the branch, or lamp, switches are placed at such points that they will turn off the one lamp only. Of course, the lamps can be placed in various positions; but the principle on which they must be arranged with the switches and cut-outs will be understood from the diagram.

In the parallel system, where there are a large number of lamps a great distance from the mains, there will be a slight drop in the potential at the farthest lamp. The conducting-wires offering a certain resistance, there is a certain loss of E.M.F., which loss will increase the farther we get away from the supply mains or the dynamo. The smaller the wires, the greater will be their resistance and the more will be the drop in the pressure, which will also increase with the amount of current passing. Two ways of arranging the wires, so that the E.M.F. at the furthest lamp is approximately the same as that at the nearest one, are shown in Figs. 111 and 112. The mains are indicated by the heavy black lines, feeding-wires to the lamps by the thinner ones, and the lamps by the black circles as before. In Fig. 111 it will be noticed that the top wire, instead of being taken, as in Fig. 106, to the nearest lamps, joins first at the farthest one, so that there is an equal amount of conducting-wire between any of the lamps and the mains. In Fig. 106 the farther we get along the mains from the dynamo the duller will be the lamps, because the circuit of each individual lamp is longer and longer as we get away from the machine. On comparing Figs. 106 and 111, it will be seen that whatever the number of lamps, the farthest would be equally as bright as the nearest.

Fig. 112 shows another way of arranging the lamps to get an equal difference of potential. The wires joining directly to the lamps are run in two circles, the wire from one main feeding the outer circle and the other the inner one, at diametrically opposite points. In large buildings, where there is a dome, this method of arranging the lamps will be found to have a very good effect, though of course it is not necessary for the loop of lamps to be circular. Whatever the shape, however, the great thing is to join the feeding-wires to the loop at such points that there is an equal amount of wire between them. Unless the number of lamps is large and the distance very great, it will in most cases be unnecessary to arrange the lamps other than on the simple parallel system shown in Fig. 106, as fall in the E.M.F. will be inappreciable.

(*To be continued.*)

PRACTICAL MICROSCOPY FOR STUDENTS.—XVIII.

By Frederick Davis, B.Sc., Associate of the Pharmaceutical Society, &c.

In treating "pond-life" it will perhaps be expedient to place before the student a table or system whereby he may acquire, and be able to refer to, the animal classes any creature he may come across in the course of his studies. This will not only give him a knowledge of the divisions, classes, and examples of the Animal Kingdom, but will season his biological researches with greater piquancy. It must be understood, however, it is not our intention to treat fully of every creature belonging to any particular division or class, but merely to take some leading type and describe its salient characters referring especially to microscopy. The Animal Kingdom is divided into two sub-kingdoms, Vertebrates, and Invertebrates—that is, animals possessed of a back-bone or vertebræ, and those not so possessed.

Animal Kingdom.

Sub-Kingdoms.	Divisions.	Sub-Divisions.	Meaning.	Examples.
Vertebrata	Mammalia		Breast-feeders	Human beings, ox, &c.
	Aves		Birds	Swallow, goose.
	Reptilia		Creepers	Snake, lizard.
	Amphibia		Liver in air and water	Frog.
	Pisces		Fish	Salmon, cod.
Invertebrata	Mollusca	Cephalopoda	Head	Nautilus.
		Pulmogasteropoda	Lung-breather and belly-walker	Snail.
		Branchiogasteropoda	Gill-breather and belly-walker	Limpet.
		Lamellibranchiata	Gills in plates	Mussel.
	Molluscoida	Ascidioida	Flask shape	Tunicata.
		Brachiopoda	Arm shape	Lamp animal.
		Polyzoa	Compound animal	Sea-mat.
	Annulosa	Insecta	Insects	Wasp.
		Myriopoda	Many-legged	Centipede.
		Arachnida	Spiders	Spiders.
		Crustacea	Hard rind	Lobster, crayfish.
		Annelida	Rings	Garden worm.
	Annuloida	Helminthozoa	Maw-worm	Tape worm.
		Echinodermata	Hedgehog-skinned	Sea cucumber.
	Cœlenterata	Actinozoa	Ray	Sea anemone.
		Hydrozoa	Water-living	Hydra.
	Protozoa	Infusoria	Animals produced in infusions	Vorticellæ..
		Spongidiæ		Sponge.
		Thalassicollidæ		Sea jellies.
		Polycistina	Many sacs	Polycistinæ.
		Rhizopoda	Root-footed	Sun animalcule.
		Gregarinidæ	Congregated	Some internal parasites.

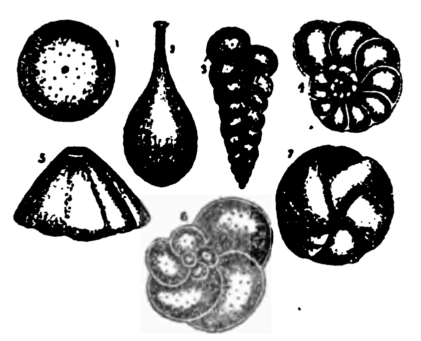
The Vertebrata are again divided into subdivisions—namely, Mammalia, or animals which suckle their young; Aves, or birds; Reptilia, or creepers, Amphibia; animals passing part of their lives in water, and partly upon land; and Pisces or fishes.

The sub-kingdom Invertebrata is much more divided, and is possessed of still further divisions, termed, respectively, classes and sub-classes.

The chief divisions of the sub-kingdom Invertebrata are, therefore, the Mollusca, Molluscoida, Annulosa, Annuloida, Cœlenterata, and Protozoa.

Each one of these divisions is again divided. The student, however, upon referring to the appended table, will find the whole thing sufficiently explained for purposes of microscopy.

It will be remembered we spoke of the Amœba in connection with the human blood at the commencement of the articles for students of human physiology. It will not, therefore, be necessary to again describe this protozoon, but will dwell upon a little creature with whom it is closely related—I mean the Foraminifera or Polycistina. We found the amœba to consist of a jelly-like mass, termed, for convenience, "sarcode," because it differs from the flesh of ordinary beings.

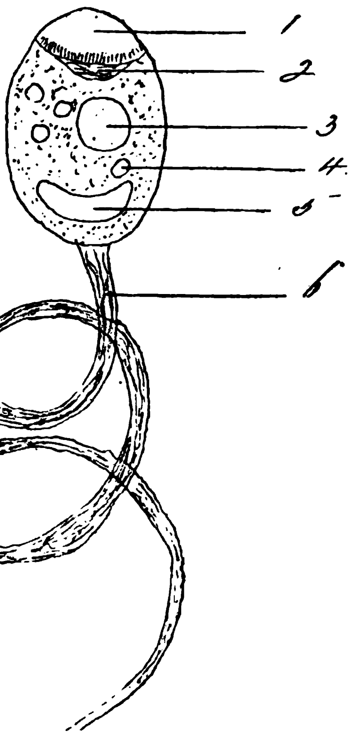


Highly-magnified Foraminifera.

1, Orbulina universa; 2, Lagena striata; 3, Textilaria; 4, Operculina; 5, Fanjasina; 6, Rosalina globularis; 7, Cassidulina.

This jelly-like substance, if resident in the sea, or in water containing chemical salts, appears to be able to isolate from the water these salts, and reconstruct certain portions, according to its nature, to form for itself a shell. The same process of intussusception goes on as in the amœba, but the isolated inorganic salts are excreted by the animal to form a home or shell for its protection. In the case of the foraminifera we find this shell is essentially chalk—chemically speaking, carbonate of calcium, $CaCO_3$; but in the case of polycistina it is essentially oxide of silicon, SiO_3, called also silica or flint. We find our cliffs, for the most part, are composed of chalk, and geologists tell us, these cliffs have at one period or another been deposited by the sea. Now, if we take a portion of any cliff, and wash away, by the process called elutriation, the lighter particles from those of heavier specific gravity, and examine some of the remaining portion with the ¼in. objective, we shall have some interesting shell-like particles known as foraminifera—that is, the beautiful shell-like structure remaining after the sarcode body, or amœba, has perished. We observe these shells have taken upon themselves a multitude of forms—in fact, have adapted themselves to the sarcode bodies which they formerly contained; hence we find very few of the same shape or design, and the varieties found at the bottom of the Atlantic or on the coast of Palestine differing so much one from the other in shape and size, that we might almost be tempted to doubt the exact origin if we did not actually know. It is on this account the dealers in microscopical objects are constantly reaping a harvest from species found in different parts of the world. We notice each shell is possessed of a number of little holes or pores; through these the sarcode body of the animal formerly extended its pseudopodia. Hitherto we have spoken only of the Foraminifera, excepting in stating that the shells of the polycistina are composed of flint instead of chalk. Really we have little more to observe or say upon the subject, excepting that the student may find thousands of these lovely shells intermingled with the sand upon the sea-coasts. The process of elutriation may be employed for separating these in a similar manner to that directed for the Foraminifera. When perfectly clean and free from other substances, the student may mount the specimens either in Canada balsam or in the dry way—that is, no mounting medium at all. I have found them keep remarkably well in this manner, forming beautiful and permanent objects. The student should in all cases label his slide with the locality or source from which his specimens were obtained. We will now proceed to the consideration of the Spongidæ. Most men, if asked, What is a sponge? would smile at apparently so simple a question; yet few indeed could really explain what a sponge is. Formerly the sponge was considered a member of the Vegetable Kingdom—viz., a plant; but it is now referred, and rightly so, to the Animal Kingdom—in fact, it is nothing more than the home of a mass of sarcode substance—that is, a multitude of amœba. It is indeed marvellous, when we consider that apparently this amœba is capable of existing and filling so many positions in life. We find it in its simplest form without a home, then in a home of chalk or silica, and finally endowed with the power of building up such a lovely object as the sponge. The student will remember that during life the substance called sponge commercially is filled with a jelly-like mass of life, and that distinct currents or streams of water are passing regularly and constantly through the "oscula" or larger holes of the skeleton from around those beneath and within. We find also the mouths or apertures of the "oscula" are protected in many cases by horny spines, called "spicules," for the purpose of preventing the intrusion of enemies into the camp. It is astonishing that even in sponges we have a multitude of varieties. It would also appear strange to an outsider that the immense sponges we sometimes see are produced by an aggregation of sarcode animals. Yet this is actually the case, the growth apparently taking place in much the same manner as coral reefs are produced, an explanation of which will be given later on.

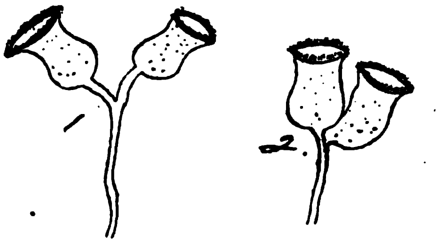
If the student is fortunate enough to be able to obtain a living sponge, let him study the methods of the currents through its substance. He will find if the water be coloured with carmine or indigo, he will the more readily observe the course of the water. A constant series of fountains will be seen to spurt from the "oscula," so that it would appear the currents enter the smaller apertures, and make their exit by way of the "oscula," after having traversed the smaller canals and becoming collected in the larger ones. We will not dwell longer upon the Spongidæ, because upon this division of the Protozoa alone we might place before the reader a very large volume—very much larger, indeed, than our Editor would care to bestow upon so interesting a subject. We will therefore report progress by dealing with the division known as Infusoria. We find, by referring to the table, that the meaning given to this term is animals produced by infusions. This statement is not strictly correct, because no infusion really of itself ever produced anything. There is no such thing as "spontaneous generation." We intend rather to infer that infusions, generally speaking, are found to be suitable fluids for the development and propagation of these animals.



Retracted State of Vorticella.

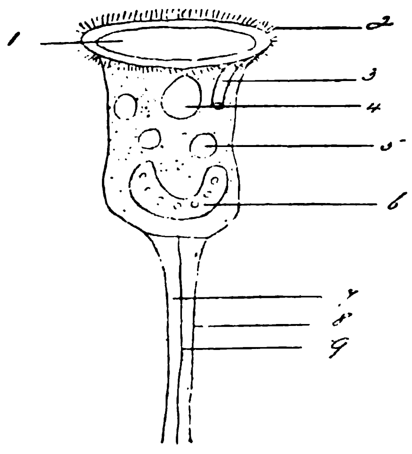
1, Inturned peristome; 2, Disc retracted; 3, Contractile vesicle; 4, Vacuole; 5, Nucleus; 6, Stalk.

Species of the Infusoria may be found both in fresh and salt water—that is, in the river or in the sea. At one time it was doubted if the Infusoria ought to be included among the Protozoa at all. It has at length, however, been decided, although possessed of a distinct internal cavity or mouth, that its position is really that of a protozoon. If the student will examine a piece of duck-weed from a pond, he will probably find existing upon it a number of little bodies, resembling inverted bells with long flexible arms, extending in each case from the base of the inverted bell to the duck-weed itself, to which it is attached. This is the type we intend to study. It is called the "Vorticella" or "Bell Animalcule." If we examine one of these creatures minutely we shall observe it to be possessed of three layers, constituting its substance—an outer, termed the cuticle; a middle layer, or "exoblast"; and an inner, called the "endoblast."



Vorticella, showing—
1, Complete fission; 2, Partial fission.

Around and over the inverted bell—or perhaps it would be more explicit to describe it as a cup—we find a thickened portion and a lid, and around the thickened portion or lip we find an immense number of cilia. These are constantly waving backwards and forward, forming a very pretty and entertaining object. Within the lip—that is, inside the bell—we find a cavity. This is termed the vestibule; and this, in its turn, is in continuance with the stem by which it is attached to the duck-weed.



Highly-magnified Vorticella.

1, Disc; 2, Cilia; 3, Œsophagus; 4, Contractile vesicle; 5, Vacuole; 6, Nucleus; 7, Stalk; 8, Stalk-sheath; 9, Axis.

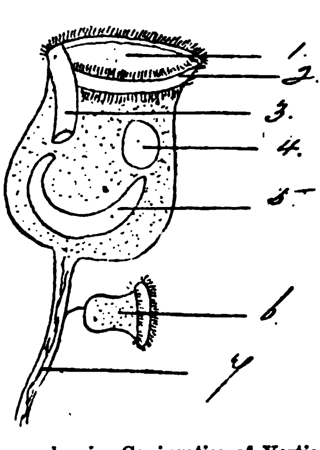


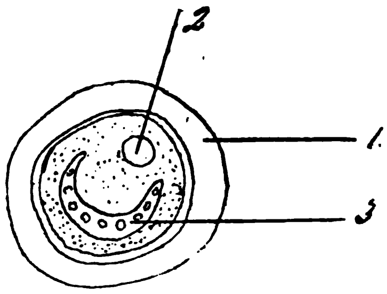
Diagram showing Conjugation of Vorticella.

1, Disc; 2, Peristome; 3, Œsophagus; 4, Contractile vesicle; 5, Nucleus; 6, Detached bell; 7, Stalk.

The movements of the Vorticellæ are peculiar; we find that each vorticella is constantly shortening this stalk by curling itself in a spiral manner. At the period of extending itself we find the bell expanded to its fullest extent, the cilia waving about and the lid removed from the upper portion of the cup; suddenly the reverse action takes place, the lid closing over it; the lip is turned in, and the whole thing resolves itself into a little ball, as it were, at the end of a string, the stalk coils itself and assumes the spiral action, completing the process of shortening itself, and so time after time the whole process is repeated.

Scientifically, the lip is termed the peristome, and inside the body or vestibule we may observe with the ¼in. objective a portion termed the contractile vesicle; this is in a constant state of systole and diastole, very much like the human heart, that is, always beating.

The student may have some little trouble in obtaining and observing a satisfactory specimen; however, let him not be discouraged, for when he has arrived at acquiring a good specimen, his efforts will be fully repaid by the grace and beauty of its movements and construction. It would appear the movements of the cilia, and the opening and shutting of the bell itself, and the contractility of the stalk, are all means to an end—namely, to catch its nourishment.



Encysted Vorticella without Stalk.
1, Cyst; 2, Contractile vesicle; 3, Nucleus.

If the student is not successful in finding a specimen upon duckweed, let him make an infusion of hay or any vegetable or animal matter. He will find in a very short time, upon exposing the infusion to the action of the air, it will simply teem with infusorial life, and the vorticellæ will probably be found among the various other species. As an object for the microscopist, few equal it, and fewer still excel it. If, after examining the movements, the student desires to more closely study its structure, he can easily and effectually kill the animal by insertion in a very weak solution of osmic acid. This prevents motion instantly, and the animal may be examined with the 1in. and ¼in. objectives in the usual manner.

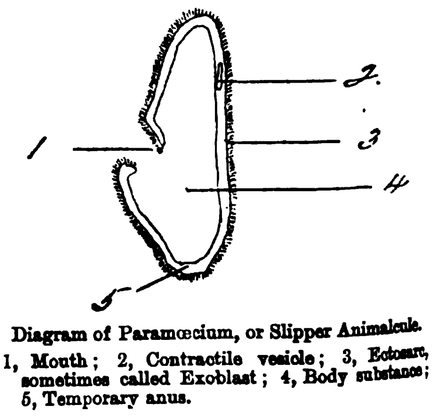


Diagram of Paramœcium, or Slipper Animalcule.

1, Mouth; 2, Contractile vesicle; 3, Ectosarc, sometimes called Exoblast; 4, Body substance; 5, Temporary anus.

These remarks upon the vorticellæ would not be complete without reference to its methods of reproduction, which may be briefly stated as "cleavage" or "fission," "conjugation," and "encystation."

In the first case the animal divides longitudinally into halves, each half closing and forming a complete creature. In the second case, free bells become attached to existing vorticellæ possessed of stalks, and conjugation results. In the latter case the vorticella forms a ball and becomes encysted—that is, forms a case for himself, and granular division occurs.

To arrive at satisfactory results the student

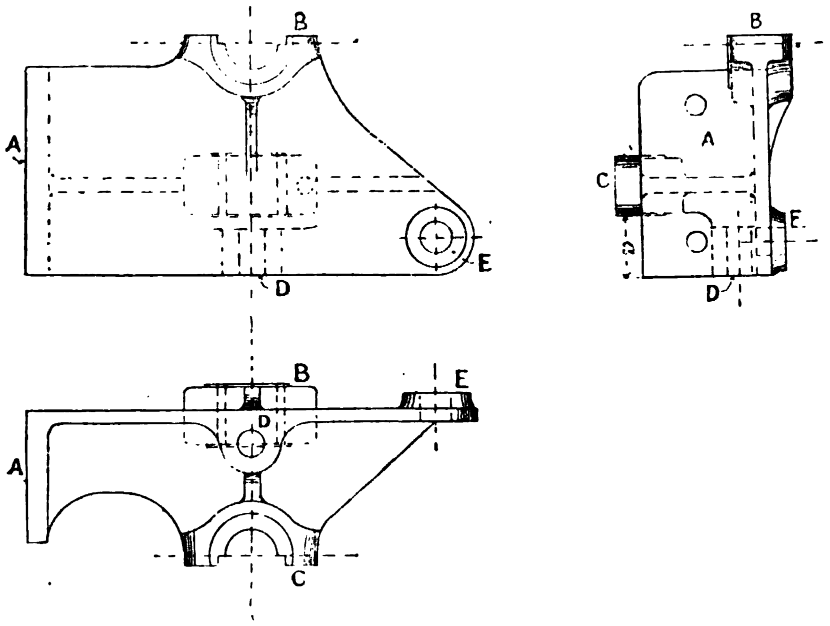


Fig. 84.

should stain his object with iodine or magneta solutions. The three layers will then become distinctly visible.

The author is indebted to Mr. Murton Holmes for drawings of sponge spicules, which, unfortunately, could not be reproduced by the photographic process.

FITTING.—XIV.

Among the illustrations given in the last article there were some of templets which are used not for lining-out as a preliminary to machining, but as guides for machining only. Figs. 70, 82, 83 were of this type. It is with templets of this character—typical of a large and elaborate class—that I shall conclude my remarks on this branch of fitters' work.

Fig. 84 illustrates a bracket having sundry bearings and bosses for shafts, and Fig. 85 shows a templet, by means of which the bearings and holes may be bored without any lining-out. There are several points about this type of templet that should be noticed in detail.

In Fig. 84, A is the bracket-foot that has to be planed, B and C are shaft bearings for mitre-wheels, D is a lug to carry a pin, E is a boss with a pin-hole. The important bearings are B and C, and these have to stand at right angles with each other upon the same centre-line, and at a definite distance from the planed foot. To line out these upon the table, two settings at right angles with each other would be required. Using a templet, no lining-out at all would be necessary, except a rough determination of the amount to be planed off the foot, and the scribing of lines round to plane it by. The templet would be the guide for most of the other tooling. In Fig. 85 the templet is seen to consist of plates and angle irons, with sundry bored bosses fastened to the plates, at the centres for boring the bearings and pinholes. In the figure there are three pieces of plate, A, B, C, of a thickness suited to the size of the templet, usually ranging between ⅛in. and ½in. These are united with angles D, E, F; D uniting A to B, E uniting B to C, and F uniting A to C. These angles are from 1in. to 1¼in. in width, and are fastened with rivets to the plates, the rivets being countersunk on the faces that go against the casting. The plates are not only united by this means, since, though thin, they are further stiffened by the angles, and so rendered amply rigid enough for their purpose. By means of plates and angles, templets of many diversified forms can be built up.

In Fig. 85 the face *d* of the plate A is clamped against the face of the foot A in Fig. 84. Then the bored boss B' is the guide for *boring* the bearing B in Fig. 84, the boss C' for boring the bearing C, the boss D' for the lug D, and the boss E' for the boss E.

Note that I use the term *boring*, and also that the bosses have circular holes instead of the proper bearing shapes shown in Fig. 84 for cap and brass. This is done in order to permit broaches to be used in the drilling machine. The broaches exactly fit the holes bored in the bosses of the templet, and are guided and coerced truly by means of these holes. Broaches, are, therefore, used, not only in the plain circular holes, but also in the semicircular seatings for the brasses. Before, however, the last are broached, the caps are fitted in by slotting or shaping, and being screwed down in place, the cap and bearing are broached out together through the templet bosses B' and C in Fig. 85.

Note, also, that the bosses of the templet are of different lengths. Merely as guides to the broach, they need not exceed ½in. or ¾in. in thickness, as in B'. In cases where they are thicker, as at C', the increased thickness is given in order to bring the faces of the boring bosses up close to the faces of the bearings on which they are used. Thus, the thickness of the boring boss C' in Fig. 85 is equal to the distance *a* in Fig. 84. Further the boring bosses B' and E', Fig. 85, are placed on opposite sides of the plate B, to suit the different horizontal planes of the bearing B and the boss E. So that when the templet is

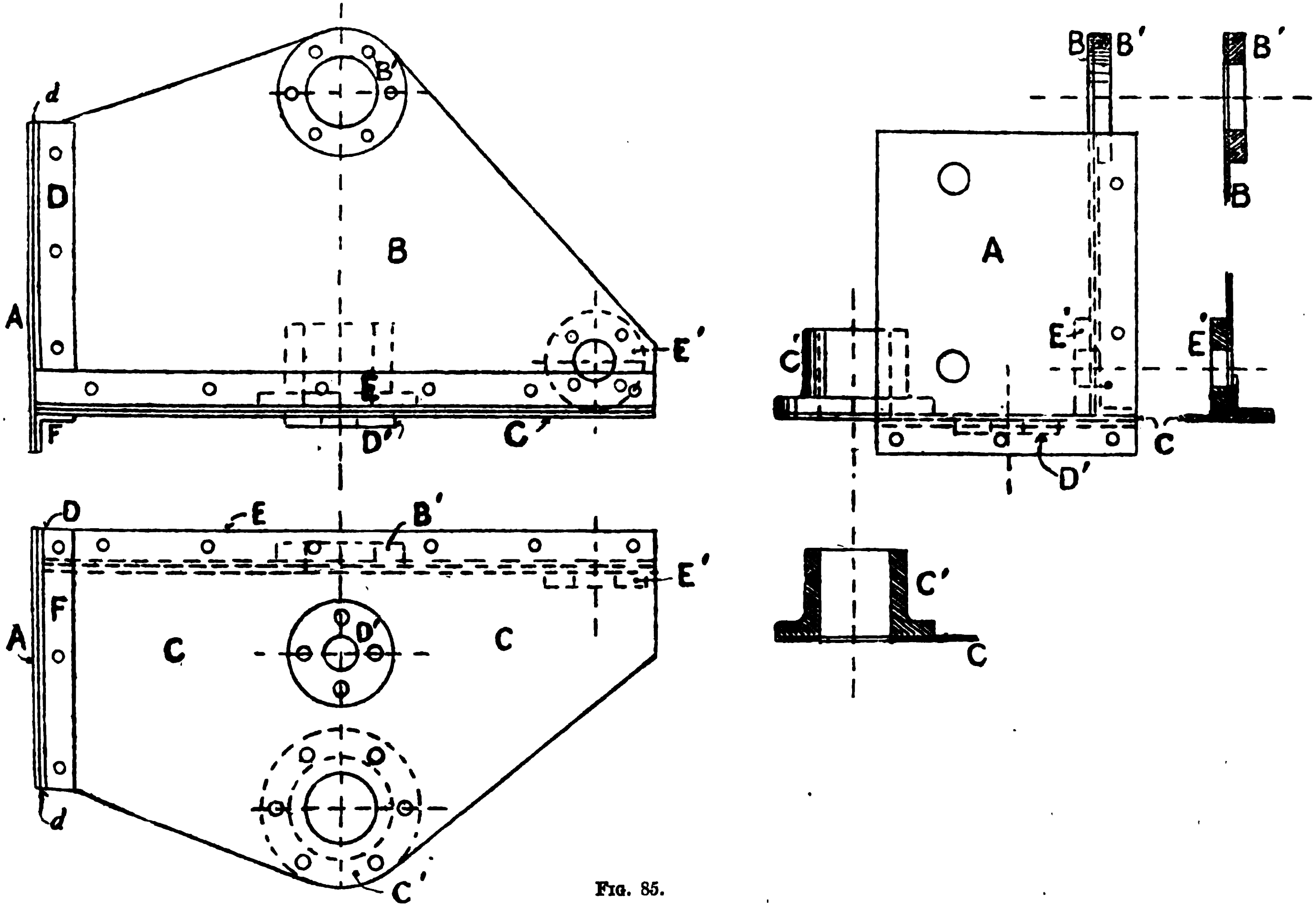


Fig. 85.

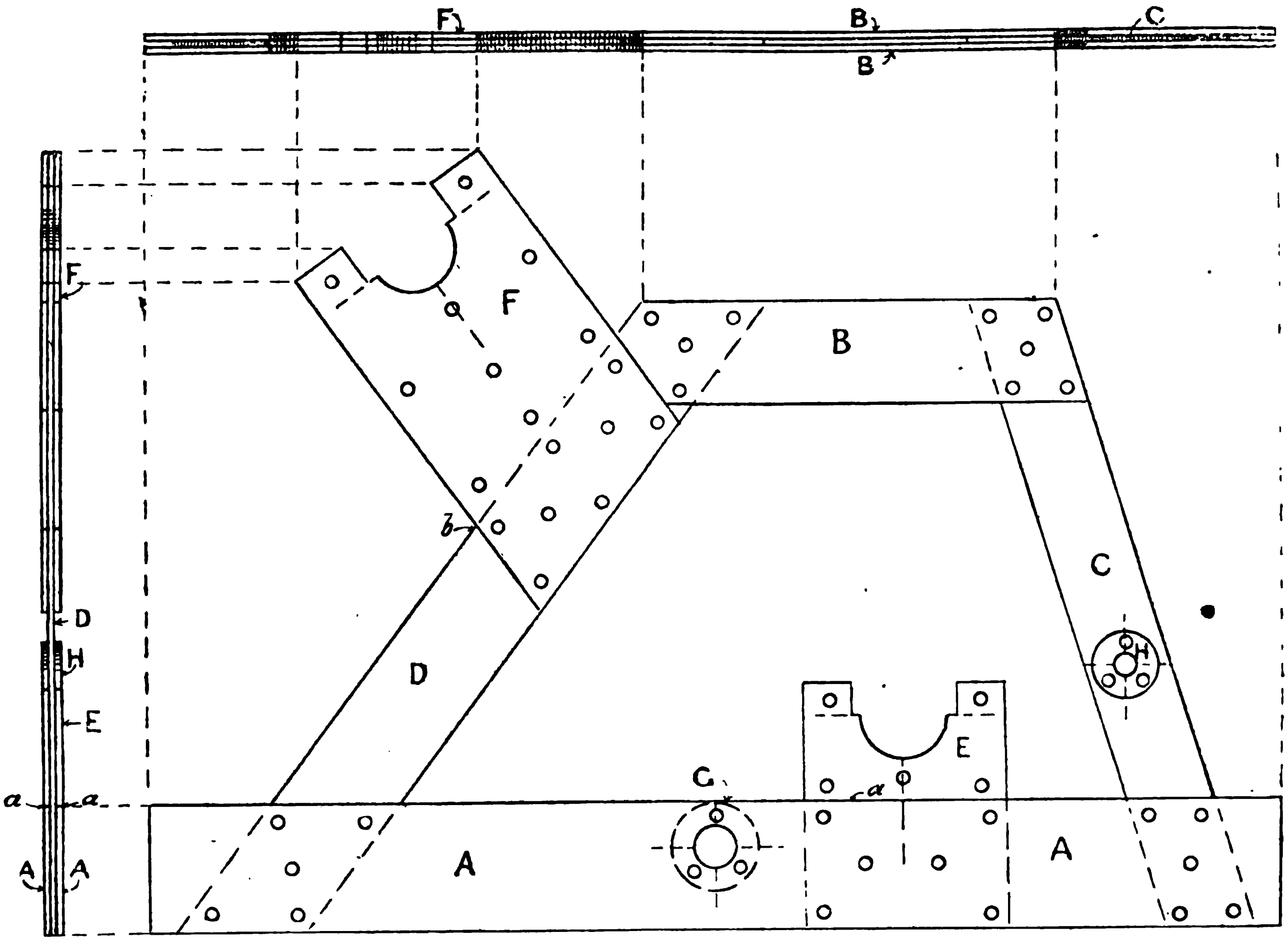


Fig. 86.

laid on the casting ready for use, each boring boss is in actual contact with the face of the bearing, or of the boss, for which it becomes the guide to boring.

The thinner bosses, like B′ D′ E′, are simple rings of wrought iron riveted upon their plates; thick bosses like C′ are flanged castings, riveted through the flanges to the plates.

Fig. 86 shows a templet suitable for machining a bracket like that shown in Fig. 57, p. 278, without previous lining out. It is of a different class from that shown in Fig. 85. For when templets of large size are employed, they are not made of solid plate, but are built up with narrow strips of sheet-iron riveted together. Templets of large dimensions, even though made of thin plate, would be cumbrous snd awkward to handle. So that large templets are invariably made of narrow strips, riveted together. The figure then illustrates a templet of this class. There is nothing special to be noted in regard to the arrangement of the strips. Rigidity is the main essential, and the strips will therefore be disposed with a view to insure the utmost rigidity, combined wsth the minimum of weight.

In the figure, the bottom plates A A, and the top ones, B B, are double; the end ones, C and D, are single. These form the main framework of the templet. The single plates pass between the ends of the double ones, and are riveted through, with rivets countersunk on both faces. The only portion of this framework that corresponds with any part of the castings is the bottom edge of A A, and the ends of the same, which coincide with the bottom and ends of the casting. The portions E and F that correspond with the bearings, are made each in three thicknesses riveted to each other, and to the main frame. The middle thickness of E passes between the pieces A, and the side thicknesses terminate at *a*, making a close joint for the sake of firmness. The middle thickness of F on the contrary abuts against D at *b*, and the side thicknesses pass across each face of D, and are riveted through it. Bosses, G and H, are riveted respectively between and on the plates to guide the driller, or for the purpose of marking the holes only.

This templet, like Fig. 85, is typical of a large class made for cheeks and frames of various forms. It is easy to scheme the framework of such templets. In this particular example all faces are flush, but it will often happen that some faces have to stand in a different plane from others, as in the previous example. Then bosses or extra thickness pieces will be put round those bearings, the faces of which are lower than others. For large frames several cross bracings, not needed in the example given, may be required. And it is better to build up a large templet with light strips well braced, than to use heavy scantlings not braced, for these templets are of considerable weight, and have mostly to be lifted by labourers.

In this example the bearing seatings in the templet are cut out to the precise form of the machined casting, instead of being circular, like the previous example. I purposely show this distinction. Using a templet of this kind, the bearings are not drilled under a drilling-machine as in Fig. 85, but are bored on a boring-machine with a horizontal boring-bar and cutters. The bearings, therefore, are lined-out from the templet, the cap seatings machined, the caps fitted in, the bearing circles completed on the caps, the cheeks bolted to the bed of the boring-mill in pairs, or in several sets at once, and bored through.

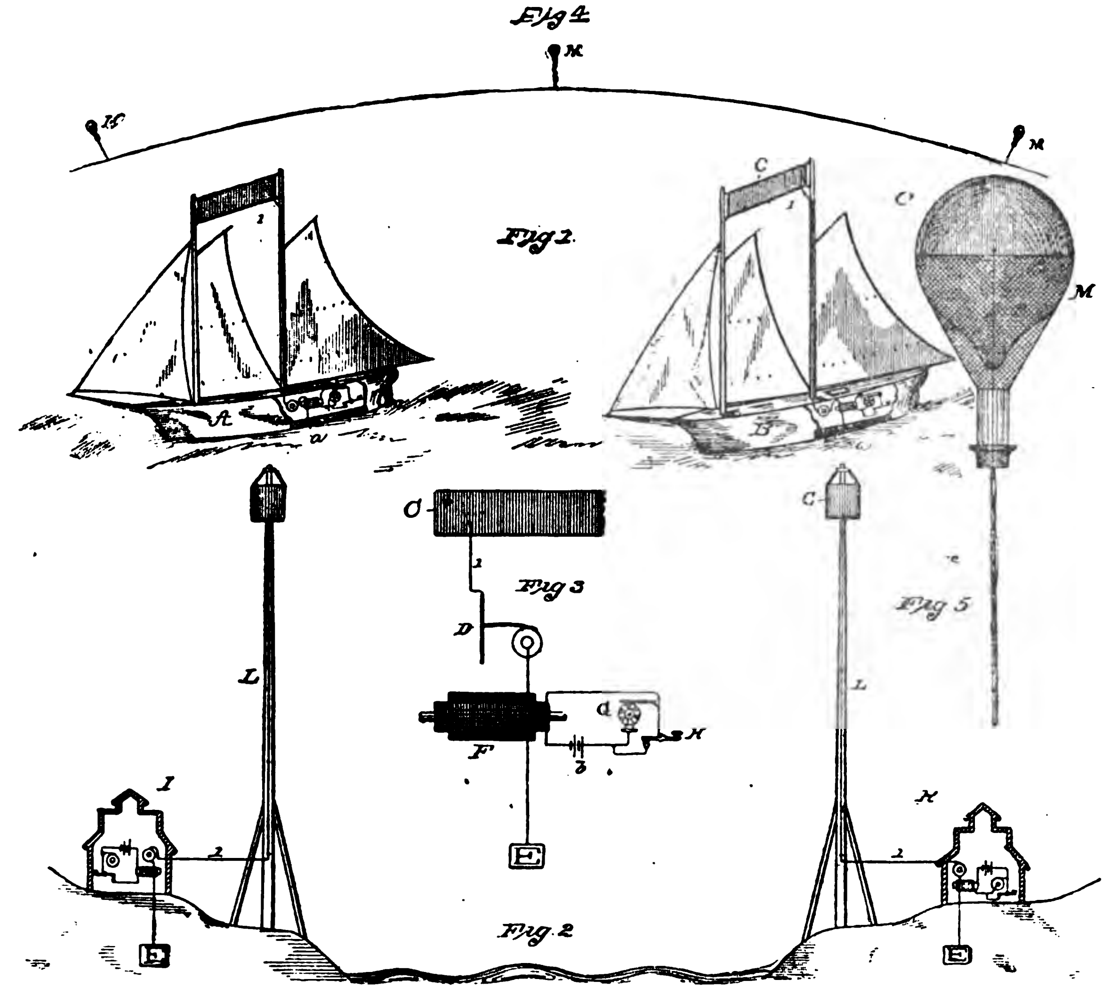
There is a large class of templets of quite a different character from those which I have described. They are, however, more of the nature of gauges than of templets proper, and scarcely come within the scope of "Fitting." They are for the most part finished sections of work, kept as permanent guides and records of standard work. Thus a standard pin will be kept as a permanent gauge to make other pins by, using it simply for the transference of dimensions to the new work. Standard glands, spindles, axles, connecting-rod ends, collars, short lengths of male and female screws, rod gauges, and caliper gauges for boring and turning, fixed trammels—and so forth, are kept for standard work. They are essentially duplicates, and therefore scarcely come within the scope of our subject.

J. H.

EDISON'S METHOD OF TELEGRAPHING WITHOUT WIRES.

AMONGST the patents recently taken out in the United States is one by Mr. Edison, in which he describes "means for transmitting signals electrically without the intervention of connecting wires." In his specification Mr. Edison says:—I have discovered that if sufficient elevation be obtained to overcome the curvature of the earth's surface and to reduce to the minimum the earth's absorption, electric telegraphing or signalling between distant points can be carried on by induction without the use of wires connecting such distant points. This discovery is especially applicable to telegraphing across bodies of water, thus avoiding the use of submarine cables, or for communicating between vessels at sea or between vessels at sea and points on land; but it is also applicable to electric communication between distant points on land, it being necessary, however, on land (with the exception of communication over open prairie) to increase the elevation in order to reduce to the minimum the induction-absorbing effect of houses, trees, and elevations in the land itself. At sea, from an elevation of 100 feet, I can communicate electrically a great distance, and since this elevation, or one sufficiently high, can be had by utilising the masts of ships, signals can be sent and received between ships separated a considerable distance, and by repeating the signals from ship to ship communication can be established between points any distance apart or across the largest seas, and even oceans. The collision of ships in fogs can be prevented by this character of signalling, by the use of which, also, the safety of a ship in approaching a dangerous coast in foggy weather can be assured. In communicating between points on land, poles of great height can be used or captive balloons. At these elevated points, whether upon the masts of ships, upon poles, or balloons, condensing surfaces of metal or other conductor of electricity are located. Each condensing surface is connected with earth by an electrical conducting wire.

On land this earth connection would be one of usual character in telegraphy. At sea the wire would run to one or more metal plates on the bottom of the vessel, where the earth connection would be made with the water. The high resistance secondary circuit of an induction coil is located in circuit between the condensing surface and the ground. The primary circuit of the induction coil



includes a battery and a device for transmitting signals, which may be a revolving circuit breaker operated continually by a motor of any suitable kind, either electrical or mechanical, and a key normally short-circuiting the circuit breaker or secondary coil. For receiving signals I locate in said circuit between the condensing surface and the ground a diaphragm sounder, which is preferably one of my electromotograph telephone receivers.

The key normally short-circuiting the revolving circuit breaker, no impulses are produced in the induction coil until the key is depressed, when a large number of impulses are produced in primary, and by means of the secondary corresponding impulses or variations in tension are produced at the elevated condensing surface, producing thereat electrostatic impulses. These electrostatic impulses are transmitted inductively to the elevated condensing surface at the distant point and are made audible by the electromotograph connected in the ground circuit with such distant condensing surface. The intervening body of air forms the dielectric of the condenser, the condensing surfaces of which are connected by the earth. The effect is a circuit in which is interposed a condenser formed of distantly separated and elevated condensing surfaces with the intervening air as a dielectric.

In the accompanying drawings, forming a part hereof, Fig. 1 is a view showing two vessels placed in communication by my discovery; Fig. 2, a view showing signalling stations on opposite banks of a river; Fig. 3, a separate view, principally in diagram, of the apparatus; Fig. 4 a diagram of a portion of the earth's surface, showing communication by captive balloons; Fig. 5 a view of a single captive balloon constructed for use in signalling.

A and B are two vessels, each having a metallic condensing surface, C, supported at the heads of the masts. This condensing surface may be of canvas covered with flexible sheet metal or metallic foil secured there in any suitable way. From the condensing surface, C, a wire 1 extends to the hull of each vessel and through the transmitting and signalling apparatus to a metallic plate *a* on the ship's bottom. This wire extends through an electromograph telephone receiver, D, or other suitable receiver, and also includes the secondary circuit of an induction coil, F. In the primary of this induction coil is a battery, *b*, and a revolving circuit breaker, G. This circuit breaker is revolved rapidly by a motor (not shown), electrical or mechanical. It is short-circuited normally by a back point key, H, by depressing which the short circuit is broken, and the circuit breaker breaks and makes the primary circuit of the induction coil with great rapidity. This apparatus is more particularly shown in Fig. 3.

In Fig. 2, I K are stations on land, having poles, L, supporting condensing surfaces, C, which may be light cylinders or frames of wood covered with sheet metal. These drums are adapted to be raised and lowered by block and tackle, and are connected by wires with earth-plates through signal receiving and transmitting apparatus, such as has already been described.

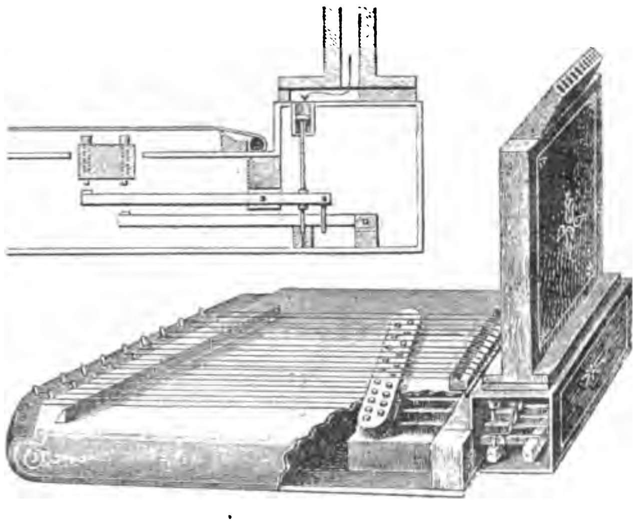
In Fig. 5, M is a captive balloon having condensing surfaces C of metallic foil. The gound wire 1 is carried down the rope *c*, by which the balloon is held captive. In Fig. 4 three of these captive balloons are represented in position to communicate from one to the other and to repeat to the third, the curvature of the earth's surface being represented.

Several claims are made, but the principal one is the following:—

"I claim as my discovery means for signalling between stations separated from each other, consisting of an elevated condensing surface or body at each station, a transmitter operatively connected to one of said condensing surfaces for varying its electrical tension in conformity to the signal to be transmitted, and thereby correspondingly varying the tension of the other condensing surface, and a signal receiver operatively connected to said other condensing surface, substantially as described."

HICKS'S NOVEL ZITHER.

AN instrument upon which any harmonica-player can perform, but in which the tones are produced by strings struck and vibrated by hammers, instead of reeds operated by air-pressure, is shown in the illustration, in section and in perspective. The playing portion is arranged similarly to a harmonica, and by the inhalation and exhalation of air through the air tubes, the hammers are arranged to strike the strings in a manner similar to the hammers of a piano. This improvement has been patented by Mr. Edwin P. Hicks, of McAlester, Indian Territory. The strings pass over bridge-



pieces of the sounding-board, and have their ends wound about the usual tuning-pins, while a detachable upright, having at its upper end a mouthpiece similar to that of a harmonica, is secured to the base of the frame, a felt strip being interposed between the upright and the base to form an air-tight joint.

The mouthpiece has key or air openings which extend down through the upright and communicate with air-chambers in the base, as shown by the arrow in the sectional view, these chambers communicating with air-cylinders, one for each pair of keys or hammers. These keys consist of levers arranged alternately, an upper set being fulcrumed upon a rod supported by end blocks, while the lower levers are fulcrumed at their rear ends in a transverse bar, the operating rods, connected with the upper set of levers, having at their upper ends pistons operating in the cylinders, while the lower levers are connected with the rear ends of the upper ones by Z-shaped wires. The front ends of both levers are tipped with felt, and arranged to strike plungers loosely held for vertical movement in a plunger-block fitting in a cut-out portion of the sounding-board, the plungers having their hammer heads normally about a sixteenth of an inch below the strings. By blowing into the mouthpiece the pistons of the different cylinders are depressed, thereby operating one series of keys to throw the plungers up against the strings, the elasticity of the strings quickly throwing the plungers back to their normal position, whereby the strings are allowed to vibrate after being struck. By drawing in the breath, and sucking up the air in the chambers, the pistons are drawn up, raising the rear ends of the upper series of keys, and causing the adjacent connected lower levers to strike the plungers, throwing them in a similar manner up against the strings. The invention provides a combined harmonica and zither or harp-like instrument designed to be of simple construction, and comparatively inexpensive.—*Scientific American.*

AN AUTOMATIC SCREW.*

GIVEN ten thousand screws to be made just like sample shown in Fig. 1, and an automatic screw machine, I would be governed by the following facts and methods. The cutting-off tool is first to be considered, because its thickness must be added to the distance the rod is fed. In fact the rod must be fed the length of the screw, plus the cutting-off tool, plus a trifle to finish the end G. The cutting-off tool in this case may practically be 1/16in. thick, and if the feed has an actual throw of 2⅜in. it will be right. This tool should be forged to shape and turned. After it is tempered it should be ground true. The edge angle is about 60°. It is made thus to leave the "tit" on the rod. This is the best cutting-off tool for this purpose I know how to make. The end of the hub A is "file-cut" for grip. This tool is held to a shank by a bolt, or within a fork like the shape tool hereafter shown. If held to a shank, the screw should be left-hand in the case shown, and in every case so that the strain of cutting shall tend to tighten the hold.

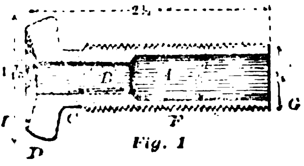
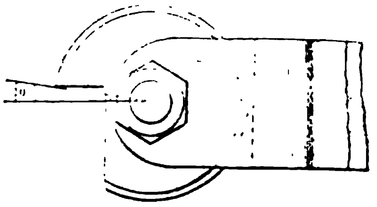


Fig. 1



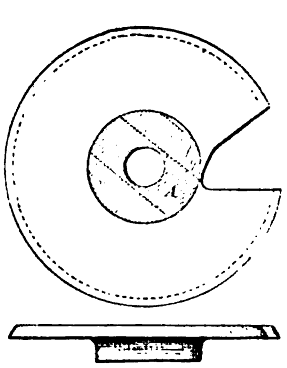


Fig. 2

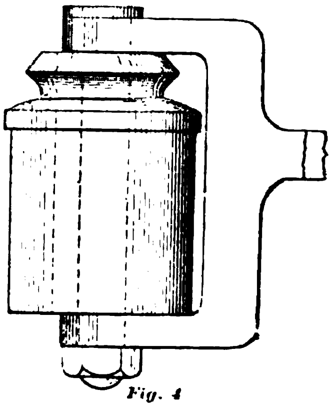


Fig. 4

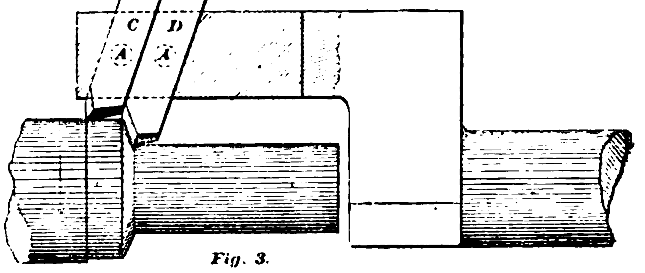


Fig. 3.

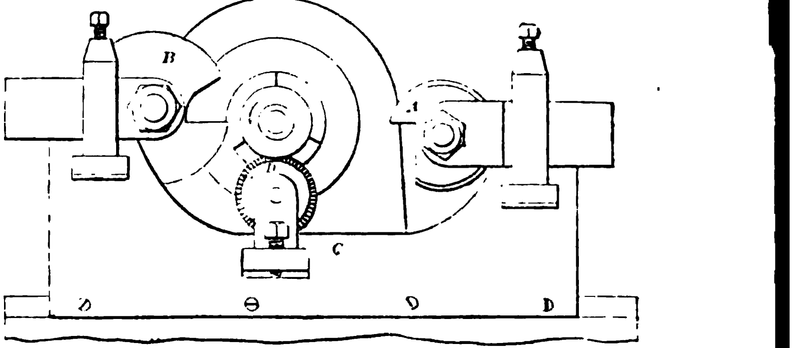


Fig 5.

Where the screw is as stiff as this one it is preferable to reduce the stock by a tool in the turret. The one shown in Fig. 3 is a good one. Hollow mills are not satisfactory, because of the difficulty of sharpening them inside. The scaling cutter C will be found to have a two-fold value. It cuts off the rust and scale, and also makes the rod true, so that the reducing cutter D shall have an even depth of cut. Much rounder and more concentric results follow this arrangement than where but one tool is used.

The screw is formed to size by the shape tool, Fig. 4. No description of this tool is necessary, except the fact that it is set on the back end of the slide, and cuts downward—i.e., the chips fall directly away from cutting edge, which is inverted. In both this tool and the cutting-off tool the edges are set 10° off the centre, for clearance. This rule will work better than the empirical ¼in. rule of some shops. This kind of tool may be worn and sharpened on an emery wheel around the whole circumference, until it is all consumed.

It will interest me very much to discover who first applied the circular shape tool to practical work. I first saw it in the works of the McKay Sewing Machine Association in Lawrence, Mass., in 1867. It was an old appliance with them at that date. Perhaps some person may know who made and used this tool first.

After the shape tool has done its work, and the blank is of correct size, and after it has retreated a distance to warrant, the die must be in progress, and if the size of the screw is important, the cams or screw that control the turret must be very carefully adjusted, and must feed the turret precisely as fast as the die cuts the thread. Also in the reverse the die must be assisted off as carefully as it has been fed on, in fact, more carefully, if possible. The die must be carried both ways. It must not depend on the thread it has made for progress; if it does, the screw will be taper, or uneven in size. It will be seen by every mechanic that in backing a die off a screw, if the screw itself be the motive power, that the thread will be shaved on the driving side. Even the friction in the die clutch makes a difference. And when the die is partly off, if there be not a perfect support, and a careful taking away of the die, the end threads will be under-size. But when everything is in dead line, and the progress is equal to the pitch of the screw in both directions, work can be practically made to ·001in. limits, in sizes below ¼in.

Make blanks are trifle small. A new sharp die will not draw a thread up much, but as it gets dull this tendency increases. In some cases this will amount to 10 per cent. of the pitch. When a die is crowded with too big a blank, the screw will be twisted and change the pitch, or the die will be retarded, with the same result. A second "sizing die" is of doubtful economy. It is better to cut the screw right at first.

After the screw in Fig. 1 is threaded, it must be knurled on D, and then it is cut off. While being knurled, the cross-slide C is travelling over, taking the shape tool A, Fig. 5, further away from the work, and bringing the cutting-off tool B into position to do its operation.

This method of knurling is patented to Messrs. Miller and McDougal. It is shown here without their knowledge, and only because it illustrated a saving, in that it operates by using an idle motion. I know also this method does good work.

There is no attempt here made to identity these suggestions with any screw machine known. But the endeavour is made to give good practice, that, as far as possible, is applicable to all automatic screw machines of whatever make.

The screw in Fig. 1, it will be seen, is not yet finished. The hole B and the counter-sink E are neither of them made. Now the hole A is a clearance, and is not particular, except that it be larger than the hole B, and yet not big enough to weaken the screw outside it. But, on the contrary, the hole B is very particular in size, and it must be concentric to the screw thread. Therefore, it would have been unsafe to drill it from the bottom of the hole A. The recess E cannot well be made until the piece is cut off. The most reliable way to make a good and concentric hole, as B, in this screw, is to carefully make a concentric screw chuck in the spindle of turret lathe, and screw these pieces in by hand. When they run true with the head outward, it is a very practical operation to drill and ream the hole B true, and to cut the recess E.

GOOD WORK, AND GOOD WAYS OF DOING IT.*

WHEN I tell of a way of doing work, I hope I shall not be understood to say *the way* to do it, for this is not what I mean, but instead, to tell

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* By A. D. PENTZ, in *American Machinist.*

* By "A MECHANIC," in the *American Machinist.*

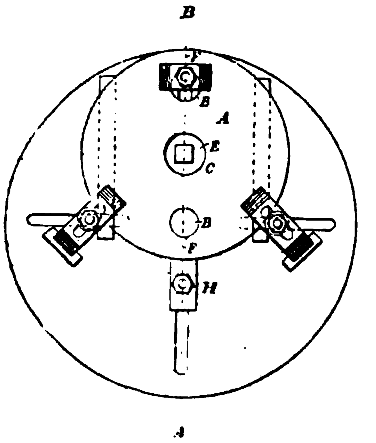

Fig. 1.

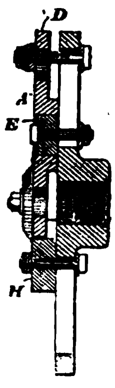

Fig 2.

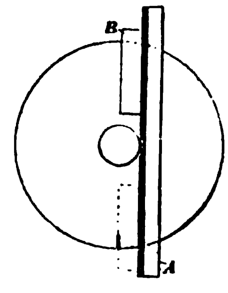

Fig. 3.

of ways that may be useful to many at some time, to fit a certain set of conditions. In this I try to show a good way to bore two or more holes in a disc, equally distant from a central hole, and equally spaced. Of course the accuracy of most any method depends much upon the skill of the person who does the work. When we have skilful workmanship and good methods, we then are about sure of good results.

In Figs. 1 and 2 I show the disc A mounted upon a lathe face-plate for the purpose of boring the holes B B equally distant from the central hole C, and correctly opposite each other. Now what would we call *correctly opposite?* If I knew this disc was only for a washer or strap, for three bolts to fetch up upon, for strengthening a brick wall; and what I would call correctly opposite, when I knew the disc was wanted for a purpose where accuracy is required, would be two different kinds of opposites altogether. If I had a strap to make with three holes for the brick wall, I would consider a good way would be to take a common wooden rule and a piece of chalk, a big centre punch and hammer for fine tools, and a drill press for the machine tool. I would consider, if I got the holes laid out within $\frac{1}{16}$in. or more of what the drawing called for, and then if I drilled within $\frac{1}{16}$in. or more of where it was laid, that it was accurate for the purpose. We will suppose that the disc A is for a jig for reaming similar discs which are intended to interchange over three studs, which closely fill the holes, and that these studs are now located to the dimensions given me to work from.

Now this job is entirely different from the "brick wall strap," although the drawing may look just the same, which is a point that some so-called mechanical engineers would do well to bestow a few moments' thought upon sometimes. Of course, there is more than one way to do this; but I shall trouble you with only one this time. I bore the central hole, and turn the disc on an arbor in the usual way, squaring it true on the back side D. I bolt the hub E (which closely fits the central hole) to the face-plate as shown, setting it the right distance from the centre by making it run out of true twice the amount it is wanted to be off centre.

I draw two lines on face of disc, as shown at F F. The accuracy of the spacing depends upon these lines being right, so if it is convenient to locate these lines from a good index plate it might save time. For some jobs it would be near enough to index from the large gear on lathe spindle; if no such way is available, we are obliged to adopt a hand method. In Fig. 3 is shown a way.

Suppose the central hole is 2in. in diameter; I use an arbor or plug to fit, and a straight-edge to extend across disc, and in contact with plug, as shown. I then take another straight edge or parallel with sharp corners, 1in. wide, to extend to centre, as shown. I hold the straight-edge firm across disc, and draw a line outside the parallel B, and then change the parallel to the other side of disc, as shown in dotted lines, and draw another line; these two lines are not just central, for these lines are, of course, drawn entirely outside the parallel. I then change the straight-edge to the other side of plug, and set it so that the parallel, when used as before, will just hide the two lines made first, then draw two more lines in the same way; the spaces between these lines are the correct centre lines. I now put the disc on the face-plate, as shown in Fig. 1, and bore the first hole most anywhere; the bearing E, of course, insures the distance from the centre being correct.

After boring the first hole, and before moving it, I bolt the piece H to the faceplate, as shown, and draw a line upon it to match the line F upon the disc. I can then turn the disc around on its stud till the opposite line corresponds with line on piece H, when it is in the correct position to bore the other hole. It will be seen that this method will answer for boring any number of holes or any kind of spacing, only depending upon first getting the lines in the right places. In boring a large disc where the holes are near the centre, it will be seen that a slight error in making or setting to the lines will be reduced at the holes.

SCIENTIFIC SOCIETIES.

ROYAL METEOROLOGICAL SOCIETY.

THE annual general meeting of this society was held on Wednesday evening, Jan. 27th, at the Institution of Civil Engineers, 25, Great George-street, S.W., Dr. W. Marcet, F.R.S., vice-president, in the chair.

The report of the council for the past year showed the society to be in a very satisfactory position. In May the library and offices were removed to more commodious premises at 22, Great George-street. After defraying the cost of fitting up the new offices, and the increased rental, there still remained a balance in hand of £224. Thirty-four new Fellows were elected during the year, the total number on the roll of the society now being 552.

Owing to the absence of the president, Mr. Baldwin Latham, M.Inst.C.E., through an attack of influenza, his address on "Evaporation and Condensation" was read by the secretary.

The question of evaporation is as of great importance as the study of the precipitation of water on the face of the earth, as the available water supplies of the country entirely depend upon the differences between these two sets of observations. The earth receives moisture by means of rain, dew, hoar-frost, and by direct condensation. It loses its moisture very rapidly by evaporation. Although evaporation mainly depends upon the difference between the tensional force of vapour due to the temperature of the evaporating surface and the tensional force of the vapour already in the atmosphere, yet it is largely influenced by the movement of the air and by its dryness, or the difference between the dew-point and the actual air temperature. Evaporation goes on at night so long as the water surface is warmer than the dew-point. With sea water the evaporation is about 4½ per cent. less than with rain water, while with water saturated with common salt the evaporation is 15 per cent. less than with rain water.

In his experiments Mr. Latham used an evaporating gauge made of copper, 1ft. in diameter, and containing 1ft. in depth of water, which was floated by means of a hollow copper ring placed 6in. distant from the body of the evaporator, and attached to it by four radial arms. This form of evaporator was found extremely convenient in carrying on all evaporation experiments. It was floated in a tank 4ft. in diameter, containing 30in. depth of water. During the period of 13 years—from January, 1879, to December, 1891—this evaporator has never once been out of order or been interfered with in the slightest degree by frost. Experiments were made with some 5in. evaporators as to the effect of colour on the amount of evaporation, one being painted white, another black, and the results given by these gauges were compared with a copper gauge exposed under similar conditions. This comparison was the means of showing that the greatest errors in evaporating-gauges arise from the capillarity of the water rising on the sides of the gauge, and thus inordinately increasing the amount of evaporation. Consequently, a small gauge having a larger amount in proportion of side area than a larger gauge, gives a very much greater amount of evaporation. The results from the floating evaporator, 1ft. in diameter, show that the average amount of water evaporated annually during 1879-91 was 19·948in. It was found, however, that as a rule during the period from October to March there were certain occasions when condensation was measured. The amount of these condensations in 13 years averaged ·308in. per annum. The 5in. evaporating gauge freely exposed to atmospheric influences gave during the same period (1879-91) an average annual depth of evaporation equal to 38·185in. The average annual evaporation during the three years, 1879-81, from the 5in. copper gauge standing in water was 27·90in., from one painted black 22·97in., and from another painted white 21·74in., whilst a gauge of the same dimensions freely exposed in the atmosphere gave, in the same period, 36 96in., and the 1ft. floating evaporator 19·40in. The 5in. copper gauge gave a larger amount of evaporation than the gauge painted black.

Mr. Latham next described some percolation experiments which were carried out by Mr. C. Greaves, at Old Ford; by Messrs. Dickinson and Evans, at Hemel Hempstead; and by Sir J. B. Lawes and Dr. Gilbert, at Rothamsted. He then detailed the results of his own experiments, and also the gaugings of the underground waters in the drainage areas of the rivers Wandle and Graveney. He further stated that in the course of his observations on the flow of underground water, he had observed that at certain particular seasons of the year it was possible to indicate the direction and volume of the flow of underground streams, even when they were at a considerable depth, owing to the formation of peculiar lines of fog.

Dr. C. Theodore Williams was elected president for the ensuing year.

BRITISH ASTRONOMICAL ASSOCIATION.

THE third ordinary meeting of the second session was held at Barnard's Inn on Wednesday, the 27th January, Captain Noble, the president, in the chair. The minutes of the last meeting were read and confirmed. Seventeen new members were elected, and a list of fourteen candidates for membership was read.

Among the presents received during the month were a number of comparison spectra of the sun and various metals, photographed by Mr. McClean, and the first number of the new American publication, entitled *Astronomy and Astro-Physics*.

The President, referring to the former, said that they were indebted to Mr. McClean for some of the most perfect spectro-photographs ever seen. He also stated that *Astronomy and Astro-Physics* was the old *Sidereal Messenger* brought out again under a new name, and that the astro-physical part was under the direction of Prof. G. E. Hale, of the Kenwood Astro-Physical Observatory, Chicago, a spectroscopist of great promise. Concerning the work itself, he had only to say that there was nothing like it published in English.

Mr. Maunder said he had pleasure in confirming the President's remarks as to the extreme beauty and high scientific value of Mr. McClean's photographs. He also said that Prof. Hale intended to give accounts, in the new publication, not only of the spectroscopic observations carried on in America, but throughout the world, and that on that account it would be of extreme use to those engaged in that particular class of work.

Sir Howard Grubb then showed a 4in. equatoreal fitted with some new appliances designed by himself. He pointed out that labour-saving contrivances for telescopes of small apertures were few in number compared with those for large ones, since the cost of adapting them was proportionally greater. Several years ago the idea struck him that it would be a great advantage to have the reading-circles of small equatoreals placed around the eyepiece, so that the observer might be able to consult them at any moment without leaving his chair. This he had now carried into practice by placing a declination circle round the eyepiece, and gearing it by means of a hollow shaft having a small toothed wheel at either end to a fixed wheel upon the declination axis. By this arrangement the teeth which engaged with the declination circle were kept always in the same phase as those engaging with the dead wheel; and also, instead of having a reading error equal to the sum of the errors which would be due to the irregularities of rolling between the two sets of wheels, he had one equal to their difference, and this was very small—only about 2′ when the telescope was turned through a right angle and back again. The motion in Right Ascension was obtained in a similar way by means of a steel rod running through the hollow declination shaft. Around the eyepiece there was a disc of white metal, divided, near its outer edge, into degrees of declination, and, nearer the centre, into hours and minutes of R.A.; this was turned round past two fixed pointers by the declination shaft. Upon this, and rotating with it, when the telescope was moved solely in declination, was another disc; this was also turned independently by a wheel upon the Right Ascension shaft, and served to carry the pointers by means of which it was read. There were one or two merely constructional defects in the instrument before them, which was made more as a model than for actual use. It did not very readily admit of taking to pieces for the purpose of packing, and the steel rod for moving the telescope in right ascension was made of very small diameter in order to work inside the declination shaft, and in consequence was not strong enough to altogether resist torsion. In consequence of this a slight error was introduced into the readings. This, however, was easily remediable. It was also found that when a person, who was not accustomed to the instrument, turned either rod, being uncertain which way the telescope would commence to move, his hand involuntarily resisted the motion, and thus sometimes occasioned the loss of a tooth. With practice this difficulty is soon overcome. On the same telescope was fitted a rotating carrier to hold several eyepieces, in order that the power could be instantaneously changed without having to pull one out and replace it by another.

Mr. J. Evershed, jun., then read a paper upon "The Distribution of the Solar Prominences of 1891." In working out the distribution of the prominences in latitude in 1890, Mr. Evershed found that there was a decided maximum of activity between the parallels of 40° and 50° on both sides of the equator, and other secondary maxima and minima in lower latitudes. He had at the time thought these lesser irregularities were due to insufficient observation; but further scrutiny had tended rather to accentuate them. In 1891 he found that the main features of the 1890 curve were still maintained. In both years there were shown two principal maxima in the northern hemisphere, separated by a very pronounced minimum, whilst south of the equator there were three points of maximum. The principal point of difference was that whereas in 1890 the south was the more active zone, in 1891 the north took the lead. The high latitude prominences had gradually advanced polewards, while the northern maximum had receded slightly towards the equator, and hence the intermediate minimum had been considerably widened. Within 25° of the pole no true prominences had been observed. Metallic and eruptive prominences had been rarely seen, and only in the spot zones. On May 31, one of great brilliancy had been observed in N. lat. 19°, the form of which could be made out in the sodium and magnesium lines; a new line, suspected to be the line 6677 in Angström's scale, had been strongly reversed. The hydrogen lines showed bright extensions of equal length on either side, reaching in the case of D_3 almost to D_2. Others had been observed on June 21st, August 11th, and Sept. 24th. Large eruptive prominences had been noticed, all north of the equator, on June 19th, July 9th, and Oct. 13th. The last of these had appeared like the flying débris of a great eruption, and its highest filaments had a velocity of approach of 140 miles a second. The results obtained during the past two years with regard to the distribution of prominences in latitude did not seem quite in accordance with the law discovered by Prof. Riccö.

Mr. Ranyard observed that the coronal protuberances became most developed at the poles during maximum sunspot periods. Did Mr. Evershed think there was any connection between this phenomenon and the distribution of the prominences in latitude? He also pointed out that if there were a resisting medium, the time taken by a prominence to reach its full height would be less, and its velocity at any part of its path greater than if it were moving in vacuo. Could Mr. Evershed give him any data with regard to this velocity?

Mr. Maunder called attention to the fact that the sunspot activity in 1891 was more than double that of 1890; but that although the number of the prominences had increased, the increase was not at all in the same ratio.

Miss Clerke asked Mr. Evershed if he had seen the D_3 line broadened at the same time as the F.

He replied that he had, and drew the form presented by the D_3 line in the prominence of May 31st, 1891.

Miss Clerke then turned to Mr. Maunder, and asked him if this were not an unusual occurrence.

He responded that as far as he could remember it was altogether unprecedented.

In reply to Mr. Ranyard, Mr. Evershed said that he had only observed about four eruptive prominences during the whole year, and that the velocity of approach of the highest filaments of the prominence of May 31st was 140 miles per second. He could give Mr. Ranyard no data by which to determine the presence or absence of a resisting medium.

The President then announced that as Mr. Green had been obliged to go to the Riviera on business, the Rev. A. Freeman had been appointed acting director of the Saturn section during his absence.

The Rev. A. Freeman then gave the meeting some notes upon "Saturn's Ring Shadow and Crape Ring in 1892." He pointed out that on March 12th the earth and the sun would have the same elevation above the plane of Saturn's rings, and that meant we should be unable to see any shadow cast by the rings on Saturn's surface. He also remarked that, according to the theory started by a Swiss astronomer, the rings were composed of myriads of diminutive satellites, moving in independent circular orbits around the planet, never coming into collision, and possibly each possessed of its own separate atmosphere. If this were correct, the small dark bodies composing the crape ring must be more sparsely distributed than those in the other rings, and hence we might be able to see the surface of the planet between them, and it would probably present a mottled appearance. On March 16th Saturn would be in opposition. The maximum difference of elevation of earth and sun would be on June 9th, and its value would then be 2° 54·3′. He had heard from Mr. A. Stanley Williams that he had watched the transit of the shadow of Tethys on Jan. 10, and that it passed close to the ring.

With regard to the opacity of the crape ring, Mr. Ranyard suggested that we should have a far better opportunity of testing it when its shadow was thrown upon one of the satellites. He believed that Prof. Barnard had watched this phenomenon at the Lick Observatory, and from it drawn the conclusion that the ring gradually decreased in opacity towards its centre. He had also been able to see the surface of the planet through the ring, and it appeared a little darker than when viewed direct, and with the inner edge of the band a slightly softer tint.

Mr. Cottam then read extracts from a paper on "Recent Observations of Bright Spots on Saturn," by Mr. A. Stanley Williams. Mr. Williams had made a large number of observations of spots, several of which were independently confirmed by Mr. Freeman, and had come to the conclusion that if the rotation period due to his last year's observations were correct, there were ten distinct spots, eight of which had already been observed on more than one night. An extract from a letter recently written by Mr. Holden was also included in the paper. The writer said that the spots would be easily seen in a small, but perfect, telescope, and that "seeing such markings is entirely a matter of detecting faint contrasts."

The Rev. A. Freeman called attention to the fact that the bright spots on Saturn's broad equatorial belt were not confined solely to the northern portion, although most frequently seen there: they were occasionally met with upon the southern side.

Mr. Cottam then read a paper by Mr. Geo. Calver on "The Present and Past Newtonian Telescope." With regard to the housing of telescopes, Mr. Calver was of opinion that an observatory might be considerably warmer than the outer air, provided the shutters were not narrow. Dewing might be prevented by suspending a small night-light 8in. or 10in. below the mirror, the cell of which should always be open at the back. Dewing could hardly take place in wooden tubes. The mirror and flat should always be kept covered when not in use.

A paper on "The Taurid Meteors," by Mr. Henry Cordar was also received, and would appear in the *Journal*.

The President announced that Mr. Wesley had kindly undertaken the office of librarian, so that what books the society possessed would be accessible to members for purposes of reference. They would be kept at Burlington House.

Whilst the ballot was proceeding, Mr. Maunder gave an account of his recent visit to Liverpool, Manchester, and Southport. At all three places he was cordially welcomed by the members of the Association resident there. He found that the Liverpool Society had cleared off their debts, and were in a position to start afresh. They resolved to call a council, and afterwards a general meeting, to decide what was to be done in the future —whether the old society should be revived, or whether they should join the Association as a body or individually. In Manchester he had a very enthusiastic meeting with the members of the Association, who were of the opinion that there were a large number of gentlemen in the neighbourhood possessing telescopes and interested in astronomy, and that, in all probability, a strong branch might be formed there. A provisional committee was formed and a secretary elected. Altogether, Mr. Maunder considered that his expedition was quite as successful as he could have hoped; perhaps even more so. He then proceeded to give the first half of an interesting lecture on the spectroscope, illustrated by magnificent lantern slides, conspicuous among which were some by Mr. Higgs, of Liverpool.

It is stated that Prof. Rowland, physicist at the John Hopkins University, has just finished grinding a perfect screw to be fitted into an improved form of his dividing engine. With the machines now in use he is able to draw 50,000 lines regularly to the inch. With this new machine he will be able to draw a million lines to the inch with regularity, but the limit of the vision in the microscope is about 100,000 lines. With this dividing engine he rules gratings on speculum metals. It takes the automatic machine—which is of marvellous construction and has many devices to compensate errors—six continuous days and nights to make one grating of the size needed to study the nature of the sun.

SCIENTIFIC NEWS.

THE position of Wolf's comet on Feb. 11 will be for Berlin midnight R.A. 4h. 38m. 4s.; S. Dec. 8° 1·6; brightness 1·38 as compared with unity at time of rediscovery.

A new nebula has been found in R.A. 3h. 56m. 20s., Dec. + 69° 30′ (1890), by Mr. Denning, who says there is probably not another nebula so conspicuous as this remaining to be discovered north of the Equator. The new object is pretty bright and large, and is curiously situated between two pairs of telescopic stars lying nearly N. and S. The star D.M., + 69°, 235 (mag. 8½) forms one of the components of the N. pair, and is placed four minutes of arc distant from the nebula. The latter may readily be found a little more than one fourth of the way from γ to α Camelopardi. The same observer has also found a small, pretty bright nebula in R.A. 3h. 31m. 13s., Dec. + 76° 18′ (1890). Neither of these objects is in the new General Catalogue.

At a recent meeting of the Paisley Philosophical Institution, the president (Rev. Dr. Henderson) announced that Mr. James Coats was prepared to add a number of instruments, principally meteorological, to the observatory, to increase the endowment by £2,000 (making £6,000 in all), and to extend the observatory property. Some of the instruments had arrived, and were on exhibition. They are self-recording instruments by MM. Richard Frères, of Paris, and include barometer, thermometer, psychrometer, actinometer, evaporometer, and pluviometer. One of Sir W. Thomson's electrometers and a heliostat for use with the spectroscope are to be added.

The *Edinburgh Evening News* states that Prof. Copeland, writing from the Edinburgh Royal Observatory, says that a recent post brought an anonymous postcard, on which was written —"*Nova* in Auriga. In Milky Way, about two degrees south of Chi Aurigæ, preceding 26 Aurigæ. Fifth magnitude, slightly brighter than Chi." Prof. Copeland awaited the approach of evening with some impatience, as an examination of star charts and catalogues showed no object of any size near the spot indicated. "By a few minutes past six," the professor continues, "an opera-glass revealed the presence of an unknown star about 5½ magnitude, or just visible to the naked eye in the place indicated. The almanac showed that it was not a planet. There then remained only the spectroscopic test; slowly the somewhat ungainly and imperfect appliances at Calton Hill were brought into position, and at last the tiny prism did its work. The spectrum of the stranger seems closely to resemble that of the new stars of 1866 and 1876—bright hydrogen lines in the red and blue, bright carbon bands in the green, bright sodium perhaps in the yellow. This much can be seen at once with imperfect appliances."

According to the sunshine report for the past ten years, the Channel Islands, as represented by Jersey, are the sunniest spots in the kingdom. The average amount of sunshine there during the whole year is 39·9 per cent. of the interval the sun is above the horizon. The nearest approach to this is 35·7 per cent. at Falmouth, then follow in order St. Anne's Head, Milford Haven, 34·7; Geldeston, near Beccles, 34·5; Southampton, 33·5; and Southbourne, 33 2.

The death is announced at Cambridge of Mr. Thomas Roberts, M.A., F.G.S., of St. John's College, assistant to the Woodwardian Professor of Geology at Cambridge. Mr. Roberts, who was only 35 years of age, graduated at St. John's College, obtaining a first class in the Natural Sciences Tripos, Part I., in June, 1882, and also obtained a first class in the second part of the same tripos for geology in June, 1883. He was awarded the Sedgwick prize in 1886 for a geological essay. He had been for some years assistant to Prof. T. McK. Hughes, who, in his annual reports to the senate, has frequently alluded to the energy and ability Mr. Roberts displayed, and the valuable services he has rendered to the students attending Prof. Hughes's classes.

By the death of Dr. Alfred Carpenter we lose a distinguished sanitarian. Born in 1825, a native of Northamptonshire, Dr. Carpenter studied medicine first at Northampton Infirmary and afterwards at St. Thomas's Hospital, where, besides gaining the first scholarship ever given at that institution, he took the Treasurer's Gold Medal at the end of his course. He held various posts at the hospital, and having taken his M.R.C.S. and L.S.A. diplomas, he went into practice at Croydon in 1852. There he continued to reside. He was an M.D. of London University, and became a member of the Royal College of Physicians in 1883. In 1859 he became a member of the Croydon Board of Health, and he was Examiner in Public Health to the Universities of London and Cambridge. In 1881 he was appointed to serve on the Royal Commission which inquired into the condition of the London hospitals for smallpox and fever cases, and into the means of preventing the spread of infection. Among his many works on sanitary subjects are "Hints on House Drainage," "The First Principles of Sanitary Works," and the "Physiological and Mechanical Aspects of Sewage Irrigation." He was elected president of the council of the British Medical Association in 1879, having in the previous year been orator of the Medical Society of London.

Mr. Collett Homersham, a civil engineer, well known to geologists in connection with the deep boring at Richmond, died the other day at the early age of thirty-six.

By the death of M. Pierre Joigneaux, France loses one of her most distinguished agriculturists. The deceased, who was seventy-seven years of age, was a staunch Republican and a Senator; but will be best remembered by his writings on agriculture, which are of a very valuable character.

At the council meeting of the Royal Society on Jan. 21, no fewer than ten deaths were announced, seven of the deceased having been Fellows of the Royal Society, and three foreign members. The average number of deaths for the whole year is 15, and such a list for a single month is quite extraordinary.

The Bakerian lecture before the Royal Society will be delivered on March 17 by Prof. James Thomson. The Croonian lecture will be delivered by Prof. Angelo Mosso, Turin, on March 24, the subject being the temperature of the brain.

The first volume of the third series of the Royal Society's catalogue of Scientific Papers has appeared. The series will consist of three volumes containing the titles of papers published or read during 1874-83.

In the course of a lecture at the Royal Institution on "The Brain, and the Structure and Functions of the Nervous System," Prof. Victor Horsley, F.R.S., said that the same principal divisions of the organ in more or less rudimentary forms are found to exist in animals of comparatively inferior organisation. In the brain of the skate, for example, it was shown by a very distinct picture on the screen that the same divisions might be traced in what might be called the developmental order as existed in that of the highest animals. There were the fore-brain, the mid-brain, the hind-brain, and the medulla oblongata. Similar results were obtained from the picture of a frog's brain, and a brain in an embryonic state. The grey matter of the brain, which formed the nerve centres, were most developed in animals of the highest type, and in the human organ the whole surface of the brain was one convoluted grey mass. One hemisphere of a chimpanzee's brain was shown to possess a highly complicated structure. The lecturer explained the two cerebral hemispheres and the cerebellum, and showed how the medulla oblongata formed a sort of bridge connecting the two divisions of the cerebellum. In the case of a frog he pointed out the pineal gland, which Descartes thought to be the seat of the soul, but which was now known to be an invertebrate eye. He also explained the functions of certain small masses of grey matter, which are two—viz., sight and equilibration. The optic nerve was situated close to the crura, and equilibration was subserved by the cerebellum.

At a meeting of the Edinburgh Field Naturalists' and Microscopical Society, Mr. Tom Speedy read a paper on the mice plague, and exhibited a living specimen of the field vole (*Arvicola agrestis*), which, he said, was the particular pest to farmers at present. This creature, Mr. Speedy observed, was one of the most productive of its kind, and frequently became a most pernicious enemy to the agriculturist. Like that terrible scourge of the East, the locust, whole mountain sides and pastoral glens were sometimes covered by countless numbers of these tiny animals. Not feeling able to agree with certain of the theories lately advanced as to the cause of the mice plague, he intimated that he had been at the pains to ascertain the exact state of matters in some of the districts in the south of Scotland most affected. It had repeatedly been confidently affirmed of late that the destruction of hawks and owls was the cause of the great increase of voles. In a recent sporting tour in the fjelds of Norway he witnessed an example of the hordes of lemmings, allied to the vole, which periodically visit that country, where owls, hawks, and other birds of prey breed, he said, without restraint. In the same way in the infected districts in Selkirkshire voles were at present found in great numbers, and yet in many parts of that district owls had never been disturbed, and kestrels had not been killed for many years, the Duke of Buccleuch and his predecessor prohibiting their destruction. In high districts where the vermin was not killed down by keepers, voles were found to swarm; while on the low ground, where vermin was destroyed, few comparatively were to be seen.

In consequence of the illness of Prof. W. C. Unwin, F.R.S., the Howard lectures on "The Development and Transmission of Power from Central Stations," which he was announced to deliver on February 5 and five following Friday evenings, has been postponed.

The Royal Society of New South Wales offers its Medal and £25 for the best communication (provided it be of sufficient merit) containing the results of original research or observation upon each of the following subjects:—Series XI.—To be sent in not later than 1st May, 1892: 37. On the Iron Ore Deposits of New South Wales. 38. On the Effect which Settlement in Australia has produced upon Indigenous Vegetation; especially the depasturing of sheep and cattle. 39. On the Coals and Coal Measures of Australasia. Series XII.—To be sent in not later than 1st May, 1893: 40. Upon the Weapons, Utensils, and Manufactures of the Aborigines of Australia and Tasmania. 41. On the Effect of the Australian Climate upon the Physical Development of the Australian-born Population. 42. On the Injuries occasioned by Insect Pests upon Introduced Trees. Series XIII.—To be sent in not later than 1st May, 1894: 43. On the Timbers of New South Wales, with special reference to their fitness for use in construction, manufactures, and other similar purposes. 44. On the Raised Sea-Beaches and Kitchen Middens on the Coast of New South Wales. 45. On the Aboriginal Rock Carvings and Paintings in New South Wales. The competition is in no way confined to members of the Society, nor to residents in Australia, but is open to all without any restriction whatever, excepting that a prize will not be awarded to a member of the council for the time being; neither will an award be made for a mere compilation, however meritorious in its way. The communication, to be successful, must be either wholly or in part the result of original observation or research on the part of the contributor. Competitors are requested to write upon foolscap paper—on one side only. A motto must be used instead of the writer's name, and each paper must be accompanied by a sealed envelope bearing the motto outside, and containing the writer's name and address inside. All communications to be addressed to the honorary secretaries, F. B. Kyngdon, W. H. Warren, the Society's House, 5, Elizabeth-street, Sydney.

Prof. Boyd Dawkins recently delivered a lecture before the Manchester Geological Society on the discovery of coal at Dover, in which he said that, looking at the total thickness of those measures, namely 762ft., as far as they had been proved, between the lowest coals and the surface of the coal measure rocks, he thought that that was a very fair allowance of coal seams. They would of course like to know the direction taken by those seams. As yet no steps had been taken to find that out, for the good reason that they hoped in a comparatively short time to sink an actual shaft. There was every probability that the measures were continued eastward in the direction of Calais; their westward direction was a matter which of course required to be proved. As to whether in that south-eastern coal-field—the existence of which had been proved up to the hilt—the coal occurred at workable depths, they had the fact that in Lancashire several mines were worked at considerably greater depths—the Ashton Moss Pit, for instance, at 3,093ft., and the Pendleton Collery at depths from 2,550ft. to 3,000ft. below the surface. When, therefore, they found coal seams at comparatively shallow depths—under 1,900ft.—they had not got at all to the limit of workable depth; and it seemed to him, in all human probability, that the further down they went the more coal they would find, just as was the case with the Belgian measures.

The *Bulletin* of the United States Fish Commission for 1888 contains a great deal of valuable information, especially in connection with Alaska and the habits of the natives. Amongst other papers, it contains a treatise on the most recent methods of hatching the eggs of fish.

What is said to be the largest lathe in the world is being constructed by W. Sellers and Co. for the Naval Gun-shops at Washington, U.S.A. It will weigh 500,000lb., and will be 133ft. in length. Its greatest height will be 12ft., its greatest width 10ft. 6in., and its boring capacity 16in. The largest guns that the naval shops can now construct are of 10in. bore, and these are also the largest employed in the service. When the new lathe is completed, however, the navy will be equipped with 16in.-bore guns, more than one-third as big again as the guns now in use.

At a recent meeting of the French Académie des Sciences, the Prince of Monaco read a paper on a new thermometer of M. Chabaud for use in the deep sea. It overcomes the drawback to the older forms of giving incorrect results when they have to pass through colder layers above the depth to which they were lowered. Four of these new reversion thermometers were tried by the Prince and Prof. Thoulet in the Channel, and were found to give very good results.

The Royal Commission for the Chicago Exhibition are endeavouring to form a typical collection, illustrating British metallurgy. Dr. E. J. Ball, instructor in assaying at the Royal College of Science, South Kensington, has undertaken to arrange and classify the collection.

Novelists do not often base their plots on scientific or mechanical discoveries. It is, however, worth notice, perhaps, that the whole interest of the marvellous story, "The Bread Carrier of Paris," by Count Xavier de Montepin, which has probably fascinated the French people more than any other romance of the present century, and Capt. Roger Gordon's admirable translation of which is now appearing in the *Weekly Times and Echo*, turns on the discovery by the employer of the villain of the story of an engine-turning machine for making lathes capable of engine-turning on curved surfaces. Some of our lathophiles may be interested in the fact.

Teak.—The use of teak wood has largely increased of late years, and now when builders and architects have had experience of its durability, there are fears, it is reported, of the diminution in the supply of the wood. The teak tree extends through Central and South India, Burma, and Siam, and though in the former country the plantations are placed under the careful supervision of the well-organised Indian Forest Conservancy, it appears, from a report on the trade of Siam recently furnished to the Foreign Office, that the "number of years which will elapse before the teak forests in the districts become exhausted is variously estimated by the foresters and teak merchants, but twenty years appears to be the longest time allowed, and under present conditions it appears doubtful whether the supply will last so long. In ten years it may not pay to work teak unless prices rise and the method of working is improved upon, as all the timber near the streams will have been felled and dragged, and only those trees will remain which are far removed from the water, or which are near streams from which timber cannot be easily got out." No young trees are planted, and no measures even are taken to protect the saplings from fire, or to insure their growth.

LETTERS TO THE EDITOR.

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[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

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RIGEL — ASTRONOMICAL CAUSE OF GLACIAL EPOCHS—BARLOW LENS? —KELLNER EYEPIECE — RELATIVE PARALLAX IN ECLIPSES — THE "ANNUAIRE" OF THE BELGIAN ROYAL OBSERVATORY — ASTRO-PHYSICS — THE UNITED STATES NAVAL OBSERVATORY — CAUSE OF AN ICE AGE — SPOTTED OBJECT-GLASSES AND SPECKLED TUBES—MR. KEELER AND THE CHIEF NEBULAR LINE — RAIN-GAUGE MEASURING GLASSES — DISTANCE BY TRIGONOMETRY—THROWING AN IMAGE OF THE SUN ON TO A SCREEN.

[33128.]—"ORION" (letter 33085, p. 486) will find Rigel given as a test for a telescope of 2in. aperture in Clark and Sadler's "Star Guide," published by Macmillans in 1886; but Webb, in his "Celestial Objects for Common Telescopes," states that it has been detected both by Burnham and Franks with 1½in. aperture, and by T. T. Smith with a speculum of only the same diameter.

Prior to reading letter 33086 (p. 486) I was unaware that any later edition of Herschel's *Outlines* than that in my possession had been published. Herschel died in 1871, and my "new edition" (obviously stereotyped) bears the date of 1875. Perhaps reference to the sections 368*a* and 368*b* may enable Mr. Monck to identify the passages to which I referred in my letter (33047) on p. 442, as indicating Herschel's view, that if the total heat received from the sun on one hemisphere of the earth during twelve months be represented by 100, 50 parts are received in summer and 50 in winter. Herschel does not actually use these numerals.

I would answer query 76345 (p. 495) by saying that I regard the expression "silvered Barlow" lens as something of a solecism. What I suspect my querist means is a concavo-convex lens silvered on one face, which fits into an eyepiece, with its concave face towards the object-glass. Its sole use is for observing the sun, the light from which is so reduced in passing through the silver film as to obviate any necessity for the use of a dark eye-cap. As long as the film remains intact, this is effective enough, but when it wears into tiny holes, adieu to its efficiency. I have not used my own for some years, but think of resilvering it again some day, and trying again.

"T. R." (query 76367, p. 496) will find that the Kellner eyepiece is chiefly of use as a low power, as it gives a very large flat field. But it has its drawbacks: for the smallest speck on the field-glass (which is *in* the focus of the eye-glass) shows most annoyingly. The field-glass is a double-convex one; the eye-glass an achromatic combination of a plano-concave flint with a double convex crown. There is nothing like the Huyghenian eyepiece for all-round work.

Mr. Tetley (query 76370, p. 496) is quite right in his assumption that the Equatorial semi-diameter of the earth as seen from the moon is the lunar equatorial horizontal parallax, and that this would be the same, absolutely, were the sun annihilated. But the term "relative parallax" is properly applied to the difference between the lunar and solar parallaxes, because upon it depends the relative displacement of the sun and moon in the heavens as seen from the earth, and, pretty obviously, the relative apparent diameters of the earth and moon as viewed from the sun.

We grumble, righteously enough, in England if ephemerides and kindred works appear a day or two too late; but I wonder what we should say if a publication like the *Annuaire* of the Belgium Royal Observatory were three weeks behindhand, and showing no signs of appearance? And yet I learn from *Le Précurseur* that up to the 20th of last month that official publication had never appeared at all, and that it was not known, in the least, when it would do so! The excuse made was that the meteorological data were not made up to Dec. 31, 1891, which seems simply ridiculous. Why the unfortunate amateur should have to go for a month without any information as to the rising, southing, and setting of the sun, moon, and planets, occultations of stars by the moon, and the like, simply because the editor could not add up the Uccle rainfall for the previous year in time for the press, must puzzle a plain Englishman. Our Belgian *confrères* seem mad about meteorology. I have long left off reading *Ciel et Terre* on the specific ground that meteorology swallowed up everything in it. It was all "Terre" and no "Ciel."

The Astro-Physical section of the quondam *Sidereal Messenger*, to which you refer in your "Scientific News," on p. 504, forms certainly a new departure in spectroscopic literature, for assuredly nothing comparable with it has so far appeared in the English language. With the co-operation in his own country of such spectroscopists and physicists as Profs. Young, Keeler, Langley, Michelson, Pickering, Rowland, Ames, and Bigelow; in England of Dr. and Mrs. Huggins, Profs. Liveing and Dewar, Captain Abney, Messrs. Maunder, MacClean, and Crookes, and Father Sidgreaves; and on the Continent of MM. Janssen and Cornu and Herr Schumann, this publication of Prof. Hale's promises to become essentially *the* journal of spectroscopy and celestial physics generally. Certainly it must and will be procured by every student of astrophysics, and by all who are interested in the subjects on which it treats.

I have received the Report of the Superintendent of the United States Naval Observatory for the year ending 1891, June 30, which contains a record of steady and enduring work during the period which it covers. The reduction and printing of the observations seems to me, though, to be a little behind-hand. The publication of the results of the observations of the Transit of Venus of December, 1882, is delayed for the reduction of certain occultations, telegraphic determination of differences of longitude, &c., "as no funds are available for that purpose." I confess that the sentence which I have quoted reads oddly, as coming from a country so wealthy, and with such an enormous annual national surplus as America.

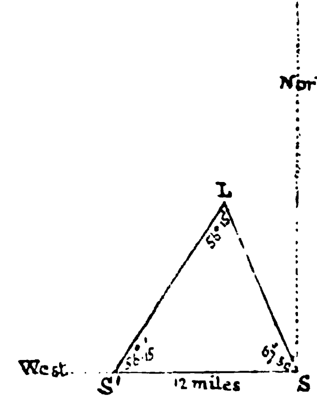
Just as Mr. Dick found it impossible to keep Charles the First's head out of his "Memorial," so do we find Mr. Garbett (letter 33106, p. 505) wholly incapable of reading anything in connection with a change in our climate, or of any alteration in the physical features of the earth, without straightway rushing into print with his *n*-times-exploded figment of a watery comet and the Noachian deluge. There is not the very slightest proof whatever that a watery comet did exist, does exist, or ever will exist. I am practically certain that your eccentric correspondent has a strict monopoly of this monomania of his about so absolutely supposititious a celestial visitant, and that, as I have before remarked in these columns, he has gone on talking about it until he really believes it himself! We ran into a comet—or rather a comet ran into us—some time in the "60's," and much the worse (or the better) we were for it! Let any one interested in the question read up the subject of the mass of comets in Herschel, Hind, or any other recognised authority, and then say what he thinks would be the effect of a body like Mr. Garbett's "watery comet," weighing, according to his own estimate, 2,273,627,000,000,000 tons, + x tons of a "smaller quantity of air," careering through a system! Neither astronomers nor geologists will for a single instant accept such nonsense on the *ipse dixit* of Mr. Garbett. What we ask for is not his assertion about "watery comets," but *proof* of their existence.

I am a little afraid that acari-like spots on his objective, of which Captain Battersby speaks (in letter 33110) on p. 506, are referable to the actual decomposition of some constituent in the glass itself—perhaps the lead in the flint component. The amount of light obstructed, however, by these unsightly blotches is practically imperceptible. If your contributor will try the experiment of sticking bits of paper on his object-glass, and viewing such an object as Jupiter alternately with the objective thus spotted and clear, he will be surprised at the little difference that several small patches make. I cannot definitely say why his tube has become so disfigured; but very little wears lacquer off brasswork, which then turns black straightway. Notably will any alkaline liquid fetch it off at once.

In connection with letter 33125 (p. 511), I would assure Mr. Gregory that he is mistaken in supposing that my note was in any sense "vindictive." I have not the pleasure of knowing your correspondent even by sight. Hence I can assuredly entertain no unfriendly feeling towards him, and am sorry that he should imagine that I do so. I certainly should not have recurred to the May Meeting of the Royal Astronomical Society, but for Prof. Keeler's own note as to the misunderstanding of his observations, and his reference to the June *Observatory* on p. 437. Now Mr. Keeler had insisted that to whatsoever it might be referable, the chief nebular line was a *line*, pure and simple, and formed no part of any "fluting," magnesian or otherwise. What I understood Mr. Gregory to contend was, not that this line was necessarily due to magnesium, but that it *might* be, and this I did regard as an attack upon Prof. Keeler's powers of observation and capacity to interpret what he saw; but, upon your correspondent's explicit statement: "If I had stated that the nebula line was due to magnesium, I should have said what I do not believe," I can only express my regret that I misunderstood him. Let me conclude by assuring him that he has equally misunderstood me, if he thinks that I would "try to stir up ill-feeling among workers in the same field—fellow-seekers after truth." It is most earnestly to be desired that all such workers should conduct their investigations in harmony, and with a view to mutual aid and the simple elucidation of facts. But leaving me and my prepossessions out of the question altogether, Mr. Gregory (viewing the question impersonally and dispassionately) can scarcely deny that we have had a trifle too much of *Athanasius contra mundum* in spectroscopy.

I have certainly answered the question put by "Non-Mathematical" (in query 76385) on p. 517 at no very distant date in these columns; but it will be less trouble to me to reply *de novo* than to hunt through the indices of my back volumes. It is an obvious elementary piece of mensuration that area multiplied into depth gives the volume of any vessel. Furthermore, my querist probably knows that the areas of circles vary as the squares of their diameters. Hence it must be evident that to find what depth in a circular glass jar of given diameter will measure an inch of water in a cylindrical vessel of any size, we have only to divide the square of the diameter of the receiving vessel by the square of the diameter of the measuring jar. Let us apply this to his own examples. His rain-gauge is 8in. in diameter, his measuring glass 4; so we say $\frac{8^2}{4^2} = 4$, as Dr. Scoffern says. Now let us take a rain-gauge 5in. in diameter and a measuring glass 2½in. across. Then, as before, we have $\frac{5^2}{2\cdot5^2}$; or again 4in. Finally, to further elucidate the principle, we will suppose that the gauge measures 9in. across, and the glass 2in. Then $\frac{9^2}{2^2} = 20\cdot25$; so that in this case 1in. of rain in a 9in. gauge would fill a 2in. jar to the depth of 20¼in.

In order to give "L" (query 76400, p. 517) the *rationale* of the solution of his problem, I must go into some very rudimentary trigonometry indeed. My querist must certainly know that as one side of a triangle is to another, so is the sine of the angle opposite the former to the sine of the angle opposite the latter. This much premised, let us put the problem into a diagram.



Here L is the lighthouse, S the ship at 2 o'clock, and S' at 4 o'clock, after she has sailed the distance S S', i.e., 12 miles due west. When she starts, the lighthouse bears N.N.W., i.e., "North," S L in our figure = 22° 30'. But "North," S S', is a right-angle, so that L S S' must be = 90° − 22° 30', or 67° 30'. The angle between the two bearings of the ship (N.N.W. and N.E. by N.) = 5 points, or 56° 15'. Hence, S L S' = 56° 15'; and as 67° 30' + 56° 15 = 123° 45', L S' S must = 56° 15', too, to make up the two right-angles, though this is immaterial for our present purpose. Then we say, as sin. 56° 15' : sin. 67° 30' : : S S' (12 miles) : S' L.

sin. 67° 30' log.	9·965615
12 log.	1·079181
	11·044796
sin. 56° 15'	9·919846
13·33 log.	1·124950

What the author of the book, whence "L." quotes, has done is to multiply by the cosec. of 56° 15′ instead of dividing by its sine, which is obviously the same thing, the cosecant being the reciprocal of the sine, and its log. the arithmetical complement of that of that function.

If "No Sig." (query 76420, p. 518) will leave in the eyepiece of his telescope, fasten a sheet of black cardboard at the eye end of it with the eyeglass protruding through it, and now turning the telescope towards the sun, project its image on to a sheet of white paper, and focus the solar image on the paper by shifting the latter backwards and forwards, he should have no difficulty whatever in seeing the mottling on the sun's surface. If the image be slightly moved about on the paper, this mottling will be more easily caught. In a small telescope it suggests the idea of the sun being made of loaf-sugar. Of course, the black cardboard is to shield the white paper from direct sunlight, which would tend to obliterate the projected image.

A Fellow of the Royal Astronomical Society.

RIGEL.

[33129.]—It may interest "Orion" (letter 33085, p. 486) to know that before reading his letter I had frequently tried to see the companion to Rigel, but failed at every attempt. Following his advice I brought this star into my field of view last night, the 25th, when it was about half-way to the meridian. The aperture of my telescope is 3¼in., but is of inferior quality, the light-grasping power being only equal to a first-class o.g. of 3in. The power I used was 60 dia. In a few seconds I was greatly astonished to see the companion. I afterwards saw it distinctly with a stop of 2¾in., and glimpsed it with a stop 2¼in. The night was a very fine one, and the rings round the stars very neat. I may also say I can just glimpse the fourth star in the trapezium with a stop of 2¼in. I shall be glad if "Orion" will state what is the smallest aperture he can see the fourth star with.

Swansea, Jan. 26. **Beta.**

[33130.]—I have read with interest "Orion's" remarks upon Rigel in last week's journal, and last night (Sunday) being fine, with only a little frost, I examined this star with a 2½in. refractor. A power of 80 gave good definition of the companion with the whole aperture, and also when cut down to 2in.; 60 did not get rid of the glare of the big star sufficient to allow of the small one being seen. As my 2½ o.g. has only a focus of 24in., I tried a 4¼ o.g. of 70in., at the same time cut down to 2¼in., and had equally good results using a power of 75.

I have found this star rather tricky at times, not being divisible when other doubles came out satisfactorily.

"Jimmy" should be able to see the companion to Polaris with 2½ o.g., but very small, and he would find a diagonal eye-tube very useful, as he would then be in a comfortable position for viewing such a star. Two inches of my 2½ o.g. brought out the four stars in the Trapezium better with a power of 80 than 60 did.

Later on—12.30, night—Saturn's ring was plainly visible, the edge showing across the body of the planet; power used, 105 on the 2¼ o.g.

J. S. G. W. S.

TESTS FOR SMALL TELESCOPES—RIGEL AND γ CETI.

[33131.]—"Orion" (letter 33085) may rest assured he has a good glass. It is not much use attempting to show the companion to Rigel to an inexperienced person with a poor 2¼. I saw it last night with a 2¾ Tulley of particularly good defining powers; but I have tried with a good 2¼ under very favourable circumstances, and always failed totally.

It may interest "Jimmy" to know what I have been able to do with a 2¼ on the tests he names, &c. I have two powers I use for stars, about 80 and 145. With the 80 I quite fail at γ Ceti, but can nicely separate α Piscium, γ Leonis, and once on a very good night I cleanly divided ε Boötis. With the higher power on a really good night I can divide γ Ceti; but it needs a good night, and though it is given as 2·7″ apart, it is to me much more difficult to separate with the 145 than ε^2 Lyræ is with 80. In fact, the latter star, although given as 2·5″ apart, appears easier to me than ε Boötis, which is given as 2·9″, owing, no doubt, to its being such an even pair. In regard to Polaris, it is only about one night in three of those I consider good that I can see the *comes*. But I am not very good at faint companions.

Jan. 26. **H. Wake.**

THE CAUSE OF THE ICE AGE—THE PROPER MOTIONS OF THE STARS.

[33132.]—I think Mr. Garbett mistakes the conditions of proof quite as much as the theorists whom he is opposing. Granting that collision with a comet is very likely to have occurred at some past period (I do not know how Mr. Garbett arrives at fifty centuries), it seems pretty certain that comets do not consist of water, or of water and air, and that few, if any, of them have the mass which Mr. Garbett supposes. Newton or Halley might, not unnaturally, have fallen into this error; but the planetary perturbations aud the spectroscope have dissipated it. Further, Mr. Garbett does not show how the gradual cooling of the earth previous to this collision could have produced an Ice Age. Cold alone may freeze seas and lakes, but it will not produce glaciers and icebergs. According to recent researches on post-glacial erosion, however, Mr. Garbett's fifty centuries is a much nearer approach to the true date of the Ice Age than the 210,000 years of Dr. Croll. Sir Robert Ball does not fix the date, but if the Ice Age terminated less than 20,000 years ago, I think his theory cannot be the correct one. As to catastrophes, nothing that can result from known causes ought to be regarded as a catastrophe.

I already intimated in your columns that the sun's motion seemed to me to influence the proper motions of the stars to a greater extent than is usually supposed. I am confirmed in this conclusion by an examination of Mr. Bossert's list of stars with a proper motion of 0·5″, or upwards, annually, in the *Bulletin Astronomique* for March, 1890. It is in these stars that we might expect to find the influence of the sun least sensible. But of 269 stars in the list, the N.P.D. of 176 is increasing, of 83 diminishing, and 10 neutral. From 6h. to 18h. R.A., the Right Ascension of 101 stars is increasing, of 35 diminishing, and 3 are neutral; while from 18h. to 6h. the R.A. of 33 is increasing, of 96 diminishing, and 1 is neutral. There are, moreover, two well-marked minima between 6h. and 7h., and between 18h. and 19h. Where the effect of the sun's motion is small, and of 80 stars whose proper motion amounts to 1″, or upwards, not one lies in either of these hours of R.A.

It may interest some of your readers if I add that, on comparing M. Bossert's list with the *Draper Catalogue*, the Solar stars appear to outnumber the Sirian stars in the proportion of about eight to one.

Dublin, Jan. 30. **W. H. S. Monck.**

METEOR.

[33133.]—Last night (Feb. 1st, at 11h. 23m. p.m.) I saw the finest meteor I have seen. I first saw it near ε Cassiopeiæ, and it travelled slowly in a slight curve towards Orion, passing immediately over Bellatrix, transiting it, and vanishing below Betelgeuse. It varied little in brilliancy until after passing Bellatrix, being about as brilliant as Venus at her brightest. When two-thirds of the path was finished, a second nucleus formed just following the principal. No noise. The flight reminded me of a swallow skimming along.

149, Essex-road, Feb. 2. **E. Holmes.**

[33134.]—At 11.20 p.m. this night (Monday, Feb. 1st, 1892) I saw a beautiful meteor near Cassiopeia moving southwards. It was a bright red when I first saw it, and double the size of Jupiter. It gradually grew fainter in passing the Pleiades, divided into two parts, and at Aldebaran into three parts, and finally disappeared in Orion. From the time I saw it till it disappeared I counted 15 slowly. It had a fine train of fire at first, which grew fainter as the meteor proceeded. I never saw a meteor appear to travel so slowly. I should imagine the distance must have been great and the meteor very large.

170, St. John Street-road. **H. Womack.**

SUNSPOTS.

[33135.]—The fine cluster of sunspots which Mr. Godden observed near the sun's W. limb (letter 33109), date not given, and concerning which he asks for information, was evidently the same which I observed near the central meridian on Jan. 21. It was one of rapid growth, for on the 15th only one two very small spots were visible near the E. limb. It had nearly the same longitude as the large spot to which he alludes as "completely bridged over" in the northern hemisphere. There cannot, therefore, be much doubt as to its insignificant origin.

The five intervening days, until the 21st, were cloudy; but on that date the cluster consisted of very small, but dark, spots in two streams—the one inclined westward and the other eastward. The preceding stream was, for the most part, connected together by penumbra, and had a leading spot larger than the rest. The following one was altogether smaller. On Jan. 24 a great change had taken place. The first stream had two distinct spots, with a clear space between them, and only a few small ones following. The second was still turned eastward, with the last spot the largest. Besides this, the two streams were much wider apart than before, measuring as much as 11° between the principal spots, instead of only 6°. They seem to have exercised some repelling influence on each other.

On the following day, the 25th, the smaller members had increased in area, making all the spots more nearly of the same size. But on the 26th, which was the date of my last observations, the two streams could not be recognised. They had given place to two distinct spots of considerable extent, without any smaller ones, unless the quickly-passing clouds obscured them. Whether they will survive long enough to reappear in due course remains to be proved.

E. Brown.

THE EQUATOREAL—SILVERING MIRRORS.

[33136.]—In my last note on silvering mirrors, in the second line of paragraph five, after "expected" there should be a comma instead of a full stop. Again, "drive," on the fourth line of paragraph six should be dew—that is, the warmth and moisture from the fingers will dull the silver; but if not touched it will instantly clear off and leave no stain.

In the equatoreal just set up at Edinburgh I have decided a point which will be interesting to telescopists. It especially interests me just now, as it will save much trouble and expense in a 15in. equatoreal I have now to build and set up. It relates to the clock and weights.

When a clock-pit has to be made under an observatory that is already up, it is not often an easy matter, but often troublesome and expensive. In the case of the one at Edinburgh, instead of a pit under the stand we had a free pulley running on a bar parallel with and directly under the clock drum. The line off the drum passing under this pulley, the pulley could revolve with the fall of the line, and also traverse from end to end of its bearing. The line was then led under the floor to a second pulley, then up to a high frame over another pulley, then falling to 6ft. below the ground into a pit, and giving in all a clear fall of 10ft. and a run of two hours to the clock.

What I had some fear of was that the several turns over the pulleys would absorb too much of the clock's power; but I was glad to find the clock had perfect control over its work with the usual weights of 200lb.

It will be seen from this that the line can be guided just under the surface of the ground across a lawn or garden to any convenient distance or place, and the weights can fall from a tree, post, or outbuilding, a position that is at all times easy to get at in case attention is needed or a line break. The drum of the clock will give full three hours run, and with the maintaining power which I arrange to keep the clock going while it is being wound up an almost unlimited run is obtained for photographing purposes—a run quite impracticable with the ordinary pit under the observatory, and with all the trouble and cost avoided.

This method of disposing of the pit would have been especially welcome in the 12½in. With mirror I recently mounted for Canon Hutchings. The soil was troublesome, and it was difficult to make it watertight. The line could have been laid under the surface of the lawn to a friendly tree outside the grounds, and instead of an hour's run, there could have been three easily.

As another help to a long running and long exposures in photographing, I have adopted a small Newtonian telescope, with its eyepiece fixed close to the eyepiece of the large telescope. The eyepiece of the small or guiding telescope has a machine-divided diaphragm, with a suitable system of five lines, similar to a micrometer. The object or field to be photographed is held and positioned in this system of lines, and can be held in one position during the exposure of the plate. This is accomplished by bringing all the motions of the instrument up to the eyepiece, with a fixed place for each—the clock clamp, the fine motion in R.A. (applicable equally whether the clock is going or not), the declination clamp, the declination fine motion.

It will be seen that with these facilities the means of photographing faint objects can be given to smaller instruments. A smaller telescope, with a longer exposure, will do what the larger does with a shorter exposure. If the object is too faint for the guiding telescope to fully grasp, any neighbouring star held in the field of wires will do just as well as the object to be photographed.

G. Calver.

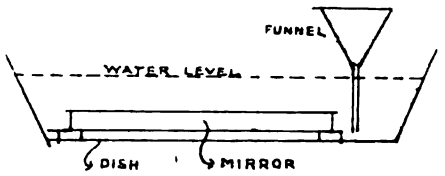
[33137.]—After many failures I have adopted the following plan, which has proved uniformly successful. The essential points are:

1. Absolute cleanliness of surface obtained as usual.

2. Closeness of surface to bottom of dish, obtained by resting mirror on three pieces of match laid on bottom of dish, thus raising the dish about $\frac{1}{16}$in.

3. High temperature of glass, solutions, &c., obtained by placing mirror in silvering-dish, covering with distilled water, and placing over water bath until contents are nearly boiling. While heating, one side of the glass should be further raised to allow free circulation of heated water.

4. The surface to be coated should be hotter than the solution, obtained by pouring the solution down a funnel pushed down to near the bottom of the dish. The solution, being of greater sp.gr. than the water, will flow under the mirror. Its course may be observed through the glass, and by tilting the dish, may be made to flow to any point it does not at once reach. If the mirror is thick, and it is feared that it may crack, the solution may be warmed before using. This should be done after mixing the silver solution, or before adding reducer, which may also be warmed. The solution should, however, be colder than the mirror.



In about a quarter of an hour the solution will be clear, and the mirror may be removed and dried with blotting paper.

As to polishing, I am unable to see the necessity for it. My surfaces as they come from the bath have already a lustrous polish it would seem difficult to improve. I have tried polishing several times, but the best surface I can obtain shows under the microscope a finely-scratched appearance, absent in the unpolished mirror, which, under similar conditions, appears perfectly smooth. Perhaps Mr. Calver or another would give some information on this point, and, if possible, give a test to determine when mirror is sufficiently polished.

Does Mr. Calver in your last issue mean that he used 400grs of $AgNO_3$ altogether in silvering 12½in. mirror, or that that was the amount used in a single bath? The amount of silver I generally use is about 2 to 3gr. to the square inch.

Could any contributor give me any information as to how flexure is prevented in mirrors above about 12in. in diameter? Below that size I believe the usual practice is thickness = 1-6th of diameter. If this is the case above the size mentioned, the mirror would become very expensive. Would it be possible to attach the glass to an iron plate strengthened by radial arms? **Ztirf.**

PROJECTILES AND THE ROTATION OF THE EARTH.

[33138.]—I notice what appears to be an oversight in letter 33088. "M.I.C.E.," in the example he gives, takes the whole height to which the shot is supposed to ascend instead of two-thirds. It is manifest that the shot could not spend the whole of its time of flight at the highest point.

Also if "M.I.C.E." will more fully consider the case, I think he will see that his formula makes the deviation only half the amount it really is.

Then I should be glad to know why the upward flight of the projectile is not one of the conic sections, and why the downward curve is a parabola. The latter is certainly to all appearances a parabola; but is not the whole flight part of an ellipse? If we imagine the whole mass of the earth collected in one dense particle at the centre, is it not reasonable to suppose that the shot would revolve round that particle as one of the foci of a greatly elongated ellipse?

I am sure "M.I.C.E." is better able to deal with the problem than I am, and I call his attention to these points in the hope that he may deal with the subject analytically.

I don't think "J. R. C." had quite grasped the meaning I intended to convey when he wrote (letter 33055, p. 446), "In all cases, however, the deflection due to the earth's rotation is equal to the time of flight multiplied by the difference in tangential velocity of the two ends of the range." This is obviously incorrect. For instance, in the example I gave (letter 33042, p. 421) of a gun fired at an elevation of 75° 9′ in latitude 51° 31′ North, when the range would probably be several miles and the time perhaps 30 seconds, yet the deviation would be *nil*. Again, if the shot were fired vertically, the time of flight multiplied by the difference of tangential velocity of the two ends of the range would be *nil*, yet the deviation would be at its greatest. Also the gun is supposed to be pointed vertically, not either to the east or west, as "J. R. C." makes out. I notice in my last letter on the subject (p. 421) either the printer or I have made an omission. In the last par but one, line six should read, "The shot is travelling at the time it is fired is only at *that moment at* right angles to the action of gravity." The three words in italics were omitted.

Jan. 26. **H. Wake.**

TAPERS AND CONE FITTINGS.

[33139.]—The subject broached by "A. H. S." is one on which there is a great deal to say. Will not "J. K. P." give us a talk on the best way to measure tapers, &c.? There is one in the *American Machinist* of Nov. 14, 1889, by "Jarno," which appears to me very good. "E.M.'s," however, who are competent to do so, do not care to give us these sort of tips—they wait till we get them from America, and then write, with a shade of scorn, to say the plan has been used long ago in England. They would not, however, take the trouble to help us to it till we get it from across the water. Now, will not some of these "practical men" give us something good from English practice, that we may not have to get it from America?

I believe the "best possible angle" for cone fittings for lathe centres is about as easy to establish as the best possible thread rate for a 1in. bolt. It does not much matter within certain limits; but in both cases it is very desirable to have uniformity. In the one case we have the Whitworth thread, and in the other the Morse taper. Possibly the Morse taper might be improved on by making all the sizes to exactly the same taper of, say, ⅝in. to the foot; but as the Morse taper exists, and so many chucks, drills, centres are made to it, is it not better to adopt it just as it is? I suggested this to Mr. Milnes a little while ago, but found he had already done so. Most English makers use a quicker or blunter cone, say, about 1in. in 12in. I think this is just as good where centres only are concerned; but if one wishes to have a hole which will take the Morse twist drills or an American chuck, or an arbor to hold a milling cutter which will not jar loose and come out, then the Morse taper is best.

F. A. M.

VIOLIN-MAKING.

[33140.]—Since Mr. Pickering has set the world to talking and thinking on the subject of violins, I wish to say a word. Mr. Pickering has certainly given all the information necessary for anyone who is ingenious enough to make a violin; but the secret of making a good violin does not lie in the tools the workman uses. There are good reasons for the presumption that the *timber* makes the *timbre*. I was, a few years ago, acquainted with a violin-maker, who made instruments for many of the masters in this country. His shop was not accessible to anyone; but I saw some of his very best work, and talked with him about it. He claimed to be able to tell what quality of tone a violin would have as soon as he began to cut the wood, and that he could produce any modification he chose. I observed that he always made the back in one piece, and that the grain never ran parallel to the longitudinal axis—that he never used the least mite of metal, bone, or stone ornaments in any part. He used what we know in this country as *curly* maple, which is only a variety of the *Acer saccharinum*, having an even short-waved grain. I once saw a lot of his backs sawed out, and observed that the boards had been smoked, apparently a long time; this, however, may have been accidental. His curves were such that the centre of the face and back were the minor axis of an ellipse.

His instruments were of beautiful contour, and the bridge seemed higher than that on other instruments;—and there seems considerable in this, for on the height of the bridge depends the amount of strain on the back and face, and this strain undoubtedly wields a powerful influence over the vibrations. A few experiments with high and low bridges on the same violin will demonstrate this to any one. As to adding weight to the different parts of the back or face only, can that not be demonstrated by coating with putty, or any gum that can be removed without injuring the instrument?

If there is nothing in the quality of the model, and the stain on the face and back only, can makers not produce the same true quality in every instrument they make exactly alike? Is it known just what variety of wood the old makers used for the face? And is it known that they did not have some peculiar method of seasoning or treating the wood? Such small items may prove to be important factors in that acoustic puzzle—the violin.

R. Gobriel.

Milford Centre, Ohio, U.S.A., Jan. 17.

[33141.]—This violin correspondence is most interesting, and Vol. LIV. of the "E.M." promises to contain the largest amount of practical information on violin matters to be found in the English language. "Grinder's" letter is deeply interesting and instructive; but there is more to be said about bridge and post arrangement than he has done. He tells as how he discovered the important fact that the bridge should not approach nearer than 7½in. from the top of the body of a 14in. violin. There is though, I believe, a much wider limit in the backwards direction. I discovered this fact accidentally. I posses a most beautiful and perfect J. B. Ruggeri violin, and being anxious to get the very best result from it, I took it over to Paris, and gave it into the care of Messrs. Gand and Bernardel. M. Bernardel said it was one of the most perfect and beautiful examples he had ever seen. I left it five weeks with him, giving him carte-blanche to do what he liked with it. At the end of the five weeks he delivered it to me with some of the finest bits of workmanship done to it I ever saw, but the interesting point is this: he had arranged it with the bridge nearly an inch further back than the sound-hole notches, the post being nearly another ¼in. farther back, but bearing its usual relationship to the right foot. The bridge, of course, was high. Nothing could exceed the power and spendid quality of the tone—so equal, so liquid, so pliable, so resonant, so powerful. Playing on it was such an unusual delight as violin-playing rarely is. It was a concert violin fit for Sarasate himself. Every key, every position was the same—the sound poured forth almost of itself — every effect came out with telling force. Unfortunately, I am cursed with short fingers and wrist, and being totally unable to command the length of stop Bernardel's arrangement required, I was compelled to rearrange it. I found it sounded quite freely in all positions of bridge and post between Bernardel's and the usual position, though not quite as free and powerful as where he placed them. Finally, I put the bridge and post at the usual place; but I was a long, long time before I could make it sing as it ought, and I have never succeeded in getting the volume and sweetness of tone and evenness and freedom of production he did. **Lancastrian.**

[33142.]—Can Mr. Pickering, or any of your other experienced violin artists, tell me what is the nature of Mr. H. D. Herring's discovery for the improvement of the tone of violins, and where you can get it carried out? as I have a violin I should much like to experiment on. All I know about it is derived from a vague article in the *Manchester Courier* of a few days ago. **Lancastrian.**

[33143.]—I thank "Scio" (letter 33116) for the lucid way in which he has answered my question (letter 33093). May I ask him yet another? Is there any rule for distance between bridge and nut on violin? Any recognised standard of length for the open strings? Violins I have measured vary from 12in. to 13½in. without respect to size of instrument. It is not only the stopping of the player that is disturbed by this. The difference in tension between the extremes mentioned to bring the strings to a certain pitch must be very considerable. How is the tone affected thereby? **John Rae.**

[33144.]—I beg to thank Mr. Pickering for his reply to mine (33074), as the instance he gives is a further proof that accurate gauging is not always essential to obtain the best results. Does he or any other correspondent think that the difference in local density of the wood could be tested for by means of the sand-figures? Is there any accurate agreement between these figures given by good instruments—that is, do the nodes come at exactly the same points in instruments of the same dimensions? If this is so, would they kindly enlighten me?—as I have no opportunity of trying it for myself. **J.**

[33145.]—My desire is not to prove myself right and someone else wrong, but to assist others, if I can in any small degree do so, and to be assisted, in solving the difficult problem of the violin; and I am grateful to Mr. Pickering for measuring his Stradivarius, because it results, if he measured it as Stradivarius meant it to be measured, in extending by 1-16th of an inch the distance between the top of violin and bridge beyond the limit 7⅝in. which I quoted; and, if I may do so, I would submit that, although Mr. Pickering's measurement (if he measured from the point Stradivarius intended) shows, as Mr. P. suggests, that Stradivarius did not adhere to his own rule, yet his divergence from that rule is in the same direction that I have been experimenting—viz., placing the bridge further back than is usual in most violins. And then the question arises, Was the violin Mr. P. measured made by the Stradivarius whose "rule" is in question? Mr. Pickering knows better than I that beyond the three great Stradivari, there were others of the family, dating back, according to M. Fétis, to the founder, Ottolinus Stradivarius, born 1127.

Now as to my authority for the "rule" which Mr. P. says he "had not previously heard of." Too many years ago to remember accurately, I read in some French work on Violins (I think by M. Raoul) of this "rule"; but at that time I was intent upon advancing the bridge so as to shorten the stop, and enable me to more easily execute, neatly and articulately, very rapid and florid passages, for which I had an ambition, and, therefore, I gave this rule of one of the great Strad family a wide berth, and solely on account of its long stop, sold my "Strad" for £70; thus amateurs "buy and sell, and live by the loss," leaving it to the dealer to grow rich. So time has gone on, until some few months ago I read a most sensible contribution in your valuable pages, which impressed me so much that on reference to my notebook I find I made an entry, thus:—"Stradivarius, for a violin of 14in. places his bridge from 7½in. to 7⅝in.

from the top of the body; 7⅝in. is the average measurement. The length of finger-board is 10⅝in., soundpost ⅛in. to ¼in. behind bridge, length of body 14in.—From English Mechanic." I did not date it, but as I have all back numbers, I can easily refer if need be. This so revived what I had read in previous years, that I was induced to experimentalise as described in 33090.

Mr. Pickering's recent purchase (33115) with (thick) ribs and back in one block, reminds me of an old instrument I in 1852 consulted a "fiddle doctor" about. He diagnosed that the constitution (not construction) of the instrument, always weak, was utterly gone, and he prescribed new and *stouter* ribs, heavier blocks, and a veneer of Swiss pine down the whole length of the belly 3in. wide. This man (Sturge I think his name) was a splendid workman, and could make a joint so clean it could not be seen. He, doubtless, much improved the violin, although it was a little muffled in damp weather on account of the glued veneer, and certainly its tendency to screech was cured.

I fully concur in all Mr. Pickering says as to amateurs learning to regulate their own instruments (I have often had to unregulate violins I have sent to be regulated), and I hope he will continue to nourish us with the like valuable information he is now furnishing.

I may add that I have read somewhere that the two renowned Cremona families selected their wood from the half of the tree which, in growing, faced the sun.

Jan. 30th. **Grinder.**

PRICE OF SILVER ARTICLES.

[33146.]—In his letter 33110, p. 507, Captain Battersby seems to overlook the fact that retail purchases are, as a rule, made from shopkeepers, not manufacturers. The price he names (£4 8s.) may be a good one for the manufacturer; but then the shopkeeper and his family and assistants have to live, besides paying a rent of anything from £100 to £1,000 per annum, according to the size of his shop, and where it is situated. Another point: The electro-plated teapot which he can buy for £2 may not have cost more than 10s. or 15s. to manufacture, the remaining 25s. or 30s. being divided between the maker and the shopkeeper, so that relatively it may be as dear as the other. I am not in the trade, and know nothing of it practically. Captain Battersby's letters are exceedingly interesting and welcome. **F. M.**

INFLUENZA.

[33147.]—The saying "Who shall decide when doctors disagree?" has never, perhaps, had so much force as at the present time. It is difficult to say who shall decide; but people have their opinions in the matter apparently more or less incorrect, and I have no other qualification to address you upon the subject other than my convictions thereon. There is one point upon which most people are agreed, viz., the cause of the disease is atmospheric. This appears so obvious from the pulmonary complications, which almost unexceptionally appear to be at the root of the mischief. The question then arises as to what there is in the atmosphere adequate to account for such a universal complaint. It is apparently no corrosive chemical property in the air, for that would otherwise make itself obvious, and it is apperently not a germ. It is true a Continental doctor has notified his discovery of such a germ; but there are strong reasons for doubting this, for other diseases make no secret of their zymotic nature, and how can it be supposed that this widespread disease should be so reticent?

There can be but one other atmospheric source, and that a non-organised, but yet organic, effluvium. You will follow, Sir, what I mean. Organic matters generally emit some effluvium by their decomposition, and generally mingled with germs or resultant organisms; but supposing these were effectually filtered out, there would still be an effluvium left, though not necessarily odorous—or, at least, apparently not so, for custom works wonders in stultifying the perceptions. It is one of the greatest wonders of organic chemistry that the same elements of which our bodies are composed, when united in a manner different to that in which they are united in a state of health, become the most mephitic and obnoxious principles. Sugar needs but a slight change to convert it into oxalic acid; and beef, calcined with potash, generates the fatal prussic acid. But it would be an unnecessary multiplying of words to enlarge upon this aspect of the question. There is one more fact bearing upon the point—it is this: The putrefaction of members of any individual species generates poisons which are particularly fatal to living members of that species. There are reasons for supposing that this is the cause of influenza. If the mischief of the poison be an unspecific chemical action upon the respiratory organs, animals and plants would be similarly affected.

It is impossible to read of the number of interments which take place annually in and around large towns, of which it is unnecessary to give particulars, and of the number of years necessary for dissolution, without feeling that there is something radically wrong in the system, and this danger is increasing in geometrical ratio year by year. If the decaying woody matter of the swamps of Brazil and Sierra Leone can generate yellow fever, how much more is the appalling accumulation of human bodies a *vera causa* of influenza, or as some declare it, malarial fever.

Now, what is the remedy for this? There is but one answer—cremation. On this subject it is needless to enlarge, it being an independent matter for consideration. Superstition bars the way, and men, as ever, will hold to this though they lose their lives. Why do not our preachers, who can best correct the evil, since others would be suspected of irreligion, protest against each generation acting as the poison and plague of its children? And why do people object to being transported, like Elijah of old, to heaven in a chariot of fire, and why are they so particular as to the means by which their bodies shall be resolved into their constituent elements? Does not such scrupulousness amount almost to a disbelief in the immortality of the soul? To those who would urge that this disease is as prevalent in country places as in towns there is an answer: malarial agents, having completed their action on one subject, generate in his body germs which are transmitted to others irrespective of town or country.

Mens Sana in Corpore Sano.

[33148.]—With reference to the letter of "Heretic," p. 510, allow me to ask whether there is anything special in this epidemic of influenza of which so much is said? That diseases of the respiratory organs are carrying off large numbers (larger numbers than usual), is proved by the returns of the Registrar-General; but the "scare" has surely attained its limits when it is gravely stated that the death-rate of Brighton has reached "the enormous figure of 60·9 for the week," in apparent ignorance of the fact that those figures refer to the death-rate "per annum,"—a vastly different state of things. A similar mistake has been made by many papers.

The Flu.

FLUID FOR PRESERVATION OF ARACHNIDS.

[33149.]—If Capt. Battersby, letter No. 33110, p. 506, will refer to the "E.M." for Dec. 18 of last year, p. 370 of present vol., he will see a preparation specially recommended for this purpose by Mr. A. Haly of the Colombo Museum, which may suit his requirements. **C. S. F.**

[33150.]—I have tried the following method for two years and found it very successful, but it needs practice:—

With scissors, turned up at the ends, cut off the abdomen; pin out the cephalo-thorax and legs on cork and leave them to dry (this may take six weeks); by pressing gently with a paint-brush and blotting paper empty the abdomen through the hole made where it joined the cephalo-thorax; be careful not to squeeze out the colour layer next the skin. Take a glass pipe, 10in. long, ⅛in. bore, draw it out to a fine point one end, and turn it up about 60° (this prevents the abdomen from falling off); fasten a small scent-squirt bellows on the other end; inflate the abdomen. Make an oven of a small tin box, put lid on three-quarters only, place it sideways over a spirit-lamp, and hold the inflated abdomen just inside it till it hardens. It is sometimes necessary with large skins to put some gum at end of tube to prevent skin being blown off, in which case the only way of removing abdomen is to break off the tube. Remove the abdomen every few moments and test the hardness with the finger, blowing continually (a second person needed for large spiders). If you remove the abdomen and cease blowing, it immediately collapses. Size of point of tube depends on size of hole, which it must fit, allowing no air to escape. Gum the abdomen to the cephalo-thorax when finished.

Collector.

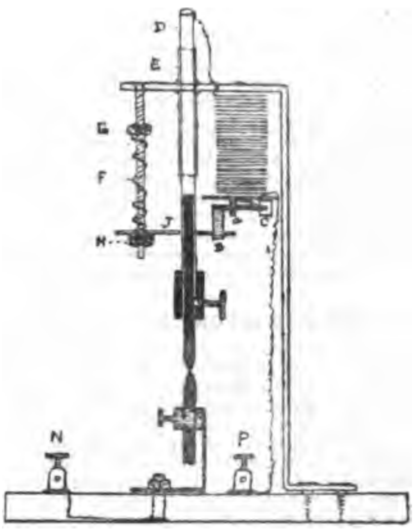
LENGTH OF AN ELLIPTIC ARC.—SUN-DIALS.

[33151.]—Referring to the question of the length of the whole periphery of an ellipse, and to the rules that have been given among the "Replies to Queries," I should like to see the following treated by J. H. Truscott and other mathematicians. If from any point in an ellipse we draw lines to the foci and bisect their included angle by a normal to the curve, we obtain the direction of the radius at that point. How can the length of such radius be determined? Let two such radii be drawn from two points in the same quadrant of the ellipse, and be produced till they intersect, and let the angle at their intersection be known, can the included length of arc be determined? If two lines be drawn through the intersection of the axis, cutting away the periphery at two points in the same quadrant, can the included arc length be determined? If equal arc-lengths be included between the successive radiating hour-lines of a horizontal or vertical south dial, what is the curve that will fulfil this condition?

I may add that I have found in an old treatise by Gregory the second rule that I gave recently for drawing a dial. **A. S. L**

HOW TO MAKE AN ARC LAMP.

[33152.]—Amateurs like myself often ask how to make an arc lamp. I beg to give description of one I have made and often use. Procure thick wood base, and firmly attach upright of metal with arm at top, rivet or screw into arm ¼in. soft rod about 2in. long, with stout piece sheet-brass riveted on lower end to keep wire in place, and also for soldering on two L-shaped pieces, one on each side of end of soft iron armature, on which a piece of stout wire is soldered, projecting ⅛in. each side to go through holes in L pieces to form hinge C. A loop is soldered on left side of armature at B, also another loop at A, soldered to sheet brass at end of magnet to keep armature from falling. In loop at B rests one end of flat strip of brass that must have two holes drilled in it, one for tube carrying top carbon to pass through easily, the other for guide-rod fitting loosely. A tube E as long as possible is fixed to arm as guide for tube D. Put about three layers of No. 16 wire on magnet, connect P terminals to one end of wire, the other end to be soldered to several small wires to be flexible, and then to the tube D. By adjusting A B G H, the right distance of lift can be obtained. Have weak spring F. Make slot in foot of negative carbon-holder for lateral adjustment. Use 5mm. carbons with about 40 volts 3 amperès. When circuit is completed magnet pulls loop B, tilts J, and lifts top carbon, forming arc. **C. L. W.**



LENS-GRINDING.

[33153.]—As many queries regarding this subject appear from time to time, and practical answers seem rather scarce, perhaps the experiences of an amateur may have some interest.

When I started on this work I had no knowledge of the process whatever, and did not know even what materials to use. Starting thus, I naturally referred largely to back vols. of the "E.M." (for the benefit of those London readers who don't know, the back vols. of the "E.M." can all be seen at the Patent Office Library, open to 10 p.m. on all ordinary days). In these I found a mass of theoretical information, and a little practical, but to all intents and purposes nothing as to actual mode of proceedure. I may say that the most useful letters, &c., I found were those of Mr. Godfrey, in Vol. XXVI., also in Vols. XXXVI., XXXVII., and XXXVIII., a series by "Orderic Vital," most of which was beyond me. I read a lot about the expense of the glass, the castings required for finishing tools, and a lot more which I can only think was intended by the writers (*not* "Orderic Vital," Mr. Godfrey, or "Prismatique") to deter amateurs from attempting this kind of work.

The process I employ is very simple. Having obtained the glass (Chance's hard crown and dense flint of second quality, of Hetley Bros., Soho-square), I cut out the disc required and cement it with pitch on a wood chuck in the lathe, and proceed to "edge" it smooth by means of a wood tool, with a strip of hoop-iron tacked on to it, and curved where it touches the edge of lens. This tool is fed slowly, evenly, and continuously with sand-and-water, the lathe being meanwhile driven at the highest speed obtainable. This quickly grinds it to a true circle, which done, the sand-and-water goes off the scene, and emery and water come on, to finish off. The disc is now cemented on to another chuck, of wood, with a sink turned to fit it, about half the depth of the glass. Having ascertained that it is flat and true, it is ground to the required curve in the lathe by means of a disc of plate-glass cemented to a wooden holder. Starting with both glasses flat, and feeding with medium emery and water, the one in the lathe becomes convex and the disc on holder concave, the curve becoming deeper as the process is continued, any desired curve being thus easily obtained and tested by card templets, till of correct radius; care insures a perfect curve. The polishing is done in the same way with a pitch-on-glass tool and rouge and water, and finished by hand motion only, having removed the chuck from the lathe and supporting it on a stand for the time being. The figure can be altered at will during polishing by varying the form of the pitch on the tool.

As this process seems to give very fair results, what I should like to know is where the expensive brass and iron tools come in? In fact, where the entire expense comes in, considering that sufficient glass, crown and flint, for a 3in. o.g. costs but 6s. if cut from the sheet, rather more if bought in discs. I read a lot about polishing with tripoli, pumice-powder, rouge on silk and paper, but can't get on with any of them like pitch and rouge. My system of curves is rule of thumb, trial and error, and it works very well on the whole, for, disregarding time, the results have been very satisfactory.

I should much like to hear the views of other glass-grinders on the above methods. F. J. G.

THE HUMBERSTONE ROAD ACCIDENT.

[33154.]—I shall hope to see a letter from Mr. Stretton on the Humberstone Road accident, which happened on the Midland last week. It appears that some fly-shunting was going on, and by a mischance some waggons were knocked on to the main down just as the express was due. Fortunately, although there was much damage, there was no loss of life; but it would be interesting to learn if the express could have been stopped if it had been fitted with the Westinghouse. It is stated that Sir J. Allport was in the train; if so, he has probably inquired into that point.

Nun. Dor.

EXPERIMENTS IN ELECTROSTATICS. —III.

[33155.]—The apparatus required for the next two experiments is the same as the last described.

5. *Electrification is Variable in Amount.*—Excite the glass rod and slowly draw it through the hook attached to the can. The pith ball will be found to diverge from the vertical. Excite the glass rod again, and again draw it through the hook. The pith ball will be found to diverge still further from the vertical, and will probably touch the can. This experiment shows that a body may be more or less strongly electrified. For as the attraction between the pith ball and the can is the size of the electrification of the latter, so it may be safely assumed that the attractive force increases with the electrification of the can, and the greater the attractive force the greater will be the divergence of the pith ball from the vertical.

6. *Example of Uniform Electrification.*—After electrifying the can so as to produce a convenient divergence of the pith ball, turn it without touching it, together with the insulating stand, on its vertical axis. It will be observed that the pith ball continues to be drawn aside from the vertical, and to the same extent. This shows that the degree to which the can has been electrified is the same on every side. Hence, although the can has been touched only at one point by the excited glass rod, the electrification has spread all over the can.

Conduction.—When any body becomes electrified throughout by contact with another body at a single point, it is said to be electrified by "conduction." Any body capable of being electrified by conduction is termed a "conductor." A conductor may be otherwise defined as a *body whose electrical state is always the same throughout.* "Sameness" of electrical state may be taken provisionally to signify that two points on a body are either both electrified or both unelectrified.

7. *Electrification Transferable to an Insulator.*—Excite the glass rod, and then pass it over a portion only of the surface of a clean piece of ebonite. Hold the ebonite over some small particles of any light material. It will be found that the particles are only attracted by that part of the surface of the ebonite which has been touched by the glass rod. This experiment may be varied in the following manner:—Pass one side of the piece of ebonite over the excited glass rod; hold it near a suspended pith ball. The pith ball will be attracted by that side of the ebonite which has been in contact with the glass rod, but not at all, or only very feebly, by the opposite side.

This experiment shows that the ebonite becomes electrified by contact with an electrified body only at the points of contact, while the rest of the ebonite remains unelectrified. Hence a piece of ebonite may be in different electrical states at different points, and is consequently not a conductor. It may also be inferred as probable, from the last two experiments, that *all* bodies become electrified, either wholly or partially, when brought into contact with an electrified body.

Insulation.—A body such as ebonite is termed an "insulator." An insulator may be defined as *a body whose electrical state need not be the same throughout*. When electrified in one part the rest of the body remains unelectrified. The above definition of insulator is consistent with the explanation given under Exp. 4 of the meaning of insulating a conductor. For, if an electrified conductor is placed on an insulator, although the surface of the insulator in contact with the conductor becomes electrified; the under surface does not, and the electrical state of the conductor remains unaffected. It is found practically that an electrified conductor loses its electrification in course of time when supported by an insulator. The latter is consequently described as good, or bad, according to the length of time during which an electrified conductor placed on it retains its electrification.

Practical Remarks.—A piece of ebonite, 3in. or 4in. square, and ⅛in. thick, is suitable for the last experiment. The attraction may be tested by means of small chippings from a feather, or quill.

G. J. B.

USEFUL AND SCIENTIFIC NOTES.

Plans for a triple-expansion locomotive have been made by a German engineer, who proposes to put the high-pressure and intermediate cylinders outside and the low-pressure inside, connecting all three with the same axle.

Improvements in the manufacture of margarine are causing great embarrassment to the experts in Paris. In a prosecution for selling margarine as butter, M. Girard, chief of the municipal laboratory, admitted that all the apparatus for detecting the mixture of margarine with butter are untrustworthy, while M. Villers, professor in the School of Pharmacy, and M. Moreau, official taster at the great central markets, both expressed doubts whether the most experienced dealer could discover the fraud by the test of the palate. Nevertheless the magistrates of the Police Correctionnelle in this particular instance inflicted heavy fines on the defendants. The profitable nature of the adulteration will be seen from the fact that, according to the evidence, margarine of the best quality can be manufactured at a cost of about 11d. to 1s. 3d. the kilogramme, while the same quantity of good butter is 2s. 10d. to 3s. 4d.

Effects of Tight-Lacing.—In the number of the *Edinburgh Medical Journal* for the current month Dr. Johnson Symington describes the conditions which were found in the body of a woman of fifty, in whom the effects of tight-lacing were very obvious. As regards the chest, he found that down to the level of the fourth costal cartilages the sternum was convex and prominent and the intercostal spaces large. This part of the chest was flattened from side to side, the antero-posterior diameter opposite the third costal cartilage being 8in., while the transverse was only 7½in. The lower part of the thoracic wall was greatly contracted, the lower costal cartilages being pushed inwards, so that the right and left seventh cartilages were in close contact with each other from their attachment to the sternum downwards for 2½in. There they touched the tips of the eighth costal cartilages, which not only approximated in the middle line, but slightly overlapped each other. At the level of the fourth costal cartilages the circumference of the chest after removal of the integuments was 27in., while opposite the lowest part of the eighth costal cartilage it was only 17 in., and with slight pressure this could be reduced to 16in. The liver was less altered than is usually described. The lower part of the right lobe was pushed inwards, and the right and anterior surfaces showed a distinct depression running outwards and upwards for 2½in. In this the tenth rib was lodged. Almost the whole of the gall-bladder projected beyond the lower edge of the liver. When the stomach was filled with air it showed a distinct constriction about the middle of its vertical portion, and the pylorus was not overlapped, as it usually is, by the liver. Both large and small intestines were distinctly lower than normal, but the kidneys and spleen had undergone no material change in position or form. The careful study of such a case from the anatomist's point of view is of the utmost importance, and the changes, both in position and form, evident in important organs in the case just described will, we hope, emphasise the evils of an absurd and silly custom.—*Lancet.*

REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75759.] — **Question in Arithmetic.** — Let x = No. of years' growth. The unit value, 80 per cent. of 1s. 3d. = 1s.

$$\text{Value of each sapling} = 1\text{s.} \times (x - 4).$$

$$\text{No. of saplings per acre} = \frac{4840}{2x}.$$

$$\text{Value in } x \text{ years} = \frac{(x-4)4840}{2x}$$

$$\therefore \text{Annual value} = \frac{1}{x} \cdot \frac{(x-4)\,4840}{2x}.$$

By question x years gives the maximum value.
(A) Therefore, using diff. calculus—

$$\frac{1}{x} \cdot \frac{(x-4)\,4840}{2x} = \frac{(x-4)\,2420}{x^2} = y.$$

$$= 2420\,x^{-1} - 4{\cdot}2420\,x^{-2}$$

$$\frac{dy}{dx} = 0 = -2420\,x^{-2} + 8{\cdot}2420\,x^{-3}$$

$$\therefore 2420\,x^{-2} = 8\;2420\,x^{-3}$$
$$1 = 8\,x^{-1}$$
$$x = 8.$$

Whence annual value from formula above is—

$$\frac{4 \times 2420}{8\,8} = 151,\ 25\text{s.} = £7\ 11\text{s.}\ 3\text{s.}$$

(B) Or simpler by guess. Period cannot be less than 5 years, nor reasonably more than, say, 20. By formula above at 5 years, we get—

$$\frac{2420}{25} = 96,\ 8\text{s.}$$

At 20 years, we get—

$$\frac{16{\cdot}2420}{400} = 96,\ 8\text{s.}$$

Try intermediate numbers, and it will be found that 8 years gives the highest value. As it so happens that our two results (5 years and 20 years) are equal, we might expect $\frac{(5-4)+(20-4)}{2}$ to give a probable result.

Max Pars.

[75851.]—**Midland Railway (U.Q.)**—Sketches of M.R. goods engines appeared in Vol. XLIV. of the "E.M." on pages 453 and 479. Mistral.

[75895.]—**How to Restore Shrunk Woollen Articles to their Original Dimensions.**—I think "Simonides" has received no satisfactory answer to the above query; and I venture to say that he may as well reasonably expect an elastic band to retain its stretched position after being liberated, as expect his woollen articles to retain their original dimensions after washing, or even wearing, unless the material has been shrunk before making up into garments. I will, however, try to give him one or two hints. My remarks will apply more particularly to woollen goods sold for coatings, trouserings, ladies' mantles, &c., but will also apply to nearly all woollen and flannel materials manufactured for under-wear generally. There is, in factories used for the finishing of cloth, felt, flannels, &c., a machine known by the name of tentering machine, which, in many instances, would be more properly named an infernal machine. The pieces are brought to this machine in a wet state generally; the last time they need to be in this wet condition. The man in charge of machine has instructions to stretch the piece to the required saleable width,—which means that the material to be operated on must be got out in some instances as much as 13in., so that a piece of cloth, or other material, passing into the machine wet, and measuring 47in. in width, must come out of machine 60in. in width. It is also dried during the stretching process. The same rule frequently applies to the length also, and such is the strain to which some pieces are subjected, that a strong piece will be torn in two; and, in rare instances, when the material has been a thick, heavy, unyielding one, there has been a tug of war between it and the machine, which has ended in a defeat for the latter, as it has broke down in the first attempt. The goods thus treated, especially those that have been stretched the most, are turned into press before having had time to absorb moisture, and creep back to their unstretched dimensions,—a process which retains, to some extent, the fictitious width and length until put on the wearer's back, unless they are shrunk by the maker-up of the garments. I cannot see how "Simonides" may hope for any remedy until he can find a tradesman honest enough to sell him goods that have been made, and not stretched, to the dimension which he requires; and the mark seen at the ends of pieces, bearing words "thoroughly shrunk," is no guarantee as to the genuineness of the same, as, in too many instances, it is put there for the sole purpose of deception, when, of course, the last to be victimised is the wearer. The best hints I can give "Simonides" to protect himself against such fraud is to deal with a firm who will allow conscience to have a say in their business transactions; or, perhaps, the next best thing will be to test the goods in the following manner:—Lay a part of the material evenly on a level board, or table; take a sponge, moderately wet, and pass it over the part to be tested, which need not be more than 4sq.in. Next take an ordinary smoothing-iron, moderately hot, and pass it over the part, to force the steam through, and watch closely for any contraction, or creeping-in, of the part tested, and if you see any, reject it at once, and try elsewhere. I believe there is no known remedy for the permanent restoration of the articles "Simonides" complains of.

Experience.

[75903.] — **Incandescent Gas - Lights.**—Our attention has been called to the correspondence in your issues of the 16th and 23rd ult., with reference to our system of incandescent gas-lighting. Your correspondent "A. X." is evidently but imperfectly acquainted with the scientific construction of our burners. We would point out to you that in gas-burning it makes all the difference whether the combustion is checked or otherwise, and "A. X.'s" contention "that the products of combustion in all forms of Bunsen burners are certainly more injurious than those of ordinary illuminating burners," is contradicted by scientific investigation. With unchecked combustion an open luminous burner gives off 1·2 per cent. of carbonic oxide, and ·04 per cent. of acetylene; whereas a Bunsen gives off ·006 per cent. carbonic oxide and no acetylene. Then comes the question, how far the combustion is checked with our incandescent gas-burners? On the face of it it is, to a certain extent, a case of checked combustion; but careful analysis will show that the amount of carbonic oxide and acetylene thrown off by our system is a negligible quantity. The reason of this is that the mantle itself is practically of the same temperature as the unchecked Bunsen flame, while the chimney, by checking the radiation, tends to maintain the temperature. Such groundless and unscientific statements as those made by your correspondent "A. X." are liable to do us considerable harm, by misleading the public, and we therefore hope you will give a space for this contradiction. With reference to the inquiry of Mr. James Cooper which has reference to our "Helios" gas-making machine, a small machine consumes about 25c.ft. of gas per nominal horse-power, and is thoroughly satisfactory in driving all descriptions of gas-engines. The cost of the gas is about 1s. 6d. per 1,000c.ft., and it can be used either for lighting or heating purposes. There is absolutely no room for any danger with this machine, provided that it is not charged with benzoline in the presence of a naked light.

L. De Fonblanque, Secretary.
14, Palmer-street, Westminster, S.W.

[75917.] — **Pressure - Gauge and Thermometer for Hot Air (U.Q.)**—An ordinary pressure-gauge may be used, for the gauge need not be exposed to the heat of the air; the pressure may be transmitted along a tube which is perfectly cold. The temperature which you propose to register borders on a dull red heat. The most satisfactory pyrometers, I believe, are specially-constructed air-thermometers.

A. E. B.

[76003.]—**Aluminium.**—I am obliged to "Metal" for hints on tempering sheet-aluminium, in common, I am sure, with many other correspondents. If I had had any of the material by me, I should certainly have tested his most obvious method before replying; failing that, however, and judging from the eminently sonorous qualities of the metal, I inferred its elasticity. It is quite possible that the condition into which "Metal" has brought the aluminium may be but allotropic, and that it may yet in time return to its pristine springiness.

A. E. B.

[76003.]—**Aluminium (U.Q.)**—The Aluminium-Industrie-Actien-Gesellschaft of Neuhausen state in their work on aluminium that in rolling the metal on the blooming or middle roll it should always be rolled hot, "but from a thickness of from 6mm. down to 0·5mm. it can be rolled cold. Any sheets which may have become hard and springy during the operation need only a slight annealing for the last turn if required to be soft. Whether this annealing has been sufficient may be judged easily from the softness of the metal, and from its property of remaining in any position when bent. The finer the metal is the less annealing is required. Thin sheets and wires need only a heat of from 100—150° C."

Mistral.

[76038.]—**Compensated Pendulum (U.Q.)**—Two articles on pendulums with zinc and steel rods appeared in Vol. XLIII. pages 547 and 572, which give a great deal of information on the subject. There is also an article on a pendulum with a wooden rod in Vol. XLVI. p. 300, with its rates, from which it would appear that it leaves nothing better to be desired.

Mistral.

[76042.]—**Wheel-Valve.**—Most makers mark "inlet" and "outlet" on their productions. The former is invariably under the valve. If fixed in this position, and gland requires packing under pressure, it is only necessary to close the valve to do so. If fixed the reverse way, this cannot be done, as the escaping steam or water prevents the insertion of the packing.

Tin Tack.

[76058.]—**Observing-Chair (U.Q.)**—There is a drawing and details of an observing chair and lamp in Vol. XXXVI. p. 294, communicated by Mr. Beaven, of Warminster, of which he writes well. He used it for many months with a 3in., also with a 6in. Berthon equatorial reflector, and found it very convenient. A chair built on simila lines might possibly answer your purpose.

Mistral.

[76104.]—**Condensers for Biunial (U.Q.)**—I expect you will experience difficulty in making a 3½in. condenser act as a 4in. I suppose your condenser is pushed as near to the slide as possible without rubbing against the slides when moved. Unless you are expert at this work, it would be worth your while to send your biunial to the maker, and let him make the alteration.

A. E. B.

[76155.]—**Drying Hose-Pipes.** — The hose-pipes should be passed over wooden rollers: iron never improves leather; but why they should be passed up a tower 100ft. high is a puzzle. The best treatment for hose-pipes is to soak them in, or pass them through, a tank containing "bottoms" of castor-oil, and leave them anyhow most convenient, coiling up afterwards when the oil has soaked in. If they must be drawn up the tower, hitch them between wooden rollers and haul up; but why not inquire the practice at the London fire stations?

S. B.

[76165.]—**Metronome.**—Had not this querist better look through his back volumes, or inspect some of the instruments to which he refers, which I suppose can be seen at any dealers in musical instruments?

Beater.

[76175.]—**Violin.**—I don't know whether anyone has ever attempted to increase the number of strings on a violin, and as to the other questions, I really do not see what the material of which the string is made can have to do with the fifth or "double fifth."

X.

[76210.]—**Torsion Balance.**—In reference to an answer given to "Student," in last week's number of the "E.M.," I find I have done Coulomb an injustice. The true explanation of how his original torsion experiment was conducted I find explained in "Exercises in Electrical Measurement," by R. E. Day. Mr. Day, quoting from the original work of Coulomb, says: "Coulomb suspended a long, thin bar-magnet in a torsion balance so that when there was no twist the bar was in the meridian. He then turned the torsion head through eight right angles, when the deflection of the magnet from the meridian was 20°. He then brought the torsion head back to zero, and placed near the N. pole of the suspended magnet the like pole of a long magnet: the magnet was repelled, and in order to bring the deflection down to 17° and 12°, the torsion head had to be twisted through 12 and 32 right angles respectively. From the first part of the experiment we find that for a deflection of 20°, the directive action of the earth on the magnet is $2 \times 360 - 20 = 700^\circ$ of torsion, and therefore for any angle x°, it will be $\frac{700}{20} x = 35x^\circ$, and from the subsequent stages of the experiment we find that for—

$$\begin{array}{ll} 24^\circ & 24 + 24 \times 35 = 864^\circ \\ 17^\circ & 3 \times 360 + 17 + 17 \times 35 = 1692^\circ \\ 12^\circ & 8 \times 360 + 12 + 12 \times 35 = 3312^\circ \end{array}$$

∴ When the arcs were as 12 : 17 : 24, the forces were as 3312 : 1692 : 864. If the law of inverse squares had been exactly true, the forces would have been as 3312 : 1650 : 828." N.B.—For "Student's" information I may state that for *small* angles, the sines of the angles are generally taken as being equal to the angles themselves, and that is, I believe, the solution of his difficulty.

Iota Dash.

[76220.] — **Electro-Motor.** — Reckoning that your 10 Bunsens will give about 20 volts, you will need about 5 ampères to make up your 100 watts. Hence, if you make a little Simplex-type motor, with field-magnet core about 1½in. dia., 4in. long, furnished with pole-pieces having a 3½in. tunnel, in which runs a ring-armature 3¾in. dia., 1in. deep, you will do very well. Wind the armature with ½lb. No. 18, and the field-magnet with 2lb. No. 14, connected in series.

S. Bottone.

[76223.]—**Terrestrial Orbital Velocity.**—To "F.R.A.S."—In response to "F.R.A.S's." invitation to give an example of the method suggested by me (p. 449) for determining the earth's velocity in its orbit for a given date, let that date be March 20. The *Nautical Almanac* gives the sun's semi-diameter on that day as 16′ 5·1″, and its variation in longitude from the 20th to 21st as 59′ 31·3′ Taking the semi-diameter of the sun as equal to 430817·363 miles (deduced from sun's distance for Jan. 2, given in "E.M." Jan. 1, p. 406, as 90,842,919 miles; and sun's semi-diameter for Jan. 2 in *Nautical Almanac* 16′ 18·2″). Sun's semi-diam. in ″ (965·1″) : Sun's semi-diam. in miles (430817·363 miles) : : Sun's variation in long. per diem (3571·3″) : Sun's apparent, and earth's real velocity per diem in Ecliptic (1594216·194m.) = 18·452 miles per sec.

J. M. Boraston.

[76228.]—**Cataract.**—It is an unfortunate circumstance that there appear to be two complaints of the eye known as "cataract"—first, a skin forming over the eye, and probably amenable more or less to medical agencies; second, affecting the lens of the eye, which becomes more or less opaque, so obscuring vision. This latter is therefore wholly internal, and, I am told by medical men, can only be remedied by the operation of removing the lens. As this confusion of terms cost me pounds, I write to save others. Will Mr. Februm oblige us by letting us know which complaint forms the subject of his communication, and of the book he recommends.

J. C.

[76246.]—**Fuller Battery.**—This battery could be used for plating or gilding little jobs; but my advice is Don't use it, but rather a Daniell, which will give you far greater satisfaction. If you only require a small number of articles done about once a week, there is a dry battery that will suit you. Having tried it myself, I can testify to its fitness for occasional work. The E. S. dry battery is the battery I have tried for plating with gold, silver, copper, and brass, also nickel, and think that for country jewellers or such like persons wishing to do a little plating, gilding, &c., and not caring for the trouble of putting up a battery every time, would find in this battery the thing wanted.

S. Robert Bonney, Electroplater, &c.

[76274.]—**Iron, Heating of by Electricity.**—Considering that a current must encounter resistance to develop heat, and that a piece of iron of the size mentioned offers practically no resistance, you will see that the current required would be enormous, far more than you could obtain from a reasonable number of cells. A large dynamo could be made to do it, but rather out of place, I should say.

F. Askew.

[76291.]—**Onyx.**—This is, for all practical purposes, quartz, though not so hard. You can dissolve quartz in hydrofluoric acid, made by simply taking a piece of fluor spar, $CaFl$, and treating it with sulphuric acid in a guttapercha (not glass, as it would eat it) vessel. Coat the quartz with beeswax. Then write on it with a stencil, and put over the vessel and you will find it soon eaten. But you must be careful, for the fumes are bad for the throat and lungs, and the acid itself produces sores wherever it touches your skin.

Z. Y. X.

[76296.]—**Prolapsus Ani.**—I was much troubled with prolapsus and occasional fits of piles, which now and then bled. They did not become very severe, because six years ago I fitted up a system of cleansing and bathing the parts by water jet, which has been effectual in checking the complaint so that now I never have piles, nor does the prolapsus trouble me except when away from home. A piece of small gas-pipe communicates with the water cistern and ends in an ordinary gas-tap. To this is fixed a length of ¼in. rubber tubing ending in a nozzle, care being taken that the jet of water is sufficient in volume and not too strong. The parts in consequence are never touched except in replacing the prolapsus. It will not be practicable in most cases to fit up a permanent arrangement like mine, but I think it can be managed so as to answer the purpose by hanging a siphon of gas-pipe over the edge of the cistern. This, if closed at the bottom by a tap, would answer very well if the cistern were not allowed to run dry. I can only say that I am glad, for my own sake, that I thought of the plan.

Threescore and Ten.

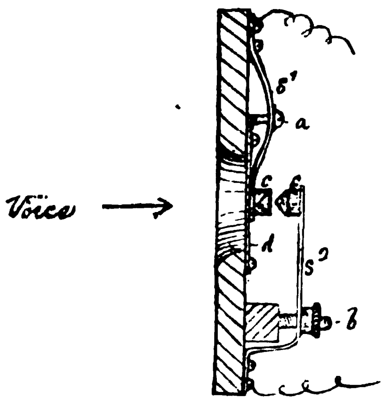
[76312.]—**Steam-Pump.**—Certainly, one column of pipes may be substituted for the present three. The diameter of pipe should equal that of a circle whose area equals the combined areas of the three cross-sectional interior areas of present pipes; and theoretically the friction will remain the same; and probably it will be less, as the velocity in large pipe will not be so great as the pumps do not act in unison, and may be taken almost as acting individually upon the pipe, small as the variations of beats or strokes may be.

Walter Strafford.
100, Balaam-street, Plaistow, E.

[76332.]—**Metal or Composition.**—Sulphur-sulphide of lead will, I think, answer; but then, "Paulistano" does not state conditions of use—such as whether it is to be employed with heat, &c., or not, or with what acids.

Z. Y. X.

[76333.]—**Microphone.** — The Hughes microphone is not of much use in practical telephony, for the simple reason that there is no provision for controlling the pressure of the carbon contacts. Employing additional carbons betwixt the upper and lower carbons—i.e., in parallel—is but an imperfect remedy, and any variation in the length of the intermediate carbons has the effect of causing some of them to be tight whilst others are slack. Perhaps E. C. Lester will try the transmitter shown in sketch herewith and report the result. S¹ and S²



are brass springs—the former of moderately stout material, the latter of thin springy brass. Two carbon pieces, *c c*—one pointed, the other recessed or countersunk to correspond—are mounted on the ends of the springs. The diaphragm *d* may be of thin wood, thin sheet-iron, cardboard, or parchment, &c. S¹ should be firmly screwed against the diaphragm by means of the screw *a*, and the pressure of the contacts regulated by the finely-threaded nut and screw *b*. An induction coil should be employed for long distances. (See reply to 76340.) J. H. Hindle.

[76336.]—**Thermo-Dynamics.**—The first two equations are right.

$$p v^{1\cdot4} = p_o v_o^{1\cdot4} = \text{const.} \ldots\ldots\ldots\ldots\ldots (1)$$

$$\frac{p\,v}{t} = \frac{p_o v_o}{t_o} = \text{const.} \ldots\ldots\ldots\ldots\ldots (2)$$

Divide (1) by (2): $t v^{0\cdot4} = t_o v_o^{0\cdot4}$.

$$\text{Hence—}\quad \frac{t}{t_o} = \left(\frac{v_o}{v}\right)^{0\cdot4} = \left(\frac{p}{p_o}\right)^{\frac{0\cdot4}{1\cdot4}} = \left(\frac{p}{p_o}\right)^{\frac{2}{7}}$$

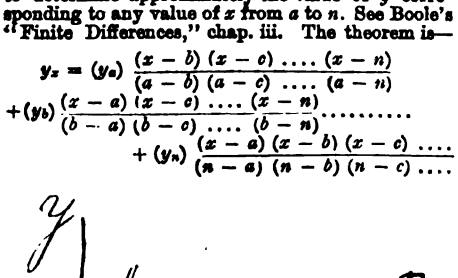
$$\text{Or—}\quad \left(\frac{t}{t_o}\right)^5 = \left(\frac{v_o}{v}\right)^2 = \left(\frac{p}{p_o}\right)^{\frac{2}{7}}$$

In the above, t, t_o, are absolute temperatures, and 1·4 is taken as an approximation to the ratio of the specific heats of a gas. The real value is 1·408. V. J. B.

[76339.]—**Equation to Curve.**—This is strictly, I believe, a question of finite differences. A series of equidistant ordinates are drawn to the axis of x, and measured, and the equation of the curve found. If the curve is known to be a conic, its equation can be determined without much difficulty; but higher curves cannot be dealt with by the same easy methods. V. J. B.

[76339.]—**Equation to Curve.**—Only a very incomplete answer, I believe, can be given to this question—it depends on the species of curve to be considered. The following, however, may be of some use. Let a curved line, A B, be drawn, and refer it to axes O x, O y. Measure off distances $a, b, c \ldots n$ (not too far apart) from O along O x, and measure the corresponding values of ordinates y; call these latter $y_a, y_b, y_c \ldots y_n$. Now, if this curve be such that its equation can be assumed to be approximately of the form $y = A + Bx + Cx^2 + \ldots + Ex^{n-1}$. Lagrange's theorem for interpolation might be used to determine approximately the value of y corresponding to any value of x from a to n. See Boole's "Finite Differences," chap. iii. The theorem is—

$$y_x = (y_a)\frac{(x-b)(x-c)\ldots(x-n)}{(a-b)(a-c)\ldots(a-n)} + (y_b)\frac{(x-a)(x-c)\ldots(x-n)}{(b-a)(b-c)\ldots(b-n)}\ldots\ldots + (y_n)\frac{(x-a)(x-b)(x-c)\ldots}{(n-a)(n-b)(n-c)\ldots}$$



To make the matter clearer, take as an example No. 3 of the exercises given in the chapter referred to—viz., "Find a rational and integral function of x which, when $x = 1, 2, 3$, shall assume the respective values 4, 6, 10." In this case—

$$y_x = (y_a)\frac{(x-b)(x-c)}{(a-b)(a-c)} + (y_b)\frac{(x-c)\ (x-a)}{(b-c)\ (b-a)} + (y_c)\frac{(x-a)(x-b)}{(c-a)(c-b)}$$

$$a = 1,\ b = 2,\ c = 3,\ y_a = 4,\ y_b = 6,\ y_c = 10.$$

$$y_x = \frac{4(x-2)(x-3)}{(1-2)(1-3)} + \frac{6(x-3)(x-1)}{(2-3)(2-1)} + \frac{10(x-1)(x-2)}{(3-1)(3-2)}$$

$= x^2 - x + 4$. Or $y = x^2 - x + 4$ is the expression required. The above represents a curve (a parabola in this case) passing through the points (1, 4), (2, 6), (3, 10). As an infinite number of curves may be passed through these points, more ordinates, in general, would have to be measured and introduced in Lagrange's formula, in order to find an approximate expression for a curve such as (A B) that might be drawn on paper. J. H. Truscott.

[76340.]—**Telephone.**—The querist will require, in case magneto-bells are not employed, a long-distance battery bell, Morse key for ringing, switch-hook, induction coil, and preferably double-pole receivers. For the induction coil, take a bobbin 1½in. between flanges, ⅝in. diam., and flanges 1¼in. diam. Wind with eight layers of 28's for primary, and fill up with 40's single silk-covered for secondary. Core of soft iron wire. Hard-drawn copper or phosphor-bronze line-wire are superior to iron, and require fewer supports. The carbon transmitters mentioned are not of much use. (See reply to 76333.)

J. H. Hindle.

[76347.] — **Coating Iron with Brass or Copper.**—Of course it is possible to coat them; but I would certainly not recommend these metals thus deposited. As I have already said, I look upon this brass electro-plating more as a curiosity than an industrial process, and although copper is easier to deposit, it takes time to get a thick coat. Besides, with either, the friction of the oars would soon wear through the coating, and then the effect of any water would set up a galvanic action between the two metals, in which the iron would be the sufferer. But if galvanised, and the coating was worn through, then the zinc, not the iron, would be the attacked metal. It would therefore appear for two reasons that galvanising would be both better and cheaper. Mistral.

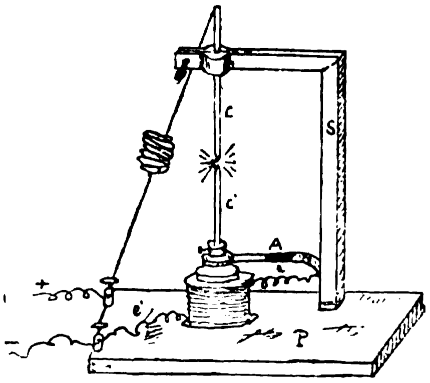
[76351.]—**Cycling.**—In cycling, the rider does not support his own weight, and the motion is continuous. In walking, the "way" is almost destroyed at each step, and therefore energy is lost on account of the intermittent stepping motion. Perhaps this may be a sufficient explanation of "Cyclist's" difficulty. V. J. B.

[76352.]—**Polishing Celluloid.**—Putty-powder polishes ivory, and I have no doubt will polish celluloid. Water and elbow grease, and plenty of the latter. If in a lathe, move the rubber of flannel about to prevent getting rings. Z. Y. X.

[76352.]—**Polishing Celluloid.**—Crocus-powder and oil gives an excellent polish. Putty-powder and water as a finish slightly improves it. I know of no substance that requires a sharper tool to finish. It is impossible to polish out the slightest imperfection.—Can anyone tell me why camphorated spirits of wine will join celluloid so that the two pieces are practically one, while it has no effect upon xylonite, apparently a similar substance?

M. H.

[76355.]—**Small Arc Lamp.**—The principle of this regulator is the same as that of the electric bell. At the extremity of the stand S there is a hole through which the carbon stick C slides with very little friction. On the board P there is a little electro-magnet composed of an iron core 2in. high by $\frac{7}{16}$in. diameter, upon which there is wound about 18ft. of insulated thin copper wire. The steel spring A is fixed by a screw on the stand S,



which is in connection with one end (e) of the
electro-magnet, the other end (e') being in com
nication with the screw (−). On the spring
ture A there is a hole and screw to hold the
stick C'. When the regulator is at rest, the
of the carbons are in real contact, the carbon
being in communication with the screw (+)
means of a wire twisted in the middle in
act as a spring. When the current is on, the
magnet attracts the armature spring A
the carbons, and therefore forming the arc,
when the carbons are disconnected the current
weaker, for the strong resistance of the arc
electro-magnet losing its power lets the
free; the carbons again touch each other,
phenomenon being repeated, they are disc
again. This alternation of connection is so
carried out, that the light is always on
rapidity of the movements makes the
descend by-and-by, so that the regulator
continuously. P. I

[76360.]—**Efficiency of Dynamo.**—The
polar machines principally used in this coun
the Victoria and Gulcher dynamos. Th
generally considered to give a slightly low
centage than the best bipolar machines;
advantages in their favour are consid
namely, low resistance of armature coils, on
of the cross connections in same, and the
amount of dead wire; moderate speed, non-
of the armature coils to fly up, and small
revolving armature as compared with
polar machines, which, when of same capa
slightly more bulky in every direction.
J. H. H

[76361.]—**Velocity of Dynamo.**—The
of a dynamo depends upon three things:—
strength of the magnetic field; 2nd, the
conductors on the circumference of
3rd, the number of revolutions per min
diminish any one of these means a de
voltage unless one or both of the others
spondingly increased. The decrease in sp
tioned would probably reduce the E.M.F.
70 volts. An increase of conductors would
necessitate a smaller wire, reducing the
ampères. Whether or not the magnetism
improved depends upon the section of field-
and quantity of exciting wire, &c., if the
is a standard one by a good maker. I
that if the querist reduces the speed, he
to be content with a smaller output either in
or current. J. H. H

[76365.]—**Oxychloride, &c.**—To Mr.
Fletcher.—I must apologise for having
veyed the impression that I wanted a ton
comparatively I only wanted a pound. I
want a cement at all; but simply a plastic
I am afraid the Editor would not allow me
describe in full detail the uses I should prop
the material; but I will state one purpose I
have used it for this week, and if it would
for that, it would answer for others. I
about 60 small castings made in brass. Of
from a single pattern this would not be
desirable job, so I had to supply six patterns
I could get anyone to do it. These six patt
had to make of wood, which took about two
work, as they were very troublesome to
Now, with a suitable plastic material to
should either have made the patterns of it,
should have made a mould in the material and
the patterns in zinc. Anticipating that you
perhaps, say, Use plaster, clay, sand, &c., I may
Plaster is too easily damaged and broken; clay
a long time to dry, and likewise shrinks, crack
distorts; and sand requires suitable boxes to
in, which I have not got. I came across
oxychlorides about twenty years ago in the
Journal of Chemistry, but of late years have
forgotten all about them. I happen to know
you are a specialist in this line, and I know
experience how freely you impart your val
knowledge to readers of the "E. M.,"—hence
query, which I will now put as: Wanted, p
material, to set without shrinking, and to sta
say, melted brass (composed of half zinc) witho
disintegration. A very brief reply would conv
the information—simply oxychloride or oxypho
phate, &c., of zinc, or as may be—although an
additional information would, of course, be appre
ciated and valued. W. M.

[76376.]—**Arc Lighting.**—To Mr. Bottone.—
Almost any pattern dynamo may be employe
provided it gives about eight ampères at 50 vo
pressure. I should advise one with a dru
armature, about 3in. diam. and 9in. long, seri
wound. This will take about ¾H.P. to drive. T
the Brockie-Pell lamp. S. Bottone.

[76377.] — **Cutting Mounts, &c.** — Moun
cutters use a sharp-pointed knife, and work by
mould. There is a patent cutter in the mark
cutting ovals or rounds any size or bevel; can
used with a diamond for glass. G. Rennie.

[76378.]—**Phonograph.**—To Mr. Bottone.
As you are going to use only half the number

, you must let twice the amount of current ulate round the motor to get the same power. must therefore employ the same weight of , but of twice the section. To connect the r in series, take the current from one terminal e brush, thence through armature and other , round field-magnets, and then to other inal. S. Bottone.

379.]—**Water Motor.**—To Mr. Bottone or ers.—So much depends on the make that I not say what power your motor could rate; but you might try what weight it could up on a string attached to axle. If it can 14lb. through 1ft. in 1sec. of time, it is giving $\frac{1}{40}$H.P., and this would drive one of my lest 5c.p. dynamos. S. Bottone.

381.]—**Electric Light.**—Do not attempt to your 16c.p. lamps by any primary battery; but 8c.p. can be lit from a battery of bichromate , the number depending on the voltage of your , which should be marked. Each cell gives volts if of the single-fluid type, and will run hree hours if the elements are lifted after use. information you require has been given so often, I cannot do better than advise you to look up ndices to recent volumes for further advice as anagement of batteries, &c. F. Askew.

6383.]—**Magnetism.** — That which has its -seeking pole downwards will be the stronger, the earth's magnetism will not be opposing of the magnet, as in the case of that which has uth pole downwards. F. Askew.

6383.] — **Magnetism.**—I think "Student" ld find the relative strengths of the two magnets rent after a time, and that the arc with its -seeking pole pointing upwards would be the ger of the two; because the other magnet ld tend to become demagnetised by the mag- influence of the earth. C. P.

6383.]—**Magnetism.**—In our latitudes, the et with the N-seeking pole downwards would n its magnetism the best, since the proximity of N. pole of the earth would tend to strengthen hile it would have the reverse effect on the one se S.-seeking pole pointed downwards.

S. Bottone.

6383.]—**Magnetism.**—Yes; in this country, in fact, any other country north of the Equator, magnet which stands with its N. pole down- ds will keep its magnetism longest, owing to the th's influence. We suppose there is S. mag- ism at the N. pole of the earth and N. magnetism the S. pole; therefore the above magnet will ive induced magnetism from the earth, which assist it to keep its magnetism, while the other gnet will lose its magnetism if kept in that ion. Tom Hagues.

[76383.]—**Magnetism.**—This and similar ques- e are favourites with examiners. The action is pendent upon the earth, which is in reality a gnet. In the case before us, with the two equally gnetised bars of steel, the one with its south- ing pole upwards would be found to have re- ed its strength much better than the other, for e reason that the north-seeking end would be rly pointing to the north, and the magnet lying the right direction as regards the line of force, ile the reverse would occur with the other gnet. S. G. B.

[76383.]—**Magnetism.**—If there be any differ- e at all, the magnet with the south pole upper- t would keep its magnetism the better. I will you why I think so. Some time ago—I forget at I was after—I tried the magnetism of the fire- tes in the house, and found them all with their th poles (for they all showed a decided mag- ism) uppermost. This I concluded was caused the terrestrial magnetism. Now, if this force oduces a south pole at the top of a piece of iron, will also tend to preserve the polarity of a magnet hich already has the south pole uppermost. avez vous? A. E. B.

[76384.]—**Gas Fire.**—C. E. Lester has evidently a downdraught in his chimney, and where this is the case a gas fire should never be used.

Thos. Fletcher.

[76384.]—**Gas Fire.**—What kind of a gas fire is yours to emit such a "fearful smell"? It surely cannot be an atmospheric stove which you have. This can, indeed, emit a slight smother, but not a smell. If you wish to let the smell of it out, do not close the register. The only suggestion I can give is that you close the whole of the fireplace, excepting a round hole to receive a pipe from the gas-stove, with thin sheet-iron, which may be painted. By this means, a better draught will be established, and unless your chimney is foul, and draught exceedingly unfavourable, I should think the fumes would be carried off. A. E. B.

[76385.]—**Rain-Gauge.**—I cannot understand why rain-gauges are made which require a lot of calculation before you can arrive at the information desired. If the diameters of the funnel and of the inside of the bottle be the same, no calculation is required. Let "Non-Mathematical" purchase, or make, as I did, a gauge so arranged, and then, when he sees 2in. of rain in it, he will know that it is 2in., and not 1in., or perhaps some awkward proportion of 1in. A. E. B.

[76385.]—**Rain-Gauge Measuring Glasses.**—A rain-gauge 8in. in diameter, measuring an inch of rainfall, would have 50·265c.in. of water, and this within one-thousandth of an inch is the capacity of a cylindrical vessel 4in. in diameter and 4in. deep. A cylindrical vessel 4in. in diameter and 2½in. deep would hold 19·6348c.in., and this is the same within 2-10,000th of an inch as the contents of a 5in. cylinder 1in. deep. The contents of a rain-gauge are calculated from the area multiplied by the depth, and then a glass is graduated by experiment with the various depths. A 5in. gauge receiving ½in. of rain would have 9·8174c.in. This, poured into a deep glass, would show where to make the ½in. mark; then, if the glass is perfectly parallel internally, this distance would be divided into 5 equal parts, and each of these parts into 10, which would give graduations to one-hundredth of an inch. Some graduated glasses are marked to one-thousandth of an inch; but these are long, narrow tubes, and not generally used. R. Godfrey, C.E.

[76385.]—**Rain-Gauge Measuring Glasses.**—You are quite right: a glass exactly 4in. deep, and 4in. internal diameter, will hold 1in. of rain, caught by a rain-gauge 8in. diameter. But 1in. of rain, caught by a rain-gauge 5in. in diameter, would only equal 1·5625in. in depth in a corresponding receptacle 4in. diameter.

Thus, the area of the gauge 5in. diameter is—

$$\begin{array}{lr} 5^2\text{, and its log.} & 1{\cdot}3979400 \\ \times\ {\cdot}7854\text{, ditto} & 9{\cdot}8950909 \\ \hline \text{Area} = 19{\cdot}635\text{in.} = & 1{\cdot}2930309 \end{array}$$

And the area of receptacle 4in. diameter is—

$$\begin{array}{lr} 4^2\text{, and its log.} & 1{\cdot}2041200 \\ \times\ {\cdot}7854\text{, ditto} & 9{\cdot}8950909 \\ \hline \text{Area} = 12{\cdot}5664\text{in.} = & 1{\cdot}0992109 \end{array}$$

$$\begin{array}{llr} \text{Then—} & 19{\cdot}635\text{in.} & 1{\cdot}2930309 \\ & \div\ 12{\cdot}5664\text{in.} & 1{\cdot}0992109 \\ & =\ 1{\cdot}5625\text{in.} = & 0{\cdot}1938200 \end{array}$$

Or exactly $\frac{9}{16}$in. F. S.

[76387.]—**Gibraltar Rock.** — Why not try coaguline or diamond cement? H. A.

[76387.]—**Gibraltar Rock.**—Try the "Polytechnic" cement. Heat the bottle in hot water, when cement is melted apply to edges, join together, and leave for some hours. I have seen the two halves of a plate sustain a dead load of 1cwt. when cemented with the glue; but the weights may have been hollow! A. D. Southam.

[76387.]—**Gibraltar Rock.**—Begin by cleaning off with a nail-brush and warm water every particle of the cement previously tried, so as to get clean, well fitting surfaces. Arrange a stand, so that your needle can stand and dry in a vertical position, with the large end downwards. Now make about an ounce of good hot carpenter's glue, not too thick and not too thin. Add to it six grains of powdered bichromate of potash, stir up well, and apply at once quite hot. Fit the parts accurately together, press out all excess of glue, and allow to dry for 36 to 40 hours without touching. Then expose to sunlight, if possible. S. Bottone.

[76387.]—**Gibraltar Rock.**—Some years ago I brought away from the caves of Gibraltar some of these crystals, which are called "petrified water" by the inhabitants; supposed to be water passing through the rock dissolving out certain salts and again congealing forming these crystals. The finest specimen that I had got broken; this I put together by drilling a hole in each piece, and inserting a piece of wood to fit tightly, and pressed both firmly together (the drilling must be gently done). If at the time I had known of any of the cements, such as giant, diamond, and the like, I certainly should have tried them.

Lewisham. S. Robert Bonney.

[76388.]—**Force and Pressure.**—No; unit velocity of a unit mass is not the same as ½ mass at double velocity. Momentum varies directly as the mass, and directly as the square of the velocity.

$$M \times V = 1$$
$$\frac{M}{2} \times 2V^2 = 2.$$

A. E. B.

[76389.]—**Crystal Cavern.**—If "Stalagmite" cannot obtain a material which will crystallise and yet be insoluble in water (a substance with which I am unacquainted), I would suggest an imitation compounded of Portland cement and crushed glass.

B. Harcourt.

[76389.]—**Crystal Cavern.** — You must be careful, in using Portland cement in connection with an aquarium, that you do not poison your fish. I once saw a quantity of gold-fish killed in this manner, their bodies and gills being coated with a kind of calcareous deposit. To remedy this I should recommend protracted soakings in water and exposing to the atmosphere. As to the crystalline appearance, I should think fragments of Derbyshire spar (as used for tar-pavements), of silex, or of crystallised gypsum, projected upon the cement while soft, would meet your wishes. A. E. B.

[76391.]—**To Mr. Bottone.**—'Scuse me. Why do you not try, by a skilful use of magnets, to bring your ammeter needle back to its correct sensitiveness? This, being successful, would save a vast deal of pains required for recalibrating. It is certainly worth a trial. A. E. B.

[76391.]—**Ammeter, to Recalibrate.**—Beg or borrow another ammeter graded to about the same readings as yours. Place it in circuit (in series) with your own. Send varying currents through both from dynamo or battery, using resistances to pull down the current for the lower readings if your source gives a large current. Mark your scale with the reading, as indicated by the instrument you are testing it with. I cannot say whether remagnetising the magnet will render your instrument more or less sensitive unless I know the type of ammeter.

S. Bottone.

[76397.]—**Size of Water Pipe.**—Use Hawksley's formula for the delivery of water in pipes, which was given in No. 75806. A. D. Southam.

[76400.]—**Trigonometrical Distance.**—Draw a line A of any convenient length to represent the 12 miles run to the westward, and from the right-hand end of A draw a line B in a N.N.W. direction, and, similarly, from the left-hand end of A draw a line C in a N.E. by N. direction. Produce B and C until they meet in a point which will represent the position of the lighthouse. In the triangle so formed the angles at the junction of A and C, and at the junction of A and B will measure 5 points and 6 points respectively. Also, since the three angles of the triangle together measure 2 right angles (*vide* Euclid), or 16 points, the angle at junction of B and C will measure 16 − (5 + 6) points = 5 pts.—Then by elementary trigonometry we have—

$$\frac{C}{A} = \frac{\text{sin. 6 pts.}}{\text{sin. 5 pts.}} = \text{sin. 6 pts., cosec 5 pts.}$$

So C = A sin. 6 pts., cosec 5 pts., and finally, log. C = log. 12 + log. sin. 6 pts. + log. cosec 5 pts. Look up Hamblin Smith's "Elementary Trigonometry."

Chrysomela.

[76403.] — **Size of Crucible.** — G. Standbrook should make an approximate calculation as to what weight of brass he will require to melt for his cylinder. He will then know what size crucible he wants. He can obtain plumbago crucibles from Mr. Geo. Wells (if he consults the Sixpenny Sale Column, as this is not the place to give addresses), who will no doubt supply him with instructions for using same. Plumbago crucibles are generally marked by the kilogrammes they will contain; thus No. 5 will contain 10lb. of copper; No. 100, 200lb.; No. 200, 400lb. By observing this rule, a suitable-sized crucible can always be ordered. Gotha.

[76404.]—**Plumbous Oxide.**—This oxide, Pb_2O, according to Dulong, may be prepared by heating lead oxalate in a tube free from oxygen to about 290° C. $2PbC_2O_4 = Pb_2O + CO + 3CO_2$.

Iota Dash.

[76404.]—**Plumbous Oxide.**—Are you sure you have not made a mistake in the formula Pb_2O? There is a purplish-brown oxide of lead having the formula PbO_2, obtained by pouring nitric acid on red lead, which is I think what you mean.

A. E. B.

[76405.]—**Lunar Photography.**—You require an instantaneous shutter if the image is taken at the principal focus of the o.g. I got some very fair negatives this way with a 5in. o.g. some years ago.

H. A.

[76405.]—**Lunar Photography.**—The want of detail complained of in this case may probably arise from allowance not having been made between the visual and actinic foci of the telescope. If used without an eyepiece the actinic focus will be about ¼in. shorter than the visual on a 3½in. objective; but the exact distance may easily be ascertained by experiment. H. G.

[76405.]—**Lunar Photography.**—As I have had some experience in this branch of celestial photography, perhaps the following remarks may be of some use. To begin with, if your telescope is not specially corrected for photographic purposes, you must proceed to find the actinic focus by trial. In many instruments this focus lies beyond the solar focal plane, and the usual plan is to focus the moon carefully on the ground-glass screen, and after having made an exposure in that position, expose, say, five or six more plates, racking out the eye-piece-tube, to which your apparatus is presumably attached, about $\frac{1}{20}$in. or $\frac{1}{50}$in. for each plate in succession. Number the plates consecutively, so that they can easily be identified with their respective distances. The resulting negative which has the sharpest image marks the position of the actinic focus. It may happen that the chemical focus of your glass lies within the solar focus, in which case proceed as above, with this difference, that you rack plates inwards instead of outwards. It would appear, from the statements of some of our celestial protographers, that an absolutely sharp picture cannot be obtained by means of an ordinary astronomical telescope, however perfect the o.g. may be, and this accords with my own experience. An increase of sharpness, it is said, may be obtained by separating the components of the object-glass somewhat from each other, the distance apart to be determined by experiment. T. D.

[76406.]—**Vacuum Tubes.**—There is some doubt as to the actual pressures at which the various phenomena occur. Probably this is not a quite constant quantity, the shape and size of the tube and terminals having something to do with it, the only definite fact being that the effects always appear in the same order as the pressure diminishes. According to Crookes, for phosphoresence the best pressure is 1,000,000th part of an atmosphere, or ·00076mm.; but Dr. Paley says, on the contrary, that the best pressure is ·02mm., and that the tube becomes almost non-conducting at ·005mm. I have not specially studied this point, but my few measures indicate that Crookes's estimate is nearest the truth. If you get the ordinary phosphorescent effects while the McLeod gauge reads ·5mm., it is quite certain the gauge is in error. These gauges require considerable practice to obtain good results, and for simply studying the effects produced at various exhaustions it is not worth while to employ them, for a single glance at a tube while discharge is passing should be sufficient to show the state of the vacuum, and whether the pressure must be diminished or increased to obtain any given result. Lead glass is very unsuitable for phosphorescent tubes, and the various makes of German glass differ very much among themselves as regards this property, some being quite useless. Your half-inch spark coil is powerful enough to show nearly all the usual experiments with these tubes. There is no definite connection between length of spark and length of tube it will illuminate, even at a constant pressure, the resistance of vacuum tubes not being proportional to their length. Given a low vacuum and fairly large terminals, your coil would illuminate two or three yards of tube, while at higher exhaustions the length would diminish rapidly. I hope to say more on these points in a third letter.

Leicester. E. E. B.

[76409.]—**Spark Coil, ½in.**—To Mr. Bottone.—Bobbin heads, 4in. square; ebonite, ⅜in. thick; tube, 6in. long; ¾in. internal diameter, ⅞in. external, also ebonite. Iron core: ¾in. dia., 7in. long, made of No. 18 best soft annealed wire. Primary, two layers No. 22 silk-covered. Insulation between primary and secondary, one turn of best sheet vulcanite $\frac{1}{30}$in. thick. Secondary, ½lb. No. 38 single silk covered, each layer carefully basted with hot melted paraffin wax, and separated from the adjacent layer by one turn of paraffin paper. Wire to reach to within ¼in. of heads only, and to diminish by ⅛in. at each layer. Condenser, 50 sheets of tinfoil 5in. by 7in., interleaved with paraffined paper. Three bichromates should work this well.

S. Bottone.

[76410.]—**Motor with Permanent Magnets.**—You will find a full description, with sketches, of the mode in which you may utilise your two bar magnets to make a motor, in my book, "Electro-Motors: how Made and how Used." I need not say that, to get good effects, your magnets must be remagnetised and strengthened. S. Bottone.

[76411.]—**Manchester Dynamo.**—To Mr. Bottone.—A Manchester dynamo, with Siemens armature, does not make a good instrument, because the short armature necessitated by the short tunnel, involves so much loss in "dead wire" at the two ends of the armature. I should strongly advise you to use a ring armature 3⅜in. in diameter, wound with 1lb. No. 22 d.c.c. copper wire, running in a tunnel 2in. deep, with F.M. cores 4in. high by 1¾in. diameter, wound with 4lb. No. 22, connected in shunt with brushes. S. Bottone.

[76412.]—**Dynamos and Batteries.**—If more than a certain current (say 1 ampère) is taken from the cells, they depolarise, and the light fails. Plating dynamos are wound for quantity with thicker wire. The power given out, whether 40 ampères at 5 volts or 2 ampères at 100 volts, is the same, for watts = amps. × volts. A. D. Southam.

[76412.]—**Dynamos and Batteries.**—Your question, as it stands, is unanswerable, because you do not state the kind or size of battery. A dynamo giving 4 ampères at 20 volts pressure will certainly light four lamps taking 1 ampère each at 20 volt. pressure. So also will 10 cells, say, of chromic-acid battery, if of sufficient size. The amount of current given by batteries depend on two factors, viz., E.M.F. and resistance. Now if the size and nature of the battery and external resistance of battery be properly proportioned, not only four, but 40 lamps, can be lighted from 10 cells. S. Bottone.

[76412.]—**Dynamos and Batteries.**—A 20-volt dynamo giving four ampères should light four lamps taking each one ampère at 20 volts; but in a battery the output in ampères will depend on the size of cells and distance of plates from each other. From Ohm's law $C = \frac{E}{R}$, or in the case of batteries, $C = \frac{E}{R + r}$ where C stands for current, E for E.M.F. or voltage, and R for resistance (external), and r internal resistance. The reason a plating dynamo gives more current and a lower E.M.F. than a lighter, is that the machine is wound with a thicker wire. An armature wound with a long fine wire will give a higher voltage, owing to its length; but a smaller current, owing to its resistance. Thus the output of a machine is generally reckoned in watts, ampères, and volts; and supposing one machine to give 40 amps. at 8 volts, such a machine being suited to plating, 8 × 40 = 320 watts; while a lighter wound for 8 ampères at 40 volts will give the same output, and be more convenient for the purpose for which it is designed. F. Askew.

[76413.]—**Chromic-Acid Cell.**—Porous cell, acidulated water, 1 in 12; outer jar, chromic acid, 3oz.; water, 1½pt.; and when cold add 4oz. sulphuric acid. F. Askew.

[76413.]—**Chromic-Acid Cell.**—Put in the porous cell bichromate of potash saturated with water, and in the outer cell water and sulphuric acid, in proportions of 3 parts of bichromate of potash, 4 of sulphuric acid, and 18 of water.

P. Infante.

[76413.]—**Chromic-Acid Cell.**—In the porous cell with the zinc put 1oz. mercury, then fill with a solution of sulphuric acid 1 to twenty of water, as the acid from the chromic acid will soon find its way from the outer cell, causing much zinc to dissolve if not closely watched. I use saturated solution of chromic acid, with 2oz. or 3oz. of sulphuric acid added in outer jar. Expensive battery to use regularly. L.A.I.E.E.

[76413.] — **Double-Fluid Chromic-Acid Cell.**—Dissolve 1lb. chromic acid in 2 quarts of water. Add thereto 2oz. chlorate of potash; when dissolved, pour in cautiously, with constant stirring, 1lb. of good oil of vitriol. Set aside to cool. This solution is to go along with the carbon rod, or plate. With the zinc, use water, 1 quart; oil of vitriol, 3oz. by measure. S. Bottone.

[76413.]—**Chromic-Acid Cell.**—There are several solutions for the bichromate battery—each one claiming to be the best. The following is recommended by Woodhouse and Rawson: Hang a lead or porcelain colander, or other sieve-like vessel, containing about 1lb. of bichromate of potash in a jar containing 8 pints of water, so that the crystals are just immersed therein. Pour slowly over these 2 pints of sulphuric acid, stopping occasionally as the liquid boils. When this operation is finished, all the crystals should be dissolved. The liquid is ready when cool. This fluid will last considerably longer than the ordinary fluid hitherto used. Prof. Ayrton, in "Practical Electricity," p. 222, gives complete details, with the chemical action which takes place on mixing. A. D. Southam.

[76414.]—**Gas or Steam.**—You want a total output of about 100H.P., it being requisite to have several engines in different parts of premises working intermittently. You do not state how many engines. My opinion is that gas-engines would best suit your requirements, especially as you will have exceptional facilities for manufacturing your own gas, such being requisite for other purposes. If I were in your place, I should communicate with Crossley's, who could probably supply you with some statistics that would enable you to make up your mind on the subject. A. E. B.

[76414.]—**Gas or Steam.**—If "T. H. S." is going to have several engines working intermittently in different parts of the premises, and can get cheap coal, he should use gas-engines. By experiment made in Italy with a gas-engine of 100H.P., using gas made by coal coming from Newcastle, I had (calculating expenses of installation, manutention, alimentation, &c.) that 1H.P. per hour costs 0 040f., consuming 1·13kg. of coal, whilst using a steam-engine of the same power, 1H.P. per hour costs 0·0581f., consuming 1·66kg. of coal. "T. H. S." will have cheaper results, as he is not going to calculate the carriage of fuel.

P. Infante.

[76416.]—**Motor, Electric.**—To Mr. Bottone.—This idea is the subject of a patent taken out by by R. H. Courtenay, about 1885 or 1886.

S. Bottone.

[76416.]—**Motor, Electric.**—The induced effect is only momentarily, and unless used with a contact breaker, as in a coil, the effect is of not much practical use. G. Rennie.

[76419.]—**Pedals.**—Oak, birch, or beech pedal-boards can be bought for 26s. solid throughout. It is not worth while to make them when they can be had so cheap. Don't have a roller-board, but stickers reaching to back end of keys. You can buy pedal-board and also connections to keys, well made, for 34s. Edwin Gibson.

[76420.]—**Image of Sun.**—You evidently do not use an eyepiece with your telescope, which is indispensable for forming an enlarged image of the sun. T. D.

[76420.]—**Image of Sun.**—Let your screen be of very smooth cardboard, or preferably porcelain. The further the screen is held from the eyepiece of the telescope, the larger will be the image. With a small hand telescope you will not be able to see much of the detail of spots, &c., and none of the granulated surface. The latter has been photographed by the aid of large telescopes with a diagonal eyepiece. A 3in. o.g. will just show the surface granulated in good air. You should try your projections in the early part of the day when you are less likely to have tremours from heated air. H. A.

[76421.]—**Gas-Burner for Lantern.**—For mantles and burners for lanterns, send to the Incandescent Gas Light Co., 14, Palmer-street, Westminster. "A. B." will find, however, that nothing in the way of gas-burners approaches the simplicity and brilliancy of the limelight, and any little trouble in procuring compressed oxygen is amply rewarded by the beauty and cleanliness of the light. The mantles are advertised to give 150 candle-power.

Brighton. H. Hilton.

[76421.]—**Gas-Burner for Lantern.**—The Incandescent Gas-Light Co. advertise their lamp specially for lanterns. Has anyone tried it? This leads one to the remark that few seem to have tried the incandescent light (gas). The idea is splendid, but the question is this: What is the realisation of the idea. As A. Bosquet is in the position of not caring for the question of consumption of gas, he may have a few spare shillings to spend on trying the incandescent gas-light burner, which cost me 10s., besides a few shillings more for extra mantles. My friend is persistently trying the burner for me.

Z. Y. X.

[76421.]—**Gas-Burner for Lantern.**—Gas by itself is not suitable. I have spent considerable time and money experimenting on this very question. I have myself tried, I believe, every kind of gas-burner, such as Argand, fish-tail, twin, and others in the lantern. I have tried several mantle burners. They are decidedly unserviceable, as when once they have been lit they are so brittle that with the least jarring they fall to pieces; until this extreme sensitiveness is obviated they are practically useless for the lantern. A mere shake, such as putting a slide in, is apt to break them when once they have been lit, and besides they are no better than the others, the light not being sufficiently bright at a point. Limelight is the best, then the 4-wick petroleum lamp. Any light less than these is not worth the candle. E. M. Johnson.

"Gofton," Woodstock-road,
Moseley, Birmingham.

[76424.]—**The Bumping of Railway Trains.**—This is caused by the wheels of the carriages passing over the joints of the rails. The number of "bumps" occurring in 15 seconds gives approximately the number of miles per hour the train is travelling. Thos. Fletcher.

[76424.]—**The Bumping of Railway Trains.**—It is caused by the wheels passing over the joints of the rails, and is much more perceptible when the rails are of iron instead of steel. If the length of rail is known, the rate per mile can be found by counting the number of rails passed over in a certain observed time. R. V. H.

[76424.]—**The Bumping of Railway Trains.**—My opinion is that this bumping sound comes from the joints of the rails. If the line is in good order the sound is not near so loud as when the joints are down. I remember once riding on a light engine up a goods line for about two miles, and I could detect lots of joints. I rode on the tender just where it is coupled to the engine. I have heard it stated that a good permanent-way inspector can detect bad joints while riding on the engine of an express. If this sound comes from gaps in the wheels, caused by occasional skidding, what would be the condition of the mail's rear-van wheels which ran skidding from Derby to Chesterfield?—a distance of about 26 miles. This train would have been stopped by signalmen, but they were under the impression that the sparks came from a vacuum brake block knocking against the wheels. The wheels were getting warm. Ex-Midland.

[76426.]—**Fuller Battery.**—Chromic acid 2oz., sulphuric acid 1oz., water 10oz. in outer jar, with carbon zinc in porous pot, with water and a spoonful of mercury. Yes. Brand.

[76426.] — **Fuller Battery.** — A Fuller's battery, charged with either chromic-acid or bichromate of potash, will answer your purpose admirably. Outer jar with carbon; porous pot, zinc. See reply 76413. F. Askew.

[76426.]—**Fuller Battery.**—See reply to 76413. It would be far cheaper for you to use a Smee's battery, or rather a Walker's made up of a zinc plate amalgamated with mercury, and clamped between two flat carbon plates placed in a diluted solution of sulphuric acid 1 to 12 of water.

L.A.I.E.E.

[76426.]—**Fuller Battery.**—The zinc is contained in a porous pot filled with a solution of chloride of zinc, the carbon plates in the outer jar, in a solution of potash bichromate with a few drops of hydrochloric acid. Put an ounce or two of mercury in with the zinc to assist in amalgamation.

G. Rennie.

[76426.]—**Fuller Battery.**—This consists in a glazed earthenware or glass jar, in the centre of which stands a porous cell. Within the porous cell is a rod or plate of zinc, the cell being filled up with plain water. Between the porous cell and the outer jar is a plate of graphite, which stands in a solution of bichromate of potash in water (3 parts bichromate to 20 of water), along with about three parts of sulphuric or hydrochloric acid. This battery does well for plating, &c., but must be dismounted when not in use. For occasional small work nothing beats the E.S. dry cell.

S. Bottone.

[76428.]—**Dynamo: Chromic Acid.**—To Mr. Bottone.—Your dynamo, if well made, should give from 3 to 4 ampères at 35 to 40 volts pressure if driven at a speed of about 2,800 revs. per minute. The advantages of the chromic-acid solution are:—1. It can be made much stronger since a pint of water will only dissolve 3oz. of bichromate, while it will dissolve more than 16oz. of chromic acid. 2. Half the sulphuric acid added to the bichromate solution is wanted in combining with the potash. 3. No chrome alum is formed when chromic acid is used.

S. Bottone.

[76429.]—**Accumulators.**—You will be able to charge 20 cells in series. I cannot tell you exactly the charge your cells will take, as you do not give number and size of plates in each cell; but you can reckon for yourself by remembering that the total ampère hours of any number of cells in series is the same as that of one cell; and that the capacity of a single cell is about six ampère hours for each square foot of positive lead surface. The negative plates do not count in this calculation.

S. Bottone.

[76433.]—**Testing Internal Resistance of Battery.**—The querist wishes to perform a specific act without the specific tool to do it with. He has, however, a Wheatstone's bridge and a set of resistance coils. Let him get two carbon plates, and immerse them in the exciting fluid of the battery to the same dimensions as those of the actual cell. Let him balance one of his coils with these two, moved to a certain distance apart; by this means he will get r, say, at 2in. apart. Then 2 : distance between zinc and carbon in battery : : r : internal resistance of battery.

A. E. B.

[76436.]—**Wimshurst Machine.**—"W. H." may make the above machine with two Leyden jars, or with four Leyden jars. The frictional machine, I think, has the fourth jar hidden by the discs; the outsides of the jars may be connected together by a wire on the underneath side of the machine. The machine will answer for all purposes and experiments which in the olden times were carried through by the frictional machine. A thin vulcanised fibre washer, cemented to the glass disc and then screwed to the end of the wood boss is by far the safer means of attaching the disc to the boss. Tinfoil of the best quality is much better for the sectors than thin brass, for brass tarnishes if not lacquered, and if lacquered, then the metallic contact between brush and sector is broken by the lacquer; moreover, by reason of the expansion and contraction of brass due to change of temperature, the brass soon breaks itself free from the disc.

J. W.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

Since our last, "Mistral" has replied to 75851, 76003, 76038, 76058; "A. E. B.," 75917, 76104.

75925. Foundations, p. 315.
75927. Small Biunial, 315.
75935. Electro-Magnet, 316.
75949. Gas-Engine, 316.
75966. Making Sulphate of Ammonia, 316.

76164. Speed.—To "Vulcan," p. 404.

M. Bouriant, of the French School at Cairo, has discovered a fragment of the Greek text of the Book of Enoch, containing the first 33 chapters. It will be published soon in the *Transactions* issued by the Cairo School.

QUERIES.

[76437.]—**Battery.**—Will any reader say what form of battery I should use for a small medical coil, not to have any action upon the zinc when the circuit is broken, and only to require charging about once a week?—Anxious Lad.

[76438.]—**Lantern Microscope.**—What lenses besides objectives are needed to make a lantern to show microscope slides? I thought a 3in. condenser was all that was needed to give fair results; but was told by someone that I must use six lenses. Is this so? A sketch showing their various positions would oblige. Is the eyepiece of microscope to be used as well as objective? Will the heat hurt the balsam?—Silly Billy.

[76439.]—**Electric Bell to Clock.**—I have an ordinary eight-day clock, cost £2 2s. I want to fix an electric bell to it. I want the bell to ring at a certain time in the morning, say 4.30 or 5 o'clock, or any time I can set it to, and I want it to keep on ringing till it is stopped by me by a switch or something of that sort. I shall be pleased for any information on it, or a drawing will greatly oblige.—J. E. D.

[76440.]—**Desiccator.**—Will "E. E. B., Leicester," kindly explain the use and action of the desiccator mentioned by him in his excellent articles on "Mercury Pumps"? Also, how can I make the P_2O_5, and will an ordinary gas-tap do for the screw-tap to start and stop?—J. C., Cheadle.

[76441.]—**Gregorian.**—Will some optical reader kindly inform me how to adjust a Gregorian reflector? The small hole in the eyepiece, and (I think) the small mirror are in correct position, but it does not define so clearly as it should. I notice that when a star is out of focus, the dark image of the small mirror is close to one side of the enlarged disc. Is this as it should be? If not, how can it be remedied? There is a dark red glass, as well as the sun-glasses, to fit on the eyepieces. For what purpose is it used?—A. E. Washington.

[76442.]—**Twist Drills.**—In examining a price-list of these drills there are five columns of prices as follows: Straight shanks, straight shank drills to Stub's letter gauge, Stub's steel wire gauge, straight shanks. These are numbered 1 to 5, 6 to 10, &c; turned drills with taper shank, tapping sizes; and, finally, twist drills, turned with taper shanks. All these have different prices attached to them. I want to have the above explained? In column, Stub's steel wire gauge, straight shank, Nos. of wire 1 to 5, 6 to 10, what would the diameter be? Would ½in. be within 1 to 5? Then there is Stub's letter gauge, which appear to be the most expensive. Again, between straight and taper shanks, there is a great difference in price. Why is this so? Why is it called "letter gauge"? What is the difference?—Corkonian.

[76443.]—**Pressure through Pipe.**—Would any of your correspondents tell me how many feet fall it would take to get 20lb. pressure through a 3-16in. pipe; also, does the size of pipe make any difference in the pressure.—W. Trelawney Adams.

[76444.]—**Looking-Glass.**—I have a frame for a looking-glass made of yellow pine. Could any of your readers let me know how to treat or stain it? I want it a deep shining black, the frame not having yet received any colour or varnish, &c.—A. W. Berry.

[76445.]—**Colouring Artificial Stone.**—Shall be glad if any reader can inform inquirer the best material for mixing with cement, &c., to make artificial stonework a red colour, about the same as Mansfield or Newbiggin stone?—T. B. S.

[76446.]—**Polygons.**—In drawing polygons it is always the second point of the circle that is used. Is there any reason for this by Euclid, or other authority?—Geometry.

[76447.]—**Horse-Power.**—A spindle in running pushes against its step-bearing with a constant backthrust of 28lb. Is there any method of calculating the loss in H.P. this back-thrust represents? Of course, if the bearing gave way, the spindle would fly backwards through the air at a certain speed, and it would then be easy, this speed once known, to convert it into foot-pounds per minute? To put the problem in another way, it might be supposed that a locomotive were attached to a buffer-stop, and under steam, doing its maximum of H.P. to get away. Or, again, that the spindle above-mentioned at a higher speed would exert such a backthrust as to pull the engine (of, say, 10H.P.) up. I know, from observation, that the 28lb. are in some way directly related to the H.P., for as the speed of the spindle and the H.P. on it increase, so does the back-thrust, and that it is practically proportional to the total H.P. (for this thrust about 9H.P.) exerted on the spindle, but cannot estimate it. Can any reader assist me?—Postduif.

[76448.]—**Bryce-Douglas and Joy Valve-Gears.**—Would some reader supply me with particulars and explanatory diagrams of these two valve-gears, or refer me to back numbers of the "E.M." in which I could find description of same, and whether they are still in print?—Loco. No. 2.

[76449.]—**Paint on Glass.**—Will one of your readers kindly inform me through the medium of your paper what kind of paint is the best for putting letters on glass that is exposed to the weather?—as I have tried both ordinary paint and enamel, and find that it either peels off or breaks away in a very short time.—A. J. Wescott.

[76450.]—**Plaster.**—Will any reader kindly tell me of a compo to take the place of ordinary plaster which has fallen away from walls close to hot-water pipes in my house? I shall be pleased to hear of anything that will adhere firmly to both. About one-half of the pipes are seen projecting beyond surface of plaster.—A Leeds Cloth-Drawer.

[76451.]—**Armature Winding.**—To Mr. Bottone.—I am making small dynamo as described in your book, "The Dynamo: How Made, &c.," and wish to use laminated armature. I can see my way to wind the wire neatly in the channel, but cannot see how to wind regularly at the ends where the spindle goes through the punchings and the nuts come in the way. I shall be very much obliged if you will tell me whether cross-winding will matter at the ends, or if there is any way to avoid it? Any hint on the matter would be a favour.—M. U. F.

[76452.]—**Resistance.**—I continually want to measure the resistance of bells, &c. (all under 50 ohms). I have a resistance box with coils 1, 2, 5, 10, 20, 30; also a horizontal galvanometer. I have Mr. Allsop's instructions for making a Wheatstone bridge, with mercury cups, in Vol. L.; but he does not say how to use it. I do not want to keep 30 cells going for this purpose. Would someone kindly tell me how best to get these resistances?—Amateur.

[76453.]—**Frustum of a Cone.**—Would any reader kindly oblige by explaining the proper way to get a frustum of a cone out with the compasses?—T. S.

[76454.]—**North Stafford Railway.**—Would some reader kindly supply me with a sketch and chief dimensions of the N.S.R. four-coupled six-wheel tank engines, built between 1886 and 1887?—Loco No. 2.

[76455.]—**North-Eastern Railway.**—Would "St. Aubyn," or some reader, kindly give sketch of Mr. Worsdell's four-coupled eight-wheel tanks, similar to those he built for the G.E.R. when superintendent of that line?—Loco No. 2.

[76456.]—**Jupiter.**—Sir R. Ball, in his "Story of the Heavens," defines the "rotational moment of momentum" of Jupiter as the product of the angle passed through in one second, multiplied by the mass of the planet, multiplied "by the square of a certain line which depends on the planet's internal construction." Can any of your correspondents say exactly what this line is? It is, I presume, a question of density; but how is the line measured?—Delphinus.

[76457.]—**Mathematical.**—Will some one of our readers explain the rule which produces the following result of figures—

	s.	d.
30 oranges at 3 for 1d.	0	10
30 „ 2 for 1d.	1	3
60	2	1
60 „ 5 for 2d.	2	0
Difference	0	1

—Puzzled.

[76458.]—**Smoke.**—Will some reader kindly inform me what substance, when burning, produces the most smoke, which burns slowly and easily, is cheap, uninjurious, and not heavy? I also want to produce a white or light grey, and an intensely black smoke?—Foggy.

[76459.]—**Waterproofing Silk.**—Can one of "ours" please tell me the way to make waterproof about 6in. square of thin silk, and still leave it fairly pliable; need not be lasting?—A New Reader.

[76460.]—**Ivory Brushes.**—Will some reader kindly inform me how to clean a pair of ivory brushes that have turned yellow with washing?—W. G. C.

[76461.]—**Boiler for Model Engine.**—Will any reader kindly inform me how to make boiler for model horizontal engine, 1in. bore, 2in. stroke? Could it be made out of copper tubing, and how stop the ends up, if possible without brazing. Traps, gauges, &c, I understand, but am ignorant as to the size, and how to fasten ends in to be safe.—W. S.

[76462.]—**Taunton Dynamo.**—To Mr. Bottone.—Many thanks for your kind answer *re* the above. Now, would you kindly say if the same machine would do for arc lighting, and, if so, you might give amount and gauge of wire for magnets? I suppose the armature is all right? You might also give size of carbons for the lamp; also the candle-power?—R. T., Paisley.

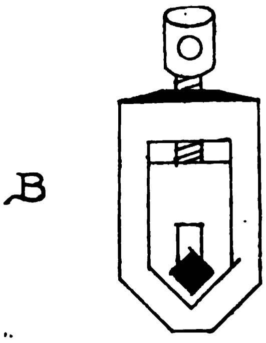
[76463.]—**Arc Light.**—To Mr. S. Bottone.—In your book on "The Dynamo," page 98, you say: Wind the F.M.'s with No. 20d.c.c. copper wire for a shunt wound; but for a series wound to light an arc lamp, wind with No. 12, two strands, connected in parallel. Why does it require so much larger wire for arc lighting? Also, at 50 volts, how many ampères are required to give 1,000c.p. in arc lamp? How long can one of your 5c.p. dynamos be driven without injurious heating if fitted with H armature?—Rebma.

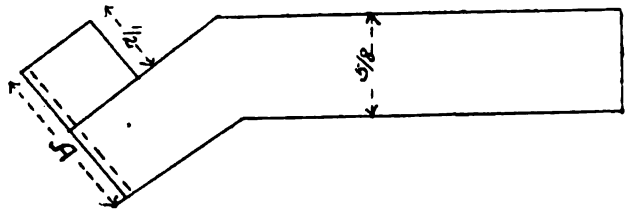
[76464.]—**To Mr. Bottone or Others.**—Will they kindly say if, in their opinion, the "arc light" would be suitable for illuminating the inside and outside of a jeweller's shop, the internal dimensions of which are: Length 24ft., breadth 21ft., height 16ft.; also the number of lights required, the height at which they should be suspended, the probable cost of material and erection (there is an E. L. and Power Co. in the town), about how much its use would cost per week, and if it is cheaper than the "glow light"? I ask the above as it is said that nine jewellers out of ten condemn the electric light in every way.—Jeweller.

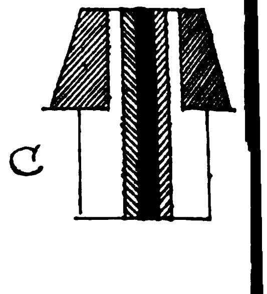
[76465.]—**Cutting Retort Carbon.**—I want to try my hand at cutting gas retort carbon into battery plates, &c. I have heard something about a circular disc of iron as a cutter, and sand-and-water as a lubricator. Any information on the subject will greatly oblige—Mechanicus.

[76466.]—**Engineering Arithmetic.**—I shall be very grateful for the name and publisher of a collection of examples in engineering arithmetic which might be used with such a book as "Humber on Strains."—F. W. C.

[76467.]—**Washable Distemper Colours.**—I see there is offered in England and the States washable tints for walls under the names "Duresco," "Alabastine," "Calcarium," &c. The old-fashioned stuff composed of whiting, glue size, and colouring matter, sold here in a powdered state, to which only hot water has to be added, is, of course, not washable. Will some kind reader give me any hints as to the composition and mode of making a "washable" distemper colour, in powder if possible, or otherwise? I should be glad to get such an article for my work. I have been a subscriber for the past fifteen years, and I don't remember anything of the sort being mentioned, and I have no back numbers here. Any information will greatly oblige.—English Painter, Hochelaga, Canada.







[76468.]—**Haydon's Cutter-Bar.**—I am desirous to make a cutter-bar of the above pattern; but I have never seen one, only woodcuts. I have a copy of "Ours" dated June 12, 1885, in which appears Part III. "Tools and Cutter-Bars"; but a portion of it is gone. I want to know at what angle the tool is held in at the end of the bar, as in inclosed sketch at A, and if the sling B is a separate piece from the bar? Is the slot or nick in the end of the bar at A for the tool square, round, or angular in section? My lathe is a 4½in. centre back-geared one, and the height of centre above top of tool-plate of slide-rest is ⅝in. That, I suppose, ought to be the thickness or square of the bar. Would the bar be sufficiently strong if a cast one of gunmetal or brass? Wrought iron or steel is, I suppose, the proper thing. A sketch would much oblige.—CORKONIAN.

[76469.]—**Neptune.**—Now that, through the death of Prof. Adams, Neptune is being so freely discussed, I should be glad to read in yours what little is known, time of its rotation, name of its first satellite, diam. of ditto and distance, and is six days the correct period?—WM. HOSKEN.

[76470.]—**Enlarged Measuring Glass.**—Will some of our chemical friends kindly help me by suggesting the best possible shape of a measuring glass that can be equally divided into divisions (at least ⅛in. apart), and yet hold quite a pint of liquid, but must not be above 5in. in height. An ordinary graduated parallel hydrometer jar 1⅞in., diameter and about 6in. high, is the nearest I can get; but the divisions then are so close together as to be barely readable; besides, it holds scarcely a half-pint. The space at my disposal where it is to be fixed is 5in. square. I shall feel grateful for any suggestion, expense being a secondary consideration.—SUBSCRIBER SINCE 1866.

[76471.]—**Sunspot Photography.**—Will some worker in this branch of photography refer me to a diagram of slit shutter? I want to apply it to an adapter fitted with two screws, one for the draw-tube, and the other to fit the camera. How is the "release" of the shutter obtained? With the Editor's permission, a diagram would be valuable, as I feel sure there are many amateurs in the same best as—H. A.

[76472.]—**Callaud's Gravity Daniell Cells.**—Will some of our readers who have had a lengthy experience with these cells give their opinions of an improvement suggested by P. B. Delany, of New York, in the *Telephone* for August 15th, 1889. It consists of the ordinary zinc and copper plates; but he incloses the zinc in a paper envelope, and the sulphate of copper crystals in a straw-board box surrounded by a strip of copper which is connected to the wire terminal passing out of the liquids. Perhaps someone has seen this pattern cell in use; if so, kindly state how long it will go without attention, and is it better to amalgamate the zinc in this particular case, as no mention of so doing is made in th article referred to.—P.M.I.Sc.S.

[76473.]—**Lathe.**—Will some kind friend give me the rules for working out the following: How to know which change-wheels to put on the lathe to cut any certain pitch thread?—PSYCHE.

[76474.]—**Electric Light.**—Will some one please say what are the disadvantages of the Jablochkoff candle, and whether it is in extensive use? Also, why arc carbons are not placed in a vacuum?—GEO. BROWN.

[76475.]—**Hydraulic Formula Wanted.**—Could any one give me a formula for gauging streams by board with a right-angled notch cut in? Prof. Thomson's formula for it is $C\sqrt{H^5} \times 2{\cdot}54$, in which C is cube feet flowing second, and H the height of water from point of notch in feet. What I want is to calculate the cube feet per minute with the height given in inches.—BOTHERED.

[76476.]—**Compound Principle.**—Is there any particular reason why the second expansion cylinder should be of greater diameter than the primary? It seems to me that what is gained in area is lost in intensity; and if a large cylinder be more economical than a small one, why not have the primary cylinder large?—A. E. B.

[76477.]—**Moulding Celluloid.**—Can you inform me how to mould articles of celluloid? I have been trying with Scheving's celloidin dissolved in sulphuric ether; but I find it shrinks after being put in the mould, and bubbles form. Is there any safe way of treating it so that it can be heated and moulded? Possibly some other form of celluloid would answer better?—SAMPE.

[76478.]—**Alternating Currents.**—A 50-unit alternator supplying incandescent lamps up to its full power—i.e., 50,000 watts, gives 2,000 volts. Will the actual amount of current in ampères be equal to, greater, or less than 25?—HUNT.

[76479.]—**Reagents.**—What strength of solutions is best for water analysis?—WATER ANALYSIS.

[76480.]—**Water Motor: Transmission of Power.**—I have a stream of water 6ft. wide, 1½ft. deep, with an effective fall of 2ft. How can I best utilise this power? What H.P. would it give, and what are the best and most economical means of transmitting the same to drive light machinery or dynamo 100 yards distant?—J. R.

[76481.]—**Battery.**—I have a 10-cell single-fluid chromic battery; plates are 9in. by 2½in. by ¼in; stoneware cells are 10in. by 6in. by 3in. What is the best solution for lighting purposes, what amperage ought I to get from it (6in. are immersed in the solution), and how many lamps could I light with it?—PUZZLED.

[76482.]—**Workshop.**—Having built a workshop at back of my premises, and stocked it with an 8ft. screw-cutting and surfacing lathe, a 5ft. ditto, a 4ft. ordinary single gear, and small drilling machine, I would like to know if a Crossley's 2H.P. gas-engine, giving 3H.P. nominal, would be sufficient to drive them all at one time, and would 1⅝in. shafting be thick enough for the main shaft, which is 12ft. long?—there being a bearing near each end and one in middle.—YOUNG BEGINNER.

[76483.]—**Enamelling Opal Portraits.**—Will some kind reader assist me a little? I propose painting some portraits on opal glass, and, afterwards, to improve the appearance, I wish to be able to enamel the same. Kindly say how this is to be done, with full instructions, and oblige—A CHAWBACON.

[76484.]—**Gas-Engine.**—I made model 1⅝in. bore, 4in. stroke, valves ⅝in. dia., firing-valve ⅜in. dia., ⅜in. from end of cylinder, exhaust, an eccentric on shaft, which I intend to cut into cam afterwards. The charge will not explode in cylinder at all; it burns out in all directions. Please say what is the matter, and oblige? The gas supply through an ordinary burner.—A STUDENT.

[76485.]—**Electric Pin or Stud.**—Would any of your readers kindly inform me the best way to make a pin or stud for wearing at a fancy dress ball, and how long it will last?—COTSWOLD.

[76486.]—**Analysing Solder.**—I want to analyse some solders, especially tinmen's.—J. L.

[76487.]—**Staining Sections.**—Will one of "ours" kindly explain the process of staining vegetable sections in one or more colours for microscopic mounting? Any information on the subject would oblige.—LUCIDA.

[76488.]—**Rotary Alternating Currents.**—Now that Mr. Nicola Tesla, the great promotor of the idea of the above, is in London, it would be interesting to have a few fundamental facts concerning rotary currents, and what is the specific difference between these and ordinary alternating currents. I cannot understand the reputed superiority of torque of machines constructed on his principle. Will someone who has studied the matter kindly explain? Also if there are any of these motors at work or on view at the Crystal Palace Exhibition?—A. E. B.

[76489.]—**Electric Lighting.**—Could Mr. Bottone tell me what kind of water-motor I should want for making the electric light to use four lights in an ordinary house, and what kind of dynamo would be needed for the same?—T. B. K.

[76490.]—**Drill.**—What is the best arrangement for the pressure-plate in a self-acting drilling-machine? I have one to fit up: spindle 1⅝in., top boss of casting 4in. long and 4½in. across. Can I not make a gunmetal cone to run in the lower boss? A sketch of both would greatly oblige.—BAT.

[76491.]—**Screw Augers.**—Can any correspondent describe the method employed by the makers of augers, gimlets, and brace-bits to form the taper-screw on their points? It is generally double-threaded and carefully made even on a cheap gimlet. Is it chased or cut with dies, and if so, how are they shaped, &c.?—VULCANITE.

[76492.]—**Electric Lamps.**—Will someone kindly tell me whether I can repair incandescent lamps? Also, can I manufacture them for my own use?—P. T. JIM.

[76493.]—**Artificial-Plant Barometer.**—Kindly furnish me with the composition and making of the artificial-plant barometer, which consists of an artificial plant in a small flowerpot, the leaves of which change colour with the variations in the weather.—C. B. H.

[76494.]—**Casting Zinc.**—Will any reader inform me how to make the moulds for casting hollow zinc cylinders for battery, the best sand to use, what to bind it with, and if I require a wooden pattern? Cylinders to be about 7in. high, 3¼in. diameter, and ¼in. thick.—PHORO.

[76495.]—**Filter for Rain-Water.**—I wish to make a filter of simple character to prevent the soot from reaching my rain-tub. I intended using sand as a filtering medium, but find, on making some experiments, that the percolation would be too slow, though I intended the aperture (filled with sand) to measure 18in. by 1½in. Can any of my fellow-readers inform me of a medium that would act more quickly, being at the same time effective and cheap? I think I have heard of pulverised granite being used. Any information will oblige.—F. M.

[76496.]—**Charcoal.**—I have a quantity of branches of felled trees I should like to convert into charcoal. Would some of "ours" kindly describe the process practically?—DOCTOR MED.

[76497.]—**Telephones.**—I have made a pair of telephones, which consist of receivers of ordinary Bell pattern, and transmitters in the form of microphones. How should I make all the necessary wire and battery connections? I propose using double-line wire, as it is intended for inside work.—ANXIOUS.

[76498.]—**Polishing Paste.**—Will some kind reader give me advice for the necessary ingredients for making the above to polish brass, and to keep so for some lengthened time?—ENQUIRER, Manchester.

[76499.]—**Gold Lacquer.**—Will some reader kindly give me instructions for making pale and gold lacquers?—ENQUIRER.

[76500.]—**Accumulators.**—Would some reader kindly give me instructions for making small accumulators, as I have had no experience in them?—AMATEUR.

[76501.]—**Broken Water-Pipe.**—Can anyone inform me how to localise a leakage in a water-pipe? It is laid under a concrete floor, and I do not want to break up more of the flooring than I can help. Any information will oblige.—SCISSORS.

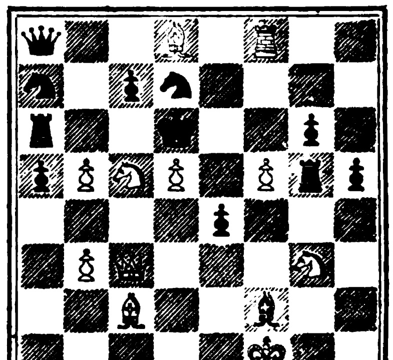
[76502.]—**Connections.**—Will Mr. Bottone kindly give sketch of connections for shunt and series coils in small dynamo? The small wire is inside. Is that right?—G. M. RENNIE.

CHESS.

All communications for this column to be sent to the CHESS EDITOR, at the office, 332, Strand.

PROBLEM MCCXCII.—By T. GUEST.

Black.



White. [11 + 12.

White to play and mate in three moves.

SOLUTION TO 1290.

White.	*Black.*
1. Kt-K 6	1. K takes Kt (*a*).
2. Kt-Q 4 (dis. ch).	2. Kt-Kt 5.
3. Q-B 5 mate.	
2. Kt-Q 4 (ch), &c.	(*a*) 1. K-Q 4 (*b*) or Kt 4 or B takes Q, &c.
2. B-Q Kt 8 (dis. ch), &c.	(*b*) 1. Kt takes Kt.

Also 1. B-R 5 (dis. ch).

NOTICES TO CORRESPONDENTS.

CORRECT solutions to 1290 by H. Fellows (very neat), A. G. Fellows, J. F. Moon, F. Slade, W. T. Hurley (two duals), James Kistruck (two duals and second solution); to 1289 by G. H. Inson, J. Kistruck, C. S. Bright, R. W. Houghton, A. C. Hurley; to 1288 by C. S. Bright (Genoa), A. C. Hurley.

C. S. BRIGHT.—1286 is sound enough. If 1. $\frac{\text{Kt-Q 2}}{\text{R-Q Kt 5}}$, 2. $\frac{\text{Q Q 8}}{\text{R-K B 5}}$, 3. P takes R mate.

A. G. FELLOWS.—Thanks for problem.

A. L. BUTLER TINDALL.—In 1290, if 1. $\frac{\text{B-Q B 5 (ch)}}{\text{K-Q 4}}$, 2. $\frac{\text{P-Kt 3}}{\text{K takes P}}$, or P moves, and there appears to be no mate next move. The proper play is 2. B-K 6 (ch).

J. F. MOON.—In 1290, if 1. $\frac{\text{P-Kt 3}}{\text{P-R 4}}$ 2. $\frac{\text{B takes P}}{}$, we can see no mate if 2...K takes P or K-Q 4.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, FEBRUARY 12, 1892.

A HANGING BOOKCASE.

THE accompanying illustration shows a plain form of bookcase for hanging on a wall. Yet for its simplicity it is not to be despised; and for the amateur who has not attempted to make one, I trust he may find this, with its description, of some service to him in making it. The measurements for the design shown are as follows:—Length 4ft., height 3ft., depth 7in., the bottom shelf extending 6in. further each end, and is 10in. wide. It may happen that the bookcase will be required to fit into a recess, in the event of which the length must be according, though the height may very well remain the same, and possibly the extension of bottom shelf may have to be dispensed with, and if so, the side moulding at the top would not be wanted. I mention this first to show it is not necessary to follow any particular measurements, but rather that the size of the bookcase can be determined upon by the space that can be spared for it. The cost of such a bookcase is but trifling, and really the most expensive part being the leather edging for the shelves. The imitation leather edging I do not recommend at all: it soon tears, and consequently looks untidy, and requires renewing, so that the real leather is cheapest in the end. The bottom shelf, which projects beyond the bookcase at the front about 3in., has a moulded edge, so that there remain but three shelves to have the edging. But this is proceeding too quickly, and, to return: the sides are of ½in. wood, 7in. wide, and 3ft. long, the wood being yellow pine used throughout.

On the inside of each side piece two strips of wood are fixed, notched out, as shown in Fig. 2, to take the shelves, making them adjustable, which is very necessary. These strips are ½in. thick by 1½in. wide, and notched out, as shown, and are fixed to the side with screws. Another plan is to have similar strips with holes drilled in place of the notches, into which are fixed what are known as "studs," four being required for each shelf (see Fig. 3), obtainable at most cabinet ironmongers.

Having fixed these strips, the top, A, should be screwed on to them with long, thin screws. This, it will be seen, comes within the moulding, and serves only as a protection from dust. The bottom shelf (measurements of which have been given, except that the thickness should be ¾in.) should then be prepared, and screwed to the sides from underneath. The moulding at the top is 2in. deep by ½in., the pattern shown being a hollow moulding. This can be obtained, ready made and any length, from a timber merchant; but the amateur will find no difficulty in making it,—of course, provided he has the necessary tools, i.e., a rebate and a hollow plane (see Fig. 4 for section of moulding), the diagonal dotted line showing where the wood is to be sawn to before proceeding to form the moulding.

The top of the moulding should be fixed 1in. above the top board, the ends being mitred. To fix the moulding a few fine brads, driven in from the front, into the top board, and in addition, several small blocks of wood glued to the top board and the moulding, will make a firm job.

The shelves are of ½in. or ⅜in. wood, and must be cut out at the ends to fit into the notches (see Fig. 5), the front edge coming flush with the front of sides. The sides with the notched strips screwed to them will be about 1in. thick each, so to cover the joins I fixed a thin strip on the front edges, these strips having a ribbed or fluted moulding running within an inch of the top and bottom, and fit under the bottom rebate of the top moulding. These can be as thin as possible, and free from knots. Why I mention yellow pine as being used in making the bookcase is because it can be obtained free from knots, and when stained it can be made to represent oak or walnut so that the imitation is hardly recognisable. The front strips are fixed with glue and fine brads. To strengthen the bookcase I find a very good plan is to fix pieces of wood, about 6in. by 6in., at the angles (A in Fig. 1) at the back, in which case they must be let in so as to allow the case going flat against the wall. Five strong looking-glass plates will be sufficient to hold the bookcase firm, three at the top and one on each side. The pressure being nearly vertical, they will sustain a great weight, providing, of course, the nails hold firm. One great objection I found in an open bookcase is that the books are so liable to get dusty, and a good plan is to hang two curtains in front, suspended from a brass rod, and by having the colour of the curtains to harmonise with the rest of the room in which the bookcase is fixed, they are rather an ornament than otherwise, and certainly a preventive against dust. The brass rod should be ¾in. in diameter, the rings 1in., the rod finished off with fancy knobs at each end, and hung on brass brackets, all of which can be obtained at any ironmonger's. The Builders' Supply Stores, 145, Holborn Bars, E.C., supply all these oddments for amateur carpenters, also stains and varnishes, and, above all, are very reasonable. Personally, I have found it very convenient frequently to have an address mentioned where I can feel sure of getting what I want at a reasonable cost.

As to finish, it is difficult to judge other people's tastes, but I can give a suggestion that the bookcase be stained with dark oak stain (Jackson's powder stain I find is the best), and having put on one coat, rub the the work well over with fine sandpaper, then apply a second coat. An hour or two is sufficient time to allow for the stain to dry, then by rubbing in some linseed-oil it gives the work a fine appearance of old wood, or, if preferred, size and varnish it, but avoid spirit varnishes.

I hope in a future paper to give a more elaborate design for a bookcase. In the present one, if curtains are not used, I would suggest that a pair of candle sconces be fixed low down on each side; they give a

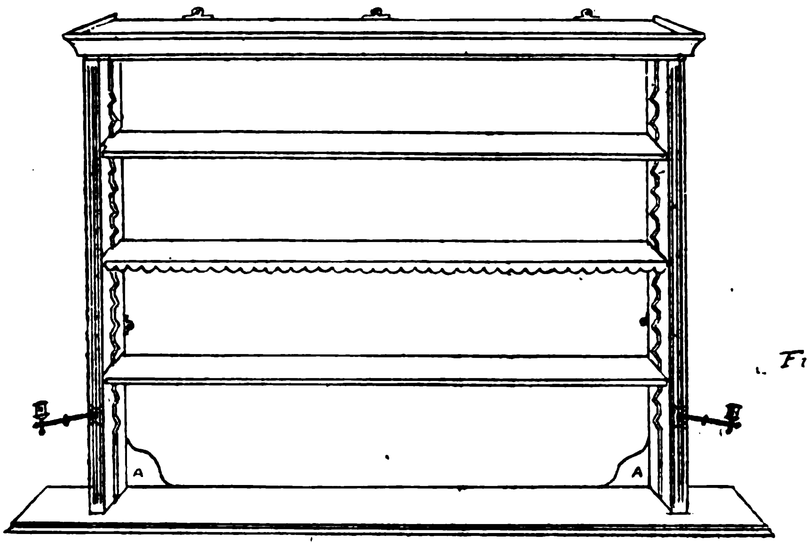


Fig 1

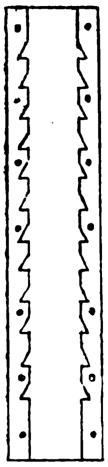


Fig 2

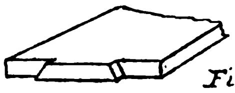


Fig 5.

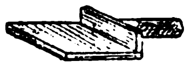


Fig 3.

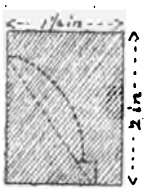


Fig 4.

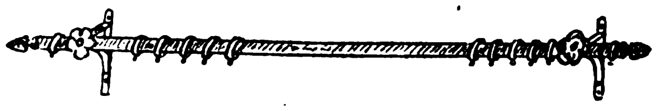


FIG. 6.

certain amount of finish, and are useful when seeking for a book at any time should the bookcase be placed in a dark recess.

THE OPTICAL LANTERN: ITS CONSTRUCTION AND USE.—IX.

By CHAS. A. PARKER.

Preparation of Oxygen and Hydrogen Gases.—(*Continued.*)

ASSUMING that a gas-stove will be employed as the source of heat, this should be turned down moderately low when first lighted, as it is undoubtedly best to start the action with a small amount of heat, than to commence with the burner turned full on, and then to lower the flame when the gas is coming off, as is usually done, for in the latter instance this rush of gas will not be found to diminish immediately upon the tap being turned. Soon after the heat has been applied to the retort, the gas will be heard bubbling through the water contained in the wash-bottle, but as it takes some little time for the atmospheric air to be entirely driven out, the operator should not expect the oxygen to issue immediately from the delivery tube; therefore, the gas should be allowed to run to waste for a few moments. If a mouldering match, which has been lit, and then blown out, is now held over the orifice of the outlet pipe of the wash-bottle, it will burst into flame if the gas is coming off in a sufficiently pure state for use, in which case the bag may be immediately connected with the wash-bottle. Before the bag is finally joined to the wash-bottle, it should be made quite soft and flexible by being gently warmed at the fire for a few moments, after which the tap is opened, and the bag rolled out perfectly flat from the thick end, in order to expel all the atmospheric air, the tap being again closed directly after.

Now place the bag on a higher level than the wash-bottle, in order to prevent the possibility of any water being forced into it by the rush of the gas, and then draw the tubing from the outlet tube of the wash-bottle, over the plug of the bag, which should be opened at the same moment. The bubbling in the wash-bottle will continue, and the bag will be seen to gradually swell, and if everything has been carefully adjusted, the evolution of the gas will continue steadily until the bag is little more than half full, when it generally slows down a little; but, by slightly raising the heat, the action will be resumed with all its former activity, until it has finally filled the bag. Fig. 55 clearly shows the arrangement of the apparatus for oxygen gas making. A is the retort, B the wash-bottle, C the bag, and D the gas-stove for supplying the heat.

It is desirable for the amount of heat to be carefully regulated, then there will be no fear of the tubes blowing off the retort. As soon as the bubbling ceases, it either signifies that the charge is spent, or that a little more heat is required to complete the evolution of the gas. In the former case, the bag should be full, which may be known by its distention; but in the latter instance the heat should be slightly increased, care being taken to see that the retort does not exceed a dull red heat.

When the bag is quite filled the apparatus may be deftly disconnected in the following order. First pull the rubber tubing off the plug of the bag, and then immediately close the tap of the latter and stand the bag up, after which the rubber tubing should be pulled off the delivery-tube of the retort and the latter removed from the fire, or the gas turned off.

It is important to remember that the tubing must always be detached from the delivery-tube of the retort before the latter is removed from the fire or the gas turned off. If this were not attended to, a vacuum would be created in the retort, causing the water to be drawn into the latter upon the red-hot mixture, where, being converted into steam, it would in all probability end in a blow-up. For the same reason it is advisable to disconnect the retort from the wash-bottle as soon as the oxygen has ceased to pass off; otherwise the water might be sucked up into the retort, where it would result in a miniature steam-explosion, as above stated. A mishap of this nature can, however, be avoided by placing an empty wash-bottle between the retort and the purifier, in which case a suck back would simply draw the water into the empty bottle, as it could go no further.

Sometimes the gas exhibits a tendency to come off rapidly and pass through the wash-bottle without being washed. When this is the case, a couple of ounces of ordinary table-salt to the pound of chlorate will be found to be of great service in steadying the flow of gas, and in this instance it will be best to use the chlorate in the form of powder.

Upon the retort being removed from the fire it should be placed aside in an upright position, until it has become sufficiently cool to be handled, when it may be washed out with several changes of hot water, and afterwards dried over a fire and put away ready for the next occasion. If preferred, the contents, which consist of chloride of potassium and black oxide of manganese, may be emptied into a basin, when the chloride can be dissolved out by means of a plentiful supply of water, but the manganese which will remain behind in the form of a black mud may be dried and used again time after time, as it suffers no change. The retort should always be cleaned out soon after use, as the residue would soon corrode it and cake it to the bottom in a rock-like mass, which is difficult to dislodge. The wash-bottle and the connecting-tubes should also be washed and dried, as the chlorine which comes over with the hydrogen will soon corrode them.

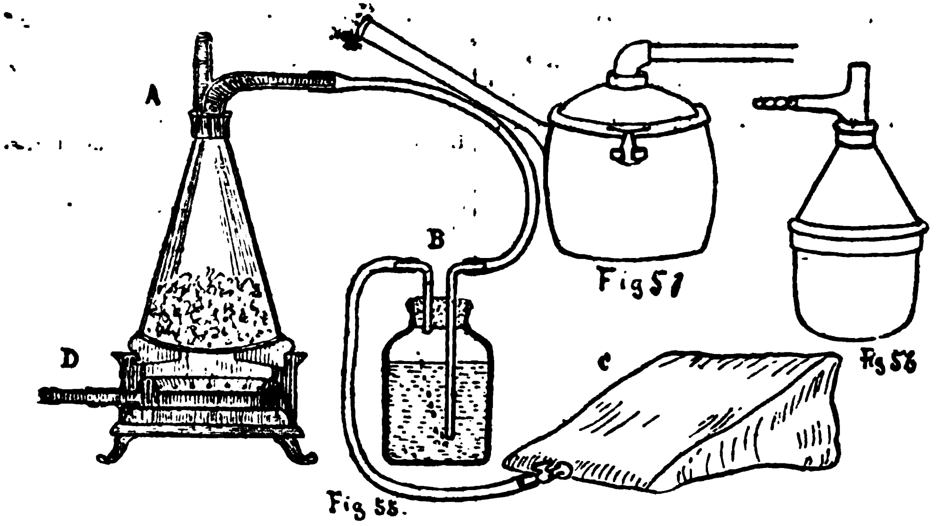
In order to guard against the possibility of an explosion by the admixture of organic matter with the black oxide of manganese, a great many operators prefer to heat the finely-powdered oxide to redness in a covered crucible, after which it is mixed with the chlorate when cool; or, if preferred, the chlorate of potash mixture may be tested in the following manner, before it is put into the retort: A small sample of the mixture should be introduced into a test-tube, which is then heated over a Bunsen or spirit flame. If the materials are pure the mixture will be seen to sparkle, and quietly and rapidly evolve the gas; but if any carbonaceous matter be present we shall have a miniature explosion, and the mixture should not be used on any account. Manganese is never intentionally adulterated, as it can be produced so cheap that it is not worth while to do so. The presence of foreign matter will be almost apparent to the eye if some of it is spread out upon a newspaper. And then, again, pure manganese is a peculiarly dense and heavy substance; but as a precaution a small quantity may be tested in the above manner, when its behaviour will soon indicate its purity. After use, the manganese may be washed and dried in the manner before directed, as a sample which has once been used with perfect safety must consequently be free from combustible matter, and this will be found a wise proceeding should it be difficult to obtain the manganese; but in an ordinary way it is scarcely worth the trouble, as this substance can be procured very cheaply in all towns.

Assuming that the chlorate of potash is pure, and the gas has been made with proper care, it should be possible to obtain about 9c.ft. of oxygen from 2lb. of chlorate. Correctly speaking, 10ft. is the quantity of gas that should be evolved from the above weight of mixture; but, from one cause or another, it is seldom possible to get more than about 9ft., owing to a certain amount of waste. The above quantity of gas should be sufficient to keep a blow-through jet alight for about two hours if carefully managed; but the same quantity, by careless manipulation, might be used up in a few minutes. Only about half this quantity of oxygen would be required with a mixed jet, as will be shown in a future article.

Ordinary commercial chlorate of potash is sufficiently pure for gas-making, provided that it is subjected to a close scrutiny in order to detect any chips of wood or straw with which it may have become contaminated. This is a necessary precaution, owing to the fact that the chlorate is sent out from the chemical works in large casks or barrels, splinters from which are apt to find their way among the crystals. English-made chlorate of potash, costing about 9d. per pound, will be found the best to use; there is a cheaper quality, but as this is of German make, it is consequently of inferior quality, and should therefore be avoided. The exact proportions of the chlorate and manganese need not be adhered to with any great degree of accuracy, as a slight variation will not seriously affect the evolution of the gas. But, at the same time, it is advisable to have sufficient manganese, otherwise the action will be too violent, and the delivery tube of the retort will be unable to carry off the gas as fast as it is generated; and then, again, if the manganese is in excess, the action will be exceedingly slow, requiring the heat to be raised frequently towards the end of the process.

In order to insure obtaining a good light, it is necessary that the gas shall be properly purified during its passage through the wash-bottle. In order to be certain of this, some operators very wisely pass it through two wash-bottles, whilst others still further dry it by passing the gas through a tube containing dry chloride of calcium, as experience would tend to show that it is not properly purified by its passage through one wash-bottle. It invariably happens that chlorine gas is liberated at the same time as the oxygen, and as the gas is particularly corrosive in its action on the gas-bags and brass fittings generally, it is advisable to neutralise it as much as possible. This may be effected to a great extent by means of a dessert-spoonful of carbonate of potash (salt of tartar) dissolved in the wash-bottle, or a small lump of caustic soda, or washing soda; or, failing these, a broken lime cylinder will answer the same purpose by changing the chlorine into chloride of lime. The presence of this gas is rendered apparent at once by its suffocating odour and irritating effect upon the throat. Excellent wash-bottles can be readily made by the operator himself by means of a wide-mouthed glass bottle or jar and a couple of suitable lengths of pewter tubing. These tubes should be firmly fixed into a good sound cock, which has been previously fitted to the bottle, and the inlet tube which reaches to within about an inch of the bottom of the bottle should have its lower end perforated with a half-dozen small holes, and the outlet tube, which may be 3in. or 4in. in length, should be left flush with the cork inside the bottle. The arrangement of the tubes will be clearly understood by reference to B, Fig. 55. A glass wash-bottle is always preferable to a zinc purifier, as the operator can determine at once the rate of evolution of the gas; besides which, a glass bottle is much easier to clean than a zinc vessel. Purifiers can be obtained from any lantern dealer at prices ranging from 2s. 6d. to 4s. 6d. for zinc or glass. An excellent glass-bottle purifier, with a brass screw cap, is sold by Mr. Place, of Birmingham, at the first-named price, or, if preferred, the operator can readily turn any wine or spirit-bottle into a purifier by means of a new arrangement of tubes which is furnished with an indiarubber cap, so that it may be fitted to any bottle. This is supplied by Mr. Tyler, of Waterloo-road, London, at 3s. 9d. each.

Turning now to the many retorts at present in the market, there is one of the safety pattern sold by Mr. Tyler which claims special attention. This is an iron retort of the ordinary conical form provided with a convex bottom; but its chief improvement lies in the neck, which is curved and of extra width in order to effectually prevent clogging. A safety-valve attached to the neck takes the form of a short length of tube fitted with a cork, which flies out whenever the pressure becomes too great. This form of retort is shown at A in Fig. 55. There are several other forms of safety retorts made by various firms, amongst which may be mentioned the excellent retort devised by Mr. Hughes, of Kingsland. Copper retorts in any form cannot be recommended, as they are very expensive, and not any more durable than iron. A great many operators entertain a great liking for cast-iron retorts, which are practically indestructible, and will last a lifetime with ordinary usage, although they cost about three times as much as a wrought-iron retort. The great drawback to their use is the extra thickness of the metal, which necessitates much more heat than an ordinary retort. Cast-iron retorts are now made of the form shown in Fig. 56, which can be unscrewed for cleaning purposes, and afterwards put together again in the reverse way for convenience in packing. They are also fitted with a branch pipe of brass and a large size safety-valve. Messrs. Cubley and Preston, of Sheffield, make up a cheap gas saucepan of the form shown in Fig. 57, which forms an excellent retort in every way. When charged the lid is fitted on with bayonet catches, after which a luting of white clay is spread round the joint in order to make it air-tight. These saucepans, which are not very expensive, range in price from 5s. for two-quart capacity, to 7s. 6d. for four-quart capacity. If either of the last-named retorts are employed they will not require to be washed out in the usual way, as the



residue which will be caked together in a solid mass can be broken by means of a few blows from a hammer, when it will come out readily. In cases of emergency an ordinary cast-iron household kettle will be found to make an excellent retort, provided that a piece of wood is tightly wedged between the handle and the lid in order to keep the latter from moving. When the mixture has been placed in the kettle the lid should be luted down with soft clay or white lead, after which it is securely wedged in position and the spout used as a delivery tube.

Ordinary coal-gas (carburetted hydrogen), as supplied to the household main in all large towns, will generally be found a convenient and economical source of hydrogen. It is seldom, however, that the gas can be used direct from the main, as the pressure or amount of force with which it impinges upon the lime is usually insufficient, rendering it necessary to fill a bag from the nearest gas-branch, and then use this in the ordinary way under pressure. When the hydrogen cannot be obtained in this way, the lanternist will have no alternative but to either make the gas himself, or purchase it ready prepared from the nearest dealer in lantern requisites. For the benefit of those readers who may be resident in country towns or villages in which it would be inconvenient, if not impossible, to obtain the ordinary coal-gas, it may be advisable to describe the process of preparing pure hydrogen for this purpose.

Hydrogen gas, which burns with a pale yellow flame, and gives out a most intense heat, is 14½ times lighter than air, and 16 times lighter than oxygen, 50c.in. of gas only weighing a grain. As this gas is one of the constituents of water, it can be readily obtained from the latter by decomposing this fluid with sulphuric acid and zinc. A handy and convenient hydrogen generator can be easily made from a large, wide-mouthed glass or stoneware bottle, which is first provided with a good round cork or bung, and afterwards fitted with a couple of glass or lead tubes, made to fit airtight into the cork, as shown in Fig. 58. One of these, which is called a safety funnel, takes the form of a long tube, ending in a small funnel at the upper portion, and the other tube, which is slightly curved, forms the exit for the gas, and is only three or four inches long. As the funnel serves as a means of supplying the zinc with the acidulated solution, it must descend to within about a couple of inches of the bottom, or so far into the liquid as to be completely covered by it. The other tube, which forms the outlet for the gas, should be so arranged as to be just flush with the cork on the inside, with the outer or curved end pointed away from the funnel.

When the hydrogen is to be generated, about ½lb. or more of granulated or scrap zinc cuttings should be introduced into the bottle, after which the cork, with the delivery tubes, should be replaced and tightly rammed home. The generator is now about three-parts filled with water, acidulated with sulphuric acid (about 1oz. acid to 6 or 7 of water), which is slowly poured down the funnel on to the zinc, and as the funnel reaches nearly to the bottom of the vessel, no gas can escape by this tube, consequently it finds an exit by the shorter length of tube. This tube is now connected by means of a suitable length of rubber tubing with the inlet pipe of an ordinary wash-bottle about three-parts filled with water, and arranged in the same manner as when making oxygen gas. The gas escapes immediately, and after a short time has been allowed for the atmospheric air to be driven off, the outlet or short pipe of the wash-bottle is connected with the plug of a gas-bag, the tap of which is turned on at the same moment. As soon as the process is complete the generator should be emptied of the residual solution, and afterwards swilled with clean water, ready for the next time. Any pieces of lump zinc which may be swilled out of the vessel should be saved for future use, but the black residuum is useless, and may be thrown away.

Before the bag is connected with the wash-bottle, it must be flattened out in every direction, or rolled up tightly, in order to effectually expel all the atmospheric air, and in disconnecting the apparatus, it is necessary to always close the taps of the bag first, and then immediately pluck off the delivery-tube of the wash-bottle. In order to tell when the gas is coming off sufficiently pure for use, it will be well to apply a light to the end of the delivery-tube from the wash-bottle, and if the gas inflames quietly, it may be at once joined to the bag. It is better to lose some of the gas than to make the connection too soon, as hydrogen when mixed with air forms a highly explosive mixture, and for this reason it will be found advisable to cover the delivery-tube of the burner with a piece of wire gauze bent in the form of a small cap when the gas is tested with a light, as this will insure safety from explosion. As a considerable degree of heat is evolved when the sulphuric acid is added to the water, it will be advisable to mix them together in an earthen pan a few hours before use, in order that they may be cool when poured into the vessel. Although this caution is necessary when a glass bottle is used for the generator, it will not be needful when an earthen vessel is employed, and in this instance the water may be poured through the funnel first, and then the acid in the requisite proportions; but the water should never be poured on to the acid, as this is dangerous.

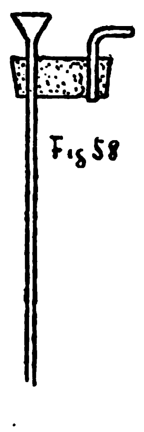


Fig 58

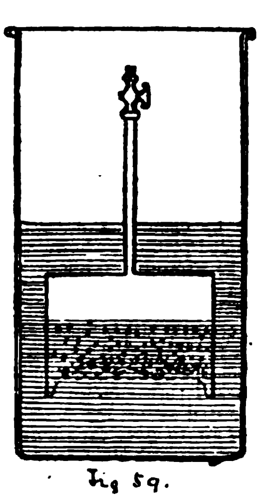


Fig 59.

An extremely useful and convenient form of hydrogen generator was introduced some years ago by Mr. Pumphrey, of Birmingham. This generator, which is shown in section in Fig. 59 is so arranged that when once it is charged it will work automatically, while the exhibition is in progress, thus dispensing with the use of a second bag, as the liquid itself affords the requisite amount of pressure. In appearance this generator takes the form of one outer containing vessel of copper measuring about 24in. by 18in., and within this is placed, in an inverted position, another smaller vessel closed at one end, and provided with a perforated metal shelf, which is situated just within the lower or open end, an upright delivery-tube with a tap attached being situated in the centre of the closed ends for the purpose of carrying off the gas as generated. To put the apparatus in action, a quantity of scrap zinc cuttings are put upon the metal shelf of the inner vessel, which is then placed inside the large one, against the side of which it is firmly wedged by means of a piece of wood, in order to prevent it from rising while the solution is being poured in. The outer containing vessel is now three-parts filled with water strongly acidulated with ordinary commercial sulphuric acid, and this fluid acting upon the zinc placed on the inner shelf, liberates hydrogen freely, which, rising into the upper or empty portion of the inner chamber, can be drawn off by means of the tap attached to the delivery-pipe, or if the gas is not required at once, it gradually fills this inner receptacle, and in so doing, forces out the fluid, thus leaving the zinc on the shelf high and dry, which consequently stops the action, until some of the gas is drawn off for use by the delivery pipe, when the shelf is again automatically lowered into the acid, and the action recommences with all its former activity. It will thus be seen that a constant supply of gas can always be obtained without the extra expense of a gas-bag, any desired degree of pressure being attained by simply regulating the quantity of water contained in the outer vessel.

(*To be continued.*)

CHEMISTRY FOR STUDENTS.—VI.

By John Mills.

Author of "Alternative Elementary Chemistry," &c.

In our last article we indicated how the main constituents of the atmosphere may be recognised, and their amounts, approximately at least, experimentally determined. We are satisfied, too, that the acquisition of a knowledge of the medium in which we move and live, and a practical acquaintance with the chemical properties of the common things around us, is the best thing to do in order to lay a secure foundation for a sound education in chemical science. By this method of procedure the student will subsequently face the purely theoretical details with far more hopes of success than would be possible in case we entered at once upon a discussion of atoms, molecules, chemical equations, and the like. We will, therefore, reserve the treatment of these matters till later on, and for the present proceed with an account of the

Effects of Animal and Vegetable Life upon the Atmosphere.

In the process of breathing we are constantly introducing—*inspiring*—fresh air into our lungs, and we are in the habit of eliminating—*respiring*—with equal regularity bad or noxious air from the same organs. The changes which the air undergoes in respiration form an instructive study for the young chemist, and a knowledge of the results of researches on this subject is of importance to the preservation of health. The lungs consist of a series of tubes which ramify, or branch, the terminals of these branches forming air-sacks, the walls of which are penetrated by a net-work of small blood-vessels. The air in the sacs is thus separated from the blood by a thin and moist membrane only. Communication between the sacs and the external air is afforded by the *bronchi* and *trachea* (windpipe), and the oxygen of the air, when inspired, is absorbed by the moist membrane, and so becomes diffused in the blood; while at the next expiration, carbon dioxide, formed by the union of oxygen with carbon contained in the animal system, passes from the blood into the lungs, and thence into the external atmosphere, a mutual exchange of oxygen and carbon dioxide being thus effected.

The blood, having undergone this process, is said to be *aerated*, and is again ready to be propelled through the vascular system, in order that the oxygen may effect a further formation of new compounds with the tissues of the body. Oxygen is the life-supporting element, and this gas is brought into contact with the internal juices of the animal system by the alternate expansion and contraction of the chest walls. The chemical changes thus brought about during respiration were not properly understood before the time of Lavoisier, although Mayow in the seventeenth century pointed out that oxygen was absorbed from the air in the process of breathing, and Black in the eighteenth century recognised that another substance was eliminated during the same operation. Lavoisier perceived that the changes referred to were in reality due to the combustion of carbon contained in the body, and that the so-called "animal heat" was maintained by a process of chemical combination similar in character to that which occurs when carbon burns in oxygen. The latter gas, therefore, is just as necessary for the life of animals as it is for the burning of a candle or coal-gas.

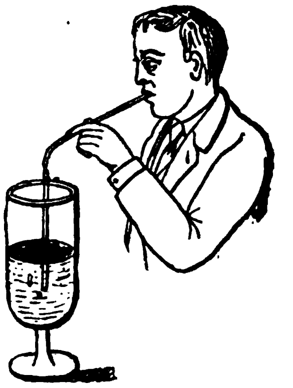


FIG. 43.

Put some lime water in a test-glass, and blow air from the lungs through the liquid by means of a glass tube, as indicated in Fig. 43. It will soon be seen that the lime water becomes turbid, thus showing clearly that something has passed from the lungs which is not contained in ordinary air in sufficient quantity to produce a like effect. The turbidity or milkiness is due to the formation of finely divided chalk, and is characteristic of the combination of lime with carbon dioxide. That no such change as that just referred to takes place with ordinary air may be conclusively demonstrated by an arrangement of apparatus devised by Faraday. The flasks A and B, Fig. 44, each contain lime-water. By sucking through the indiarubber tube shown, air may be drawn through the liquid in flask A, but no turbidity will occur. Now blow through the liquid in flask B by applying the mouth to the indiarubber tube. The lime-water in flask B will thus become milky, owing to the carbon dioxide contained in the breath acting chemically on the lime in the lime-water.

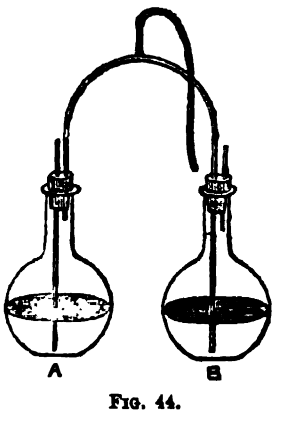


FIG. 44.

The process of respiration, then, must be regarded as an act of oxidation comparable to that which takes place when iron rusts; certainly no flame results, but the whole body is maintained at a temperature considerably above that of the inanimate objects around us, yet the lifeless body turns as cold as marble. The human body has been compared to a furnace, and the heat given out by the union of its carbon with oxygen is just the same as that eliminated by the burning in oxygen of an equal weight of carbon obtained from a piece of wood or coal.

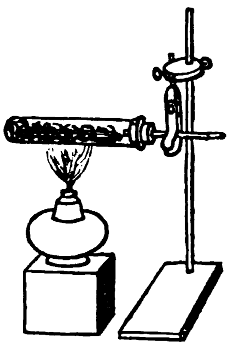


FIG. 45.

We may readily satisfy ourselves that carbon is a constituent of the animal system by means of the apparatus represented in Fig. 45. Introduce a bone or some pieces of flesh into a test-tube provided with a cork and exit tube, and apply heat as indicated. In this way water and other substances will be driven off, while a charred mass, consisting of carbon, remains behind. Carbon obtained in this way will remain unchanged in the air at the ordinary temperature for any length of time; but if the carbon be heated even slightly, slow oxidation takes place. This fact may be verified in the following way:—Allow water to flow into a basin by opening the screw clip attached to a tabulated bottle as shown in Fig. 46. Air will thus be aspirated through the flasks A and B, which contain lime-water, as well as over a piece of charcoal in the horizontal tube. No change will occur in either flask. Now heat the carbon while the air is still passing over it, when it will be seen that almost immediately the lime-water in flask B becomes turbid, thus indicating that the heated carbon has combined with the oxygen of the air to form carbon dioxide.

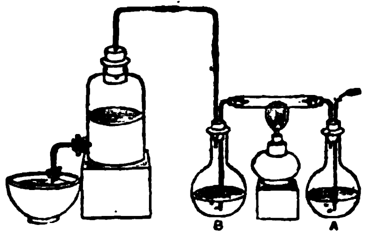


FIG. 46.

That expired air differs in composition from atmospheric air may be determined by analysis; thus, if a strong solution of *caustic potash* be introduced into a graduated tube closed at one end, filled with dry expired air, and standing over a trough of mercury, the carbon dioxide present will be rapidly absorbed, and the diminution in volume will represent the proportion of carbonic acid present. By now adding a concentrated solution of *pyrogallic acid* to the potash, the oxygen will be quickly imbibed, the volume again diminishing corresponding with the amount of oxygen present, the residue being nitrogen. In this way expired air is found to contain three to five volumes of carbonic acid in 100 volumes; but when respiration is very deep, the percentage of carbonic acid may be as much as eight or nine volumes. While, therefore, the amount of pure oxygen in air is diminished by contact with the blood in the lungs to the extent of some 20 per cent., the amount of carbonic acid is increased enormously. In all probability the oxygen taken into the lungs is absorbed in the arterial blood and conveyed through the body by the smaller vessels, so that in its passage products of oxidation or combustion are formed, among which is carbonic acid. The latter gas, therefore, may be supposed to take the place of this used-up oxygen, or the two gases mutually displace each other.

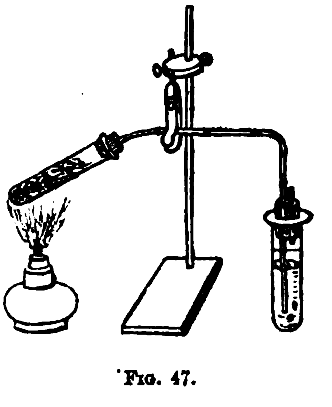


FIG. 47.

The effect of respiration on the air, if the latter be imperfectly renewed, is such as to cause great discomfort in a space in which many persons breathe. Even one per cent. of carbonic acid in the air produces uneasiness, and a proper ventilation of apartments in which people live is imperative. Instances of disastrous results produced by the accumulation of carbonic acid during respiration are not wanting, to wit, the confinement of the unfortunate prisoners confined for one night in the Black Hole at Calcutta. A person might live much longer, and with greater comfort, in a close place if a few pounds of slaked lime were introduced. The carbonic acid being thus absorbed by the lime, its injurious effects would, to some extent at least, be avoided.

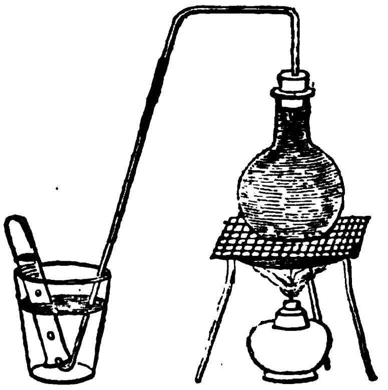


FIG. 48.

We have seen that ordinary articles of food contain carbon, and we will now indicate how the production of carbon dioxide from these materials may be illustrated. The oxygen necessary for the oxidation of the carbon can be supplied by a substance which readily gives up its oxygen to other oxidisable substances. Thus, mix some pieces of bread, cheese, or flesh with *black oxide of copper*, and place the mixture in a test-tube provided with a cork and delivery tube, the latter being arranged so as to dip in lime-water in another test-tube, as shown in Fig. 47. On heating the tube containing the bread, &c., the carbon in these food stuffs will unite with some of the oxygen liberated from the copper oxide, and the turbidity caused in the lime-water furnishes evidence that the evolved gas is carbonic acid. There is, of course, a constant waste going on in the animal system during life, and to compensate for the loss thus sustained, food containing carbon, &c., must be provided.

We have previously alluded to the fact that when air in a bottle is shaken up with a little water, some of it is dissolved by the liquid named. In fact, natural waters all contain air in solution; but the gases—*oxygen* and *nitrogen*—when expelled from the water, and subjected to analysis, are found to exist together in the relative proportion of 1 : 1·9. From this it will be seen that there is a greater percentage of oxygen in dissolved air than is the case in ordinary air. Fill a small flask with water, attach a cork and delivery-tube, as indicated in Fig. 48; heat the water to boiling, and continue the ebullition for some time—say, half an hour. In this way the dissolved air is liberated from the water, and may be collected in a test-tube in the ordinary way, as shown. The air thus held in solution in water is the source from which fishes derive the oxygen required to maintain life. These animals appear to be constantly swallowing water, but in reality they merely force the liquid over their *gills*, and so bring the dissolved air in contact with those organs, which are equivalent to the lungs of more highly developed animals.

Assimilation of Carbon Dioxide by Plants.

It will be seen that by the combustion of coal, wood, and the like, and by the oxidation of the tissues of animals, carbon dioxide is being continually passed into the atmosphere. Moreover, large volumes of this gas are emitted into the air from subterranean sources, the amount of carbon dioxide which thus finds its way into the air being estimated to exceed by far that produced from all other sources combined. It is plain, therefore, that if no means existed for counteracting the deleterious effect thus brought about, it would in time render the atmosphere unfit for inhalation. Fortunately, however, plants possess the remarkable power of decomposing carbon dioxide. Their green portions, under the influence of sunlight, resolve the gas into its constituent parts, *carbon* and *oxygen*, and retain the carbon as food, while the oxygen is liberated and escapes into the air.

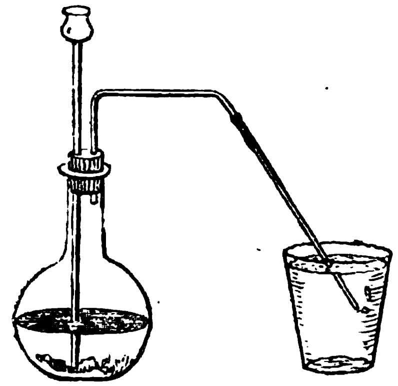


Fig. 49.

We may illustrate the decomposition of carbon dioxide by plants in the following way: —Nearly fill a large tumbler with water, and saturate the latter with carbonic acid gas. To do this, put a few small lumps of marble in a flask, cover with water, and add a small quantity of stong hydrochloric acid. On attaching a cork and delivery-tube, and allowing the latter to dip in the water in the tumbler (Fig. 49), some of the evolved carbon dioxide will dissolve. Now place a bunch of water-cresses in the water under a funnel, and over the end of the latter invert a test-tube filled with water, Fig 50. On placing the apparatus in bright sunlight for some hours; a colourless gas will collect in the test-tube, and on testing the gas it will be found to be oxygen. That sunlight is essential to effect the change referred to may be demonstrated by trying the experiment in some dark place; no escape of oxygen will in this case be noticed, even after the elapse of several days.

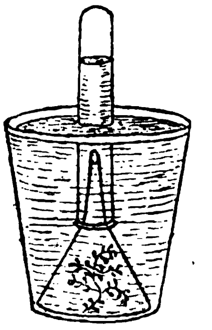


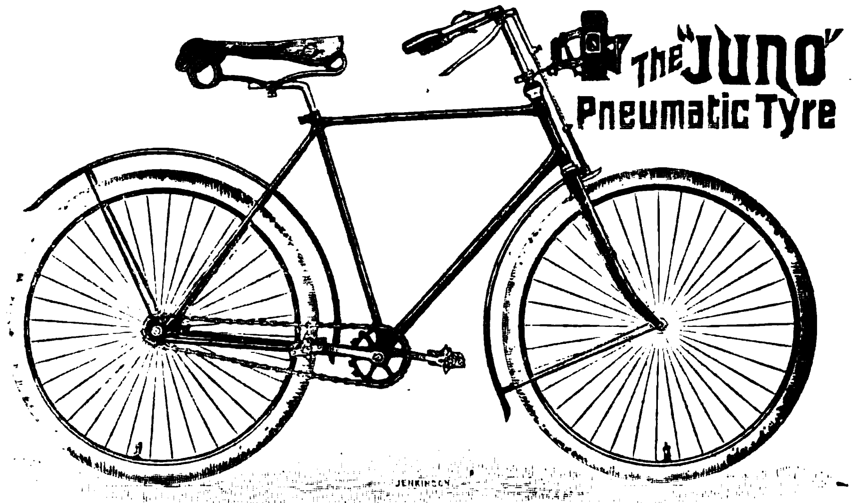
Fig. 50.

In animal and vegetable life we observe that the former live on organised materials, while plants derive their sustenance from unorganised matter. In the process of respiration, the tissues of animals undergo oxidation, while plants under like circumstances during sunlight, reduce or decompose such bodies as carbon dioxide, water, and ammonia. Since plants depend upon the small percentage of carbon dioxide in the air for all the carbon in their tissues, and animals can only assimilate carbon already elaborated for them by plants, it will be seen that all organised bodies depend upon the carbon dioxide in the air for the carbon they contain. How important this gas is may be inferred from the fact that coal, which is consumed in immense quantities is a product of plant lite, and is therefore derived indirectly from the atmosphere.

(*To be continued.*)

JUNO CYCLES.

THE engraving gives a representation of one of the latest or 1892 pattern of the favourably-known Juno machines. The makers are the Metropolitan Machinists' Co. On reference to the Company's 1890 price list, and turning to the Juno Safety No. 12 of that year, we shall find what is really the germ of the above machine, which is its development. That machine of 1890 at once met with much favour, and the form of frame grew steadily in popular estimation during 1890 and 1891, and now it has been very generally adopted. The Juno shown above is built on the same "straight lines"—there is not a curve anywhere in the frame. The base is somewhat prolonged, so that the rider finds himself in the rear of his work, and in the position which has been found most suitable for long-distance riding. Roller chain and hammock saddle complete the leading details. Several other new types of "Juno" for 1892 are also included in the Metropolitan Co.'s models, including a semi-diamond fitted with pneumatic tires, and two or three light roadsters of new designs. Junos are fitted with Dunlop, Clincher, Boothroyd, or Silvertown pneumatic tires, with cushions, or with solid rubbers, according to the expressed wish of the purchaser.



TESLA'S EXPERIMENTS IN ELECTRIC LIGHTING.

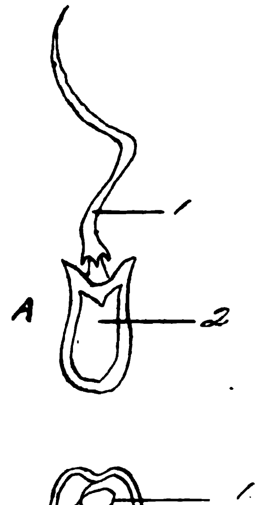
THE remarkable experiments in a new system of electric lighting shown by Mr. Nikola Tesla at the Royal Institution last week seem to have astonished those who do not keep themselves abreast of the progress of the science of electricity. Mr. Tesla performed some of his more interesting experiments before the Institute of Electrical Engineers in New York some months ago, and the news of his achievements led to a pressing invitation being sent to him from this country. Our readers will remember that on July 24 last we gave an illustrated description of Mr. Tesla's system, which gives incandescent lamps without return current and light by condenser discharge. The chronological order of development, omitting details, may be stated to be Geissler tubes, Crookes's "bombardment," and Tesla's remarkable discovery of the effects to be produced by a very high potential and excessively short period.

In commencing his lecture, Mr. Tesla referred to the work of Mr. Crookes, which he said had given a bent to his studies while at college, and induced him during the last two or three years to make those researches which have so far led to discoveries which are obviously of the greatest importance. In his investigations, Mr. Tesla found that a frequency as low as 15,000 to 20,000 per second, and a potential of 20,000 volts would give some remarkable results; but he also found that both frequency and potential may be enormously increased,—the practical limits being determined by the character of the apparatus, and its capability of standing the strain. Mr. Tesla's alternating generator consists of a stationary armature, about 30in. in diameter, having 380 coils projecting inwards. A thin disc of iron, with 380 little magnets connected in series, driven by a motor at about 2,000 revolutions, generates a current of 13,000, or more, periods per second,—indeed, more are needed for the production of some of the phenomena. The current obtained is sent through the primary of an induction coil of peculiar form, the primary being outside the secondary and insulated by oil. The potential is by this means raised to something estimated at about a million volts. In the circuit of the secondary coil there is also a battery of Leyden jars, which produce a frequency of almost inconceivable rapidity. The use of oil is necessary, as Mr. Tesla is convinced that a solid dielectric cannot be used, and the most perfect insulation is an absolute necessity. With the aid of the article above referred to a sufficient idea of the apparatus can be obtained, but the experiments must be seen to be appreciated. For instance, taking in one hand an exhausted tube 4ft. long, and connecting the other hand with one terminal of a coil, the tube immediately glowed with a brilliant luminosity, the light being sufficient to enable the spectators to see the experimenter and his assistants when the gas was turned down. It must be understood that there was no metallic circuit, but the few particles of air left in the exhausted tube glowed by the effects of the molecular bombardment. The theory is at present that in consequence of the enormously high frequency, together with the very high potential, the "current" can pass through the human frame without injuring the tissues. Another remarkable experiment consists in joining two sheets of tinfoil, one over the lecturer's head the other on the table, to the poles of his generator. The space between these two sheets immediately became electrified, and a long vacuum tube waved about in it, without attachment to any conductor whatever, glowed in the darkness like a flaming sword. This experiment was intended to illustrate the possibility of rendering an entire room so electric, by plates in the ceiling or under the floor, that vacuum bulbs placed anywhere within it would yield a light. The experiment was modified by placing a large zinc plate about 10ft. from the floor, and another on the floor, and connecting them respectively to the terminals or poles of the coil. The whole air between them became apparently intensely electrified, and an exhausted tube passed between the plates became luminous, and the vacuum lamps of Mr. Tesla's design, which contain a button of carbon attached to a wire (see July 24, 1891), glowed brilliantly without having any connection of a metallic or other substance. In another experiment, Mr. Tesla connected a variety of vacuum tubes containing small discs of metal, and even non-conductors, such as aluminium, lime, or carbon, to one pole of the coil, and produced some beautiful effects. In the midst of a luminous haze, due to the residual gas in the tube, the disc of solid matter became brightly incandescent, and yielded a comparatively powerful light, which became brighter when he brought his bare hand close to the bulb, and brighter still when he placed over the bulb an ordinary shade of metal. Extremely beautiful effects of phosphorescence were also produced by touching one wire from the generator and holding a bulb containing the phosphorescent material, such as yttrium, sulphate of zinc, and artificial diamond. The sulphate of zinc in particular gave a magnificent green glow altogether surpassing the phosphorescence phenomena producible in the ordinary way. But experiments must be seen to be appreciated, and though the effects produced by Mr. Tesla have occupied the attention of electricians for some months both in America and this country, they have not yet been explained. It is evident that an important discovery has been made, and numerous workers will investigate the phenomena wherever suitable appliances are available.

PRACTICAL MICROSCOPY FOR STUDENTS.—XIX.

By Frederick Davis, B.Sc., Associate of the Pharmaceutical Society, &c.

In examining the subdivision known as Cœlenterata, we have to deal with the Hydra and Actinia. The hydra may be found in most of our ponds and rivers, whilst the actinozoa are essentially sea inhabitors. If we take a piece of duckweed, and observe closely any little particles which may be attached to its surface, we probably shall find little gelatinous bodies other than the animals studied in our previous chapter, to which we gave the name of vorticella. The hydra to a degree resembles the vorticella, but is of a higher type of organisation.



Thread Cells.

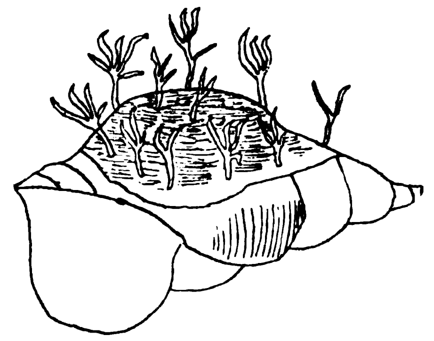
A.—1, Cnida everted; 2, Capsule.

B.—Closed Thread Cell.

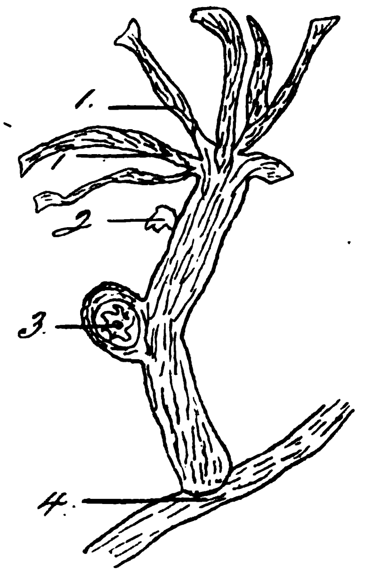
1, Undisturbed thread; 2, Thread cell.

It may be considered to be a mass of amœba arranged in a definite manner, forming an outer layer or "ectoderm," and an inner layer termed the "endoderm." The base of the hydra or polype is attached to some form of water vegetation, or, maybe, shell, such as the freshwater mussel, and extending from this base or foot we have a number of arms or tentacles waving about and oscillating according to the strength of the current in which they exist; or the tentacles may be drawn in upon themselves, and for a time be apparently at rest.

Our old naturalists were at a loss to know whether the hydra was really a plant or animal; but it has now been decided that it is indeed an animal—in fact, the student will arrive at the same conclusion as we proceed with its description and the general mode of life. Plants, we know, absorb nourishment by the roots, the portion corresponding to the base or foot of the hydra; but the hydra does not do this. Its nourishment must be of a proteid character, ready formed, and is received or caught by the ends of the tentacles, and then carried down into its central cavity, termed the stomach. To look at the hydra we might imagine it to be anything but powerful; yet we find it capable of catching, holding, and eventually devouring, inhabitants of the water ten, and even twenty, times the size of itself. It becomes only natural to ask: How is this? The answer is found in the fact that the polype is provided with thread-like cells, called cnidæ, capable of paralysing the smaller animals with which it is likely to come in contact, and thus, by passing a kind of electric current through these animals, they at once become quiescent, and remain in their grasp. The tentacles of the hydra appear to be merely blind filaments—that is, they have no specific opening, their duty apparently being to catch the food and convey it to the body cavity or stomach, the position of which is in the centre of the body or foot at the base of the tentacles.



Hydræ Existing on Shell.

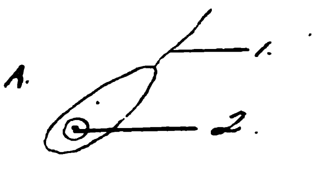


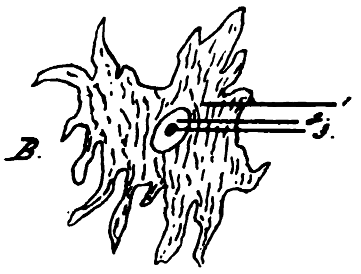
Hydra Viridis.
1, Tentacles; 2, Testas; 3, Ovary; 4, Foot.

The hydra is possessed of great tenacity of life; we may cut it into any number of pieces, and yet every one of these pieces will grow and develop into a perfect hydra. We have two principal forms of Hydrozoa in our ponds, the one termed Hydra fusca, the other Hydra viridis. They take their names respectively from the fact that in the one case the body cavity is filled with a brownish-colouring substance, and in the other with green colouring matter. Both forms are possessed of chlorophyll grains, but for what purpose this exists is unknown.

The hydra propagates by two methods, the most general being the process known as gemmation, or budding; the other "gamogenesis," that is by fertilised ova. The former method occurs during the summer, and the latter during the autumn. If the student would like to observe the process, let him obtain a well-fed hydra, and keep it in a wineglass in *slightly* tepid water; in a very short time he will see, with the aid of the one-inch objective, little excrescences occur in the cells of the "ectoderm," and these continuing to enlarge, will ultimately form the young hydra, which may either remain attached to its parent, or a constriction occurs, with the result that it becomes detached, floats away, and sets up in life upon its own account.

The student may observe the whole process by occasionally removing the polype from the wineglass by a pipette, and placing it upon the glass of the instrument known as the live-box, generally supplied with all good microscopes. The size of the hydra is seldom more than half an inch in length—indeed, more frequently we find it about one-eighth of an inch only. We spoke of the two layers, the ectoderm and endoderm; now between these layers we find a muscular layer, assumed to be arranged in both a transverse and longitudinal manner, or else how, indeed, would it be possible for the animal at one time to elongate itself, and, at another, to shorten itself? We cannot actually detect the two layers of this muscular intervening coat, even by the aid of the most powerful lens, but common-sense would dictate this most probable inference. The consideration of this muscular coat brings us to the power of locomotion possessed by the hydra. If it were a plant, we could understand its remaining stationary or, at least, in one place. But the hydra has greater ambitions than this. Occasionally it detaches itself from the weed, stone, or shell which it previously favoured with its presence, and swims away—

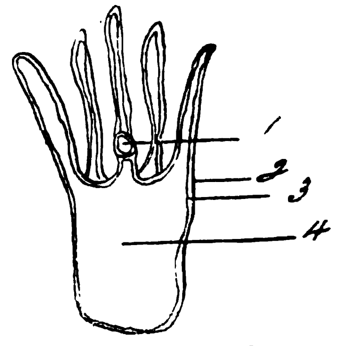




Ripe Ovum of Hydra Viridis.
B.—1, Vitellus; 2, Germinal vesicle; 3, Germinal spot.

Endoderm Cells.

A.—1, Cilium; 2, Nucleus.



Longitudinal Section of Hydra.
1, Mouth; 2, Ectoderm; 3, Endoderm; 4, Body cavity.

that is, it extends its foot or base above the surface of the water, and this, rapidly becoming dry, acts as a kind of float, and is blown by the wind, or carried away by the current of the river, in any direction, the motion of the inverted tentacles acting as a kind of rudder. But this is not its only method of changing its position. A second plan is that of proceeding much in the same manner as the common leech—namely, a series of somersaults, attaching itself to any object first by its foot, and then by its tentacles. A third plan consists in holding on to any floating particle of weed, &c., by its mouth or tentacles, detaching its foot from its previous position, and being supported whithersoever the floating particle may carry it.

The hydra appears to possess no actual organs for the digestion of the particles of proteid matter which it catches, yet that it does digest them is an established fact. It would appear, however, the cells of the endoderm are constantly secreting a viscid substance which has the power of digesting all the substance which is of any service to the animal; the remaining unabsorbed portion is then disgorged by way of the mouth.

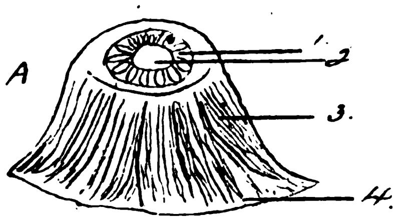
The hydra has no anus, excepting that improvised for itself, which occasionally is a matter of compulsion, from the fact that it swallows hard shells, &c., which are valueless to it, and which it cannot disgorge by way of its mouth; it then becomes imperative that an anus be improvised.

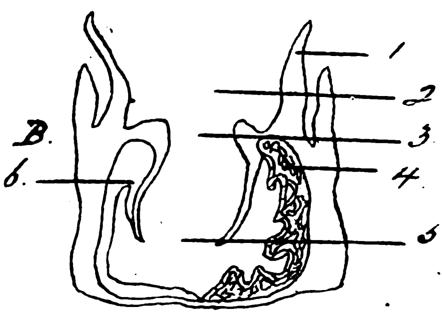
If we keep a number of hydræ in an aquarium for a time and observe their character, we shall find them most pugnacious—that is, as far as appetite is concerned. One, indeed, will endeavour to devour the other, with the result that the weaker is entirely swallowed by its opponent, or that in the struggle probably a portion of its body or tentacles meets the same fate. However, little notice appears to be taken of such a mishap: the defeated one merely perfects itself by growth, and all this apparently without the least pain. Many times, when keeping them, I have carefully turned the body portion inside out,—that is, the ectoderm inside, and the endoderm outside. The polype then simply proceeds to adapt itself to existing circumstances, by also reversing its tentacles, and goes on feeding in the ordinary manner. Such a method of adaptation is, to say the least, very convenient. The cells of the ectoderm are well supplied with thread cells, which give rise to the nematocysts, and are smaller than those of the endoderm, which are large, and as well as giving rise to nematocysts. With regard to the propagation of the hydra by sexual means, we find the sperm-cells are developed upon the ectoderm, about the bases of the tentacles, which, when ripe, drop off, and swim about in the water, being provided with cilia for this purpose. The ova are also developed by the cells from the ectoderm, and in their turn, when ripe, and after fecundation, take to the water; but previous to this, each ovum envelops itself in a covering of chitin, a hardened membrane developed by the protoplasm.

Each ovum is possessed of a germinal spot, like other animal ova. The ovum, after it has taken to the water, falls into the mud and there remains until such time as by favoured circumstances it is capable of producing the young hydra, which, being supplied with cilia, swims about, develops tentacles, and eventually occupies the same positions as its parent. In concluding these remarks upon the "hydra," we may add, it is possessed of a high state of irritability; but why this is the case we know not, seeing that all investigators hitherto have failed to find any evidence of a nervous system; it may therefore be sufficient to say, as a very poor explanation indeed, that each "cell is capable of conveying a stimulus."

The next subject for study is the "Actinia." This animal really represents the division of the "Cœlenterata," which are to be found in the sea only. Frequently after a storm or heavy sea, the student may find upon the coasts or shore, conical-shaped bodies, beaten about by the waves and tumbling here and there, resembling pieces of flesh, these are the "actinia," or "sea-anemone." If the student is not fortunate enough to be upon the shore after a storm he may find the actinia fixed by its foot or base to the rocks, as the tide recedes. Now, if he takes one of these lumps of flesh and places it in a pail or aquarium containing sea-water, he will shortly observe at the apex of the cone a slight excrescence. This will slowly extend itself, and eventually he will observe one of the most beautiful sights possible to imagine. I mean the glorious hues of the extended tentacles varying in colour according to the variety he has been fortunate enough to capture. The name of the most common actinia is *Actinia mesembryanthemum*, and this animal, with so long a scientific appellation may be found on all parts of our coast.

It is a curious fact that the actinia, with its tentacles spread, much resembles an ordinary Compositæ flower, although I think in justice to the actinia, it should be mentioned, as far as beauty is concerned, it holds the premier position.





A.—Actinia Closed.

1, Disc; 2, Mouth; 3, Column; 4, Foot.

B.—Section of Actinia.

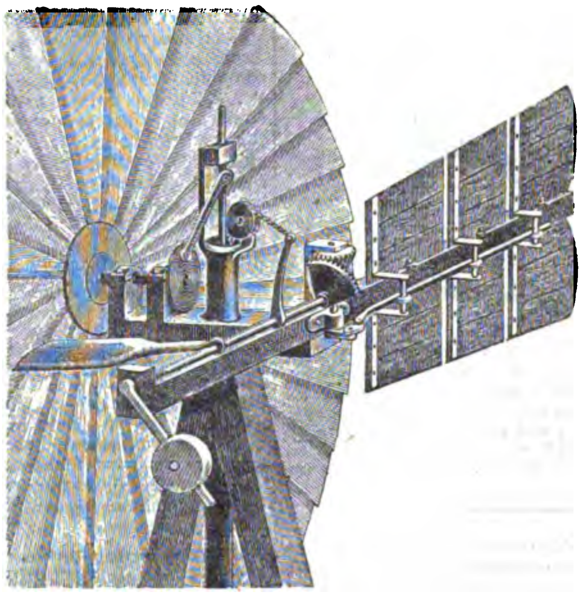
1, Tentacles; 2, Cavity between; 3, Mouth; 4, Bands where sperm-cells or ova are developed; 5, Somatic cavity; 6, Mesenteries.

The actinia is very hardy. It appears to be able to bear almost anything excepting placing in fresh water, which immediately kills it. If, therefore, the student wishes to examine the anatomy of the animal, let him place the specimen in fresh water for a few minutes. He may then cut sections and examine with the lens in the ordinary manner. He will find in many respects it may be compared with the hydra. We observe the ectoderm outside, the muscular layer between, and the endoderm or internal layer. We have also, in the same relative positions, cilia and thread cells, which, as we found, give rise to the cnidæ or nematocysts. The muscular power of the actinia is very great indeed as compared with its size, even more so than that of the hydra.

I have seen, upon more occasions than one, a huge prawn approach a comparatively small actinia, with the result that the moment a portion of its anatomy touches the actinia the shrimp appears to be paralysed; the actinia forthwith extends its tentacles, seizes the shrimp, and conveys its body to the somatic or belly cavity. This paralysing effect is, as in the hydra, due to the action of the cnidæ. The muscular power of the anemone may, however, be tested by placing upon its body a weight of about three or four pounds. It will be found the body will gradually expand and remove the weight in much the same manner as is the case with cheese larvæ. We find these little things capable of removing pieces of cheese very much larger than themselves. In all other respects but one we find the actinia resembles the hydra; this is, that the actinia is bisexual, the hydra being hermaphrodite. The actinia develops the sperm-cells, or ova, as the case may be, according to its sex, upon the bands found upon the faces of the mesenteries. With regard to the presence of a nervous system in the actinia, hitherto nothing is actually known; naturalists have not succeeded in finding such a system, and the most powerful microscope we have cannot detect anything resembling a nervous system; yet such a system must exist, or why the sensibility to light shown by the animal?—even a passing cloud will cause the tentacles to be retracted. Let the student endeavour to solve this problem.

AN IMPROVED WINDMILL.

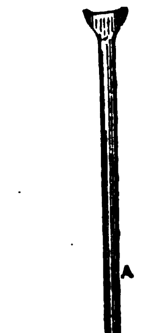
The illustration represents a windmill in which the vane is designed to throw the wheel out in a moderate wind or in a gale, as desired, the turn-table being carefully balanced upon the tower, and the parts of the mill made so light and perfect in action, that it can be stopped or started with very slight effort. The improvement has been patented by Mr. Frank H. Evarts, of Arlington, Kansas. The turn-table has two opposite horizontal arms, and a vertical tubular extension, above which is supported a guide-strap in which the pump rod moves, connected with the wheel shaft by the usual crank disc and pitman. Upon the other end of the turn-table arm, opposite the wind-wheel, is secured the body bar of the vane, the end of which extends beyond the edge of the wind-wheel, and on this portion of the vane are pivoted vertical plates, which may be separated and made to stand at a right angle to the axis of the stem, or closed, to stand parallel with it. Each blade has on its outer face a yoke, all of the yokes being connected with a pitman, and the latter is connected by a link with a horizontal crank arm on the lower end of a short shaft, journalled in the body bar, the upper end of this shaft having a bevel pinion meshing with a segmental bevel gear on a line shaft journalled on the stem or body-bar. On the outer end of this shaft is an arm, on which is held an adjustable weight, a fan being also secured to the shaft, and a curved arm, a chain or cable attached to the upper



end of the latter leading over a guide pulley, and down through the tubular casting of the turn-table, to within convenient reach of the operator, affording means for stopping or starting the windmill, or throwing the wheel into or out of the wind. When the blades on the vane are closed, the fan assumes a position at one side of the wheel shaft, as shown, and presents its full face to the wind when the edge of the wheel is so presented; but when the blades are open, the fan is in a vertical position. When the cable is loosened at its lower end, the weight turns the line shaft, and brings the fan to vertical position, and the wheel is swung into position to be driven by the wind. The weight may be so adjusted so as to require a moderate or a high wind to blow the fan down to a horizontal position, when the wheel will be swung around so as to present its edge, and the mill will be stopped. If the wind has not sufficient force to blow the fan entirely down, only partially closing the blades, the speed of the wheel will be slackened, but it will not be stopped.—*Scientific American.*

HANDY BOLT-HOLDER.

THE illustration shows a handy bolt-holder which Mr. Lewark, of Herbst, Ill., U.S.A., says is one of the best he has seen, and accordingly forwards a description to the *Blacksmith and Wheelwright.* Mr. Lewark says: "I have not found a bolt that I could not hold from turning. I believe it to be worth five dollars to a shop. I first take a piece of ⅝in. round rod steel, 2ft. long (shown at A in the cut), and make it sharp at one end, and temper. The other end I swell and make cup-shape. I then make the eyes, B, one of which goes on the rod and the other on the hook. I then take a piece of steel and make it T-shape, flatten out one end, as shown at E, to keep from bruising the wood, and turn down the other end as at D, to catch on the side of what you are working, or catch the head of the bolt. The end C should be tempered thin, and should be 6in. or 7in. long, with a hook so as to hook on to the eye. To use it, throw the hook over what you are working on and put the point of steel rod against the head of the bolt, and slide the eye up the rod so as to make it tight and then bear down. The eye will not slip on the rod, and the chisel will cut in the side of the head of the bolt as you turn it. Then it cannot slip, and something must give. I have twisted bolts off when taps would not give. On some bolts use the cupped end, as you can change the hook."



Last year the Metropolitan Railway Company carried 87,729,719 passengers, or nearly three and a half millions more than the previous year, while that had overtopped 1889 by a million and a half.

Since 1878 the yearly number of passengers carried in tramway cars in the United Kingdom has increased from 146,000,000 to nearly 566,000,000 There were only 269 miles of tramway lines open in all the United Kingdom in 1878. There are now 983 miles open. Of this length of tramway line about 256 miles are under local authorities, the rest belonging to private companies. Detailed information on this subject is contained in a Parliamentary return on tramways issued on Thursday.

SCIENTIFIC NEWS.

IT appears that the new star in Auriga had been photographed at Harvard in December, for Prof. Pickering's telegram circulated through the "Centralstelle für Astronomische Telegramme," Kiel, states that Copeland's Nova was bright on a photograph taken Dec. 10, faint on Dec. 1, and at a maximum on Dec. 20. Spectrum is described as "unique." The Astronomer Royal says that it will thus appear that Prof. Pickering had photographed the new star on the three dates named in the course of the photographic mapping of stars and their spectra which he is carrying out at Harvard College Observatory, U.S.A., with the aid of funds provided as a memorial to Dr. H. Draper, and that thus a photographic record of this star has fortunately been obtained two months before its recognition as a new star.

The *Edinburgh Circular*, No. 22, says that the star was easily found with an opera-glass, and when examined was immediately seen to possess a spectrum very like that of the Nova of 1866. The place for 1892·0 is R.A. 5h. 25m. 3s., N. Dec. 30° 21′. It does not occur on the Bonn maps. Dr. Huggins, who received an early telegram, says that the most noticeable feature of the new star's spectrum—common also to the stars of 1866 and 1876—was the very great brilliancy of the red, green, and blue lines of hydrogen. The reality of these lines was made certain by comparison with the corresponding lines of terrestrial hydrogen. The bright double line of sodium was conspicuous, and its nature confirmed by comparison with a flame containing sodium. Very striking were three brilliant lines in the green on the red side of F, and making with it a remarkably splendid quartet of bright lines. The first line is distant from F about one-third of the interval separating it from the second line. The next line falls, as was shown by the method of direct comparison, very near the position of the chief nebular line. But it is not possible to say certainly yet whether it is the nebular line or a line of some other substance accidentally close to it.

Mr. J. Norman Lockyer read a "preliminary note" before the Royal Society last week, in which he states that C was the brightest line observed. In the green there were several lines, the brightest of which was, in all probability, F, the position being estimated by comparison with the flame of a wax taper. Another line was coincident—with the dispersion employed—with the radiation at wave-length 500 from burning magnesium wire. A fainter line between the two last-named was probably near λ 495, thus completing the trio of lines which is characteristic of the spectra of nebulæ. There was also a fairly bright line or band coincident with the edge of the carbon fluting at λ 517 given by the flame of the taper. A feeble line in the yellow was coincident under the conditions employed with the sodium line at D. The hydrogen line at G was distinctly seen, as well as a band, or group of lines, between G and F. Nearly all the lines appear to be approximately, if not actually, coincident with the lines seen in the various types of Cygnus stars, the chief difference being the apparent existence of carbon, hydrocarbon, and calcium in the Nova.

Mr. Christie, commenting on a remark that some organisation is needed to further quick-transmission of news relating to astronomical phenomena, points out that such an organisation has been in existence several years, and thinks it unfortunate that so few English astronomers have hitherto subscribed to the Centralstelle für Astronomische Telegramme, Kiel, which is supported by the contributions of the subscribers.

Brooks's comet (known as 1890, II.) was observed by M. Javelle, of the Nice Observatory, on Jan. 6.

Much interest is exhibited in speculations as to the successor of the late Prof. J. C. Adams.

The University of Cambridge has recently suffered severe loss by the death of distinguished members. Sir George E. Paget, K.C.B., F.R.S., Regius Professor of Physic, died the other day in his 82nd year, and the Rev. George Phillips, D.D., President of Queen's College, is also dead at the age of 88. He was a mathematician, but was chiefly distinguished for his knowledge of Hebrew and Syriac.

Lieut. D. Orell died at the Imperial Château of Miramar, near Trieste, at the age of 50 years. He was formerly in the Austrian Navy, and took part in the Austrian expedition to the North Pole under the command of Peyer and Weyprecht. In company with Peyer and a common sailor he left the *Tegetthoff*, which was icebound, to undertake an expedition by sleigh, reaching on the 12th of April, 1874, as far as 82·5°. On this occasion Lieut. D. Orell saved his companions' lives at the risk of his own. He had been for several years steward of the Imperial Château of Miramar.

M. Ferdinand Raoul Duval, a well known French civil engineer, died suddenly while presiding at a meeting of the gas company in Paris.

The death of Sir Morell Mackenzie removes from us one of the most distinguished laryngologists of this country or of the world. He made a special study of diseases of the throat, and founded the hospital in Golden-square specially for their treatment. Sir Morell Mackenzie was a native of Leytonstone, in Essex, and was born in 1837.

Mr. G. A. Rowell, well known to all visitors at the Oxford Museum, died the other day in his 88th year. He had been assistant in the Natural History Department since the opening of the museum, and was always ready to give information to those who sought it. Some of our readers may remember him as an occasional correspondent on meteorological subjects, electricity, and the cause of rain—subjects on which he wrote several papers, which are entered in the Royal Society's Catalogue. Although Mr. Rowell has, through failing health, been absent from his post several times during the last two or three years, he may be said to have "died in harness."

Statues of Boussingault and Chevreul, famous French chemists—the former by M. Dalou, the latter by M. Fagel—are to be erected in Paris in connection with the Conservatoire des Arts et Métiers. The figure of Boussingault will be placed in the court of the chapel near the Rue St. Martin; that of Chevreul in one of the galleries of the Conservatoire. The Chevreul is a repetition of the statue for which M. Fagel gained much reputation when it was in the Exposition Universelle, 1889, and which is now at Roubaix.

The annual general meeting of the Geological Society will be held on Friday, 19th inst., at 3 p.m.

The Joint Grand Gresham Committee has decided to co-operate with the Medical Colleges of London and University and King's Colleges in the establishment of the proposed University for London, on the understanding that it shall be called Gresham University.

In a lecture (one of a series) on the "Induction Coil and Alternate Current Transformers," delivered by Prof. J. A. Fleming, at the Royal Institution, experiments were made with the large coil which Mr. Apps made for the late Mr. Spottiswoode. In one the terminals of the secondary were attached to a large Leyden jar, and it was shown by a revolving mirror that the discharge of the jar consisted of loud snapping sparks, consisting of a series of discharges' oscillating backwards and forwards. The utility of transformers for lighting incandescent lamps by main currents of high pressure, and also for the transmission of energy, was shown by experiment, and the lecturer concluded with a description of the alternating current transformer station at Rome, part of the current for which is to be supplied from a waterfall at Tivoli. The amount so obtained will, it is stated, be sufficient for 40,000 lights, and the installation is expected to be complete by next summer.

In the course of a lecture at the Royal Institution, Prof. Roberts-Austen, F.R.S., referred to the difficulty which formerly existed in measuring very high temperatures. Using the device of H. Le Chatellier, he showed the point at which gold passes from the liquid to the solid state to be 1,045° C., and of palladium 1,500°. The modern instruments are capable of measuring up to 2,000° C. with approximate accuracy.

The use of pental as an anæsthetic seems to be practically condemned, though when its properties are better understood it may become of considerable value in dental practice.

It is stated that an attack of influenza protects from a second infection, and the more severe the first attack the less likely is there to be another.

Major-General Hutchinson reports that the collision which occurred at Norwood Fork Junction in December was due to a mistake which might have been rendered harmless if a system of electrical interlocking had been in force.

The broad gauge will, it is stated, disappear finally from the Great-Western system before the end of next May.

It is stated that an electric railway, worked on the patents of Dr. W. Adams, is to be laid down between St. Louis, Mo., and Chicago, Ill., U.S.A., a distance of 250 miles. The speed is to be 100 miles an hour by through cars. The country through which the line will pass is said to be practically level.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the Editor *of the* English Mechanic, 332, *Strand, W.C.*

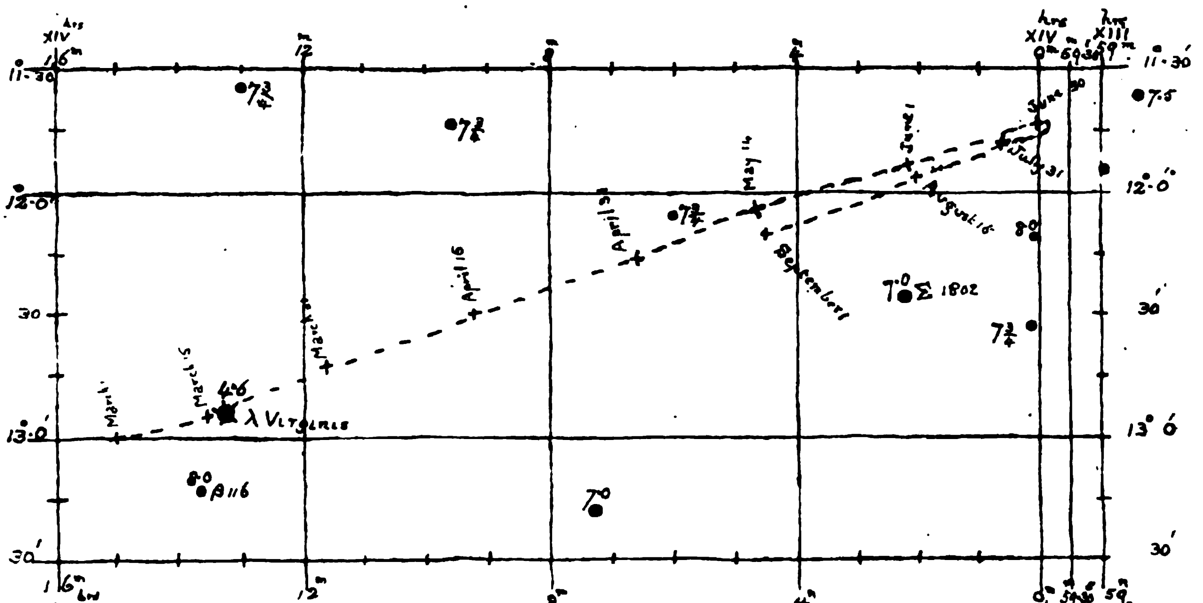
All Cheques and Post-office Orders to be made payable to J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

PATH OF URANUS.

[33156.]—The accompanying map, which is a continuation of the one given in Vol. LII. No. 1350, shows the path of Uranus (and all stars to 8·0 magnitude near for the epoch 1892·0) from March 1st, 1892, to September 1st, 1892. Uranus, owing to his proximity to λ Virginis, 4·6 magnitude in the photometric scale, is favourably situated for picking up with the naked eye, or, better still, with an opera-glass or small telescope throughout March, as during the whole of the month he is never more than 30′ distant from that star.



At midnight on the 1st he is 1m. 40·6s. following λ, and 7′ 38″ south, and on the 31st he is 1m. 43·7s. preceding λ, and 10′ 15″ north. The following little table, which gives roughly the differences in R.A. and Decl. between the planet and star at midnight on the days named, may assist the amateur.

Mo.		Δ A.R. Pl.—St. sec.	Δ δ ′ ″
March	13	+ 35·1	− 1 51
,,	14	+ 28·4	− 1 17
,,	15	+ 21·7	− 0 42
,,	16	+ 14·9	− 0 6
,,	17	+ 8·0	+ 0 30
,,	18	+ 0·9	+ 1 8
,,	19	− 6·4	+ 1 46
,,	20	− 13·7	+ 2 25
,,	21	− 21·4	+ 3 5
,,	22	− 29·1	+ 3 45

Uranus is in conjunction with λ at about 2h. 45m. a.m. on the 19th, the planet being 1′ 12″ north of the star. The distance of Uranus from the earth at the coming opposition is about 1,627,650,000 miles, and his apparent star magnitude 5·4 in the photometric scale. Two pretty little pairs are shown on the map; Σ 1802, for which Dembowski gives 7·7, 8·7 mags.; 284·7° 4·68″; and β 116, for which Leavenworth finds 8·2, 8·2 mags.; 277·7°: 3·01″. The amateur will of course be on the watch for the occultations of Uranus by the moon on the morning of March 17th, and the evening of July 3rd.

H. Sadler.

SPLENDID METEORS.

[33157.]—On Thursday, Jan. 28th, I had the pleasure of seeing a most splendid meteor. I was walking in the village of Melbourn, near Royston, at 6.30 or 6.35 a.m., and towards the south, when I was somewhat startled by a flash of light, and looking round towards the north I saw a most brilliant meteor falling rather towards the west of the parish church. I did not see the meteor at the *exact* instant of its coming into view, when I was told by another observer that it was slightly blue in colour, for when I saw it its colour was a most bright, dazzling white—quite *twice* as bright as ever I saw Venus. I looked up to try and get a knowledge of its position, and, from the position of the Great Bear, I should say it started close to the Pole Star, or perhaps a little to the west of it, and somewhat lower down. It seemed to travel slowly down only slightly to the west of north, and lastly it turned a dull red, which I thought at the time was just like the colour of a piece of red-hot iron. I noticed it falling for perhaps a second *after* it had turned red, and then lost sight of it behind buildings. Duration, say, four seconds. Sky was cloudless.

Villager.

[33158.]—Walking along the Western Shore at 7.50 (G.M.T.) this evening, I observed a very brilliant meteor, about size of Jupiter as seen with the naked eye, of a very ruddy colour, and having a long train; motion rapid and unsteady; duration of visibility, should say, three seconds; path commenced near Gemini, terminating near sword-handle of Orion.

Southampton, Feb. 3. **A. Green.**

[33159.]—On Friday evening, the 5th inst., 7h. 25m. G.M.T., while pointing out the radiant of the Leonids to a friend, we were startled by a brilliant meteor blazing out just below Eta Leonis. It passed with slow motion a little east of Mu Leonis. A building in the field of view prevented us seeing its extinction. Its apparent brightness was twice that of Venus, then setting in the west.

Henry Pollard.

Totterdown, Bristol, Feb. 6th.

FAINT STARS, AND SEEING THEM WITH SMALL APERTURES.

[33160.]—Those gentlemen who are writing about the visibility of *comes* to Rigel, Polaris, &c., with small apertures, must not imagine that the mere visibility of faint objects at a distance from brighter ones is any proof of the excellence of a telescope in itself. Whether these small stars will or not be visible with a 2½in. telescope is far more a question of clear atmosphere and steady definition with a sharp eye than it is of any excellence in the telescope. The dividing of close pairs, and especially close unequal pairs, is the test above all others of a good instrument, and one otherwise quite poor in quality might succeed, not in dividing (it is not dividing), but in showing such pairs as Polaris to be double.

It is generally considered that it is unfair to match a larger instrument stopped down against small telescopes. We are told the middle 3in. of a 4in. or 5in. will always beat a 3in. There can be no reason for this except imperfection of the smaller instrument; indeed, in the case of a refractor, the smaller ought to show faint objects better than the larger, with a stop to equalise aperture, for the lens being thinner absorbs less light. Whenever I find such failure in a small telescope to equal a similar aperture on a larger, I consider it proof positive of want of attainable perfection. I know also that it is not true of reflectors, in all cases at any rate. I have a 9in. mirror, and have been using for 18 months a 12¼in. which is not mine—both are good. I need say no more of the quality of the 12¼in. when I say that it has lately divided OΣ 2 Andromeda and PXI. 9 Leonis, both clearly apart. Reduced to 9in., it has no advantage whatever over the 9in. mirror. The latter is quite equal to the central 9in. of the 12¼in., so that a smaller instrument is not necessarily inferior to the reduced aperture of a larger. I should like to know if any refractor can beat the above performance at the present time with same aperture.

Now, with regard to the aperture required for the stars referred to in letters 33129, 33130, &c., I find I have seen *comes* to Polaris with 1¼in. side aperture and a single lens eyepiece. I have seen *comes* to Rigel with 1½in., easily with 2in. γ Leonis discs in contact with 1½in., divided with 1¾in.; with 2¼in., one clear disc betwixt the stars. ε Böotis seen divided 1⅜in., and with 1¼in. with high power. This is in London, with so restricted a sky that I cannot get down to the other stars mentioned.

Theoretically, as far as distance is concerned, Polaris, if bright enough, should be "divided" with a little over ¼in. aperture, and Rigel by ⅓in., but it requires the light from 1½in. for Polaris and 1in. for Rigel to render them visible. I believe that 1in. in clear air might do both.

E. Holmes.

THE ICE AGE.

[33161.]—May I say, in reply to "F.R.A.S.," that I can see nothing in 398 *a* or 368 *b* of Herschel's

Outlines which is not strictly correct? He has given an explanation of the seasons in the preceding sections, in which it is clearly implied that each hemisphere receives more heat during its summer than during its winter. 368 *a* commences: "Let us next consider how these phenomena are *modified* by the ellipticity of the earth's orbit and the position of its longer axis with respect to the line of the solstices." In considering how these phenomena are *modified* by the eccentricity, he does not think it necessary to repeat over again the explanation of the seasons already offered; but 368 *c* shows that he has not lost sight of it; for if each hemisphere received equal quantities of heat during its summer and its winter, the condition which he describes as "an approach to perpetual spring," and which Croll less correctly describes as perpetual *summer*, would occur when the eccentricity was at a minimum, not at a maximum, and when (if there could be any seasons save those determined by the positions of the perihelion) the perihelion would coincide with the equinox instead of the winter solstice. I desire to add, however, that I do not think Sir Robert Ball's blunder as to the doctrines of Herschel and Croll detract much from the merits of his own investigations, and I believe it would be difficult to find a more worthy successor to Prof. Adams than the Irish Astronomer Royal.

Dublin, Feb. 6. **W. H. S. Monck.**

TWO REAL CAUSES OF AN ICE AGE.

[33162.]—Both the "F.R.A.S." and Mr. Monck insist that a comet containing 15,000,000 cubic miles of water, and a less quantity of air, would be enormously massive; but they might just as well say enormously below any known comet's mass. Of the hundreds of known comets, not one has been seriously estimated as light as my supposed one. "F.R.A.S." follows Sir Robert Ball's disguise of bringing it into tons, looking, of course, vastly bigger than 80,000th of the earth's mass. Now I turn to "authorities." Guillemin's "Heavens," Englished by Norman Lockyer, with annotations by R. A. Proctor: "The mass of Donati's comet (of 1858) has been valued by MM. Faye and Roche at about the 700th part of the bulk (meaning mass) of the earth." That is about 113, you observe, times my deluging comet! But the three authorities proceed: "That is," says M. Faye, "the weight of a sea of 40,000 square miles, 109 yards deep." I should have thought about 800,000 of such seas. However, these are the kind of authorities you hang upon. Of course, I do not believe Faye fixed on this as "about the mass," but as an upper limit for the 1858 comet, which, though conspicuous for its tail, was not a large comet. The giants of 1729, or of 1811—the latter far bulkier than the sun—may very well have exceeded this limit.

The "F.R.A.S." story of a comet running into us "in the 60's," merely means that one day in 1861 we ran through a comet's tail, some 30 million miles from the body itself, which has as much to do with cometary impact as passing through a shadow of one. He might as well say: Collisions with trains can do no harm—we went through the shadow of one lately.

As for its being "pretty certain that comets do not consist of" *a* or *b*, as Newcomb says, "that only an insignificant fraction of all existing comets have ever been observed, we may regard as *certain*." Not pretty certain, you see, but absolutely certain, that you know simply nothing whatever of what a comet of 50 centuries ago contained.

Mr. Monck says I do not prove "how the gradual cooling of the earth could have produced an Ice Age." Cold alone may freeze seas and lakes, as he says, but the gradual cooling of the earth is not "cold alone." The earth, with her form of surface, keeps the same varieties of climate and seasons. Instead of seas freezing, they would evaporate wherever warm, and fall in snow on the colder regions, and produce glaciers. This is one sufficient cause, to which I have added another quite independent. With no change in supply of heat or of seasons, I maintain that a diminution of either fluid on the earth, of air or of water, would produce an Ice Age. With the present atmosphere we have vastly more water than was necessary to form ocean. But a certain quantity was necessary. With less than x cubic miles of water, there would be no liquid at all. The whole would be in steam and ice. Now suppose all air removed, some of the ice would evaporate, and a still smaller quantity of water would be the least that could form a sea. The less air, with the same heat-supply and seasons, the more icy the clime, as now seen on mountains. On the whole, I may claim to have given three independent causes for an Ice Age—the cooling of the earth, and less air, and less water. Sir Robert Ball's book, on the contrary, does not suggest any demonstrable cause for it. When the earth's orbit was more eccentric, he admits, it was smaller, and the yearly heat-supply greater. But because in one hemisphere this was concentrated into a shorter summer, the winters being just *one month* longer, he would suggest the earth radiated so much more heat in each of those winters than was received in summer, as to make our *temperate* regions Greenlands. The more one looks into the case, the less possible does it seem to me to admit this as probable. I really do not believe any glacier would grow a mile equatorward for this reason.

Mr. Monck admits the probability of a cometic catastrophe at some past time; but wonders whence I get the "fifty centuries." Of course, there is no astronomical clue: I get it simply from geology. See Lyell especially (the arch anticatastrophist). Where is there a single river delta or alluvial plain on earth where, if you find carefully the amount added per century, and dig to 50 times that depth, you do not find either the bottom or a layer of pebbles or gravel? It is just 50 centuries since the Nile, the Ganges, the Mississippi, the Niagara, the Thames, were each copious and rapid enough to carry down stones to their present mouths, where they have since carried nothing but fine silt. Of course, Newton and Halley had only tradition and history for this date. They believed the tales of Noah, Deucalion, &c.; but now geology makes them totally unnecessary. The diluvial and drowning nature of the Flood they similarly took on historical trust, which now is utterly superseded, most notably by poor Darwin himself—the besotted Lyellist in geology! Also by Howorth, who runs after the ridiculous "partial-flood" theory. In the pamphlet advertised, Mr. Monck will find all this treated very briefly; but with no reference to Sir Robert Ball's theories, as they had not appeared. I take for granted that all he says about the length of seasons was really worked out and is correct, because his formula, which, both in the book and appendix, is totally wrong, does not give the printed results. The difference in number of days between summer and winter is easily found from the eccentricity, but is not "465 × eccentricity," nor anything else × eccentricity. It is not reducible to any such form. Not having been reckoned by this formula, it may be assumed to be reckoned right, and the formula put in by some blunder. Not that it matters a straw in such a theory whether it be right.

If Mr. Monck thinks nothing produced by known causes ought to be called a catastrophe, of course Halley and Newton were quite wrong (and Comte also) in calling a star-encounter so. He might consent to revive an old astrological term, and call it a *disaster*, the only historical event rightly to be so called. But I must insist against "F.R.A.S." that we cannot well keep it out of geology. It was probably necessary to our world's present existence. Without it our globe would, long ere this, have been as lifeless as the moon.

Mr. Monck will not allow even Sir Charles Lyell's death to be a catastrophe. The anticatastrophist was descending his stairs, and stumbled, fell, and broke his neck, which the jury pronounced a catastrophe. **E. L. Garbett.**

VIOLIN MATTERS.

[33163.]—I cannot think amateur makers will agree with "Grinder" that there is little or no chance of making a satisfactory instrument "excepting by a mere fluke," as he suggests. In my view his own experiments indicate with certainty that in one instance he had got a violin which had simply been constructed without a due regard to the thicknesses. The essence of Mr. Pickering's papers is beyond doubt his simple method of leaving thick plates, and thereby preventing any necessity for a "patch" such as described by "Grinder." Mr. Pickering's subsequent method of testing must undoubtedly commend itself to all, because if final reduction had not been suggested on such a plan, no maker could construct a violin excepting on the lottery system, that is, by measure and gauge, leaving result to chance, after doing his best by those means. I cannot help thinking most amateurs must have been delighted to hear of such a method. It is the pith of Mr. Pickering's papers, and probably his main inducement to publication. Many minor details of construction are simple, and could safely be left to the amateur.

All the letters on the subject prove how much depends on air-space and thicknesses, and how little seems to rest on shape. I quite admit the great effect of the position and width of soundholes, but the best-shaped and placed holes would not make good a violin which was not balanced with wood and "voiced" or rendered flexible by the reed-like reductions of the plates.

I venture to think "Grinder" would admit that if Mr. Pickering's method had been known to him he would have tried it with his Wardour-street wood, and if he had, it is more than likely he would not have found any need for his oblong block or patch. As to soundholes, I have the greatest respect for the shapes and positions as settled by Strad, and can believe that his experiments, even down to lowering the hole on the bass-bar side (to leave on that side a greater central vibrating space of uncut wood), have left no room for improvement. No doubt, the holes have a great influence, and next only to air-space and balance; but it is in my own peculiar experience that two circular sound-holes—a large one behind the bridge, and a second and smaller hole near the end of the finger-board, both holes being central—have been made in an instrument, and with satisfactory results.

The maker (an amateur) had made one hole only in the first instance—the larger one. He found the result bad. He then cut the second, and found, to his astonishment, a great and satisfactory improvement in his instrument. It is, of course, absurd to make choice of or weaken an instrument with such holes, and it was simply an extraordinary trial freak; but the tonal result was so good as to shake my previous opinion with reference to the rule absolute as to sound-holes.

I cannot too strongly, however, repeat my belief in the main point of thicknesses. By systematic reduction, air-space may even be brought into agreement or obedience. This surely is a great matter; and when a system is found—such as Mr. Pickering's—to work upon, I feel bound to candidly admit its merits with my thanks, and I think it is now very evident many other readers agree with me.

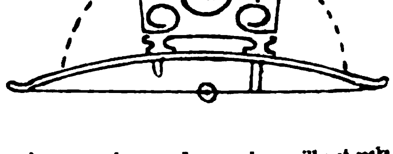
Mr. Monk probably saw a Matthew Hardie, or other violin, with cedar linings, not walnut. He asks for opinions on walnut lining. I don't suppose they have ever been so used, as the wood is, I should think, not at all suitable. If such linings could be used, they might not even suit the back, whilst cedar would be still more durable, and much nearer pine in its value, although not, I think, so good for the purpose.

I have failed to notice, or find, any "turn" in the correspondence. Will "Scio" explain where the turn was, or is? He had (or, rather, took) his turn, and was warmly requested to go on, and make it a good one. I fear "Grinder" and others will share my own mystification as to the grounds for "Scio's" very sudden and recent sorrow, and much-to-be-regretted determination.

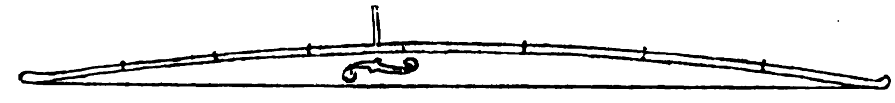
Coventry, Jan. 30. Vio.

[33164.]—My question about strings to bear high tension follows upon that regarding to the usual number of strings on a pose a fifth string be added, it mus fifth above the present E string, and sixth string be used, it would have t sharp, a fifth above B. Gut strings cannot bea the requisite tension, and steel strings are uncertain even for the ordinary E. Yet on the piano much higher notes than those required by our hypothetical fifth and sixth violin strings are obtained. I should feel obliged if any of your contributors would inform me if strings for the required tension can be obtained. I have no doubt the addition of the supplementary strings would be detrimental to the tone of the instrument; but this point is beside my present question. Ned.

[33165.]—I suppose that what I am about to state in explanation of what is to follow will not be new to the readers of "Ours"—viz., that if we grasp or hold a violin-breast, or, in fact, any board or piece of wood, in the hand on a ventral segment and tap it, we hear a short dead sound; on the other hand, if we grasp it on a part where there is a node and tap it, a clear free sound is produced. I mention this fact in order to point out how necessary it is that the bridge of a violin should stand on a node, and, if possible, on the central one, which, of course, the form of the violin indicates. I may add here that if the upper part of the violin were as wide as the lower, the central node on the breast and back thereof would naturally be in the middle of the waist on which the bridge ought to stand, and consequently there would not be sufficient room for bowing left. Now, independent of the form of the violin, the breast has to be shaped outside perfectly, so that nothing need be done to it afterwards beyond varnishing. For reasons which, in order to save space I do not state, the breast ought to be equally thick throughout; but it has to be worked in such a way that the central node is exactly opposite the nicks of the F. holes—i.e., where the bridge must stand. The other nodes should have equal distances between them, and if this be gained it does not matter how the wood be chopped out.



Gauging, scraping, and papering will not make a good instrument. Having a curiosity to see in how far some of our present violin-makers come up to the mark, I bought an unvarnished violin; it was a beautiful copy of a Stradivarius, and the wood and workmanship were equal to that of the great master. But the tone! Well, any box will sound, and to some people, very agreeably, too. Now for the measurement. I took the breast off, cut it across into four pieces, to find the nodes thereof.



and here they are marked in the sketch. To bring the bridge on the central node of the breast it would have to be shifted ¼in. higher up, which would make the scale too short; and to put it on the node next the central one it would have to be shifted 1⅜in. towards the tail-piece, which would make the scale too long. I have not tried the back, but I make sure that the soundpost stands on a neutral segment also. I was surprised to find, however, that the feet of the bridge stood on a node, measuring across the waist; but the height of the bridge was wrong—it had most likely been fitted to suit the height of the fingerboard, instead of being fitted as in the sketch, where the fingerboard is arranged to suit the height of the bridge. The violin was made either in France or Germany. I have forgotten its nationality; but being a fair sample, I conclude that they are all more or less made in the same manner, and it is therefore no wonder that some require the bridge, some the soundpost, to be shifted out of the position where it really ought to be. Others require a higher or lower bridge, as the case may be, to make the tone something bearable, and this is called fitting. Yes, violins made in the present day do want fitting. **J. H. Schucht.**

VIOLIN-MAKING.

[33166.]—IN answer to "Lancastrian" (No. 33142, page 532), I am pleased to be able to say that Mr. H. D. Herring's "acoustic improvement" is a decided success. I have seen and played upon several violins, both before and after the application, and also had my own best instrument operated upon by Mr. Herring's agent, Mr. Chanot, of Manchester, and in all cases I have found that the tone is made more mellow and full, the instrument responds with much greater freedom in even the highest positions, and most curiously the fifths across the strings become pure and true, even when the strings are slightly unequal in thickness. Of course, if the strings are very bad it is not to be expected that any alteration of the instrument will make the fifths true; but I suppose that every player knows that the thin ends of all the strings must be in one direction—i.e., either towards the bridge or nut. There is not the slightest risk in having Mr. Herring's patent applied to the most valuable violin, as the instrument is not in any way tampered with or opened—in fact, the application is very simple, but no less valuable on that account. The London agent is Mr. Georges Chanot, Wardour-street.

Manchester. **W. B.**

P.S.—As the invention is only at present provisionally protected, "Lancastrian" must not expect any details of the improvement to be published until the completion of the patent.

[33167.]—IN common with others, I would offer my thanks to Mr. Pickering for his papers on constructing violins. The correspondence since has been of much interest; but I am sorry to see it drifting into how to make a new violin sound like an old one. Depend on it, as long as men look about for wood cut fifty years ago, and expect, in 1892, to construct an instrument that, in their lifetime, shall resemble in tone an instrument made in 1792, so long their efforts will only end in ultimate failure. It is what Stradivarius never did.

Three years since, by the courtesy of the Editor, I offered an explanation of what might reasonably be thought to be the object of the makers of those days, when quantities of stringed instruments were required for church work (Vol. XLVII. p. 33).

Stradivari's object, and the object of all makers of those days it seems reasonable to think, was to make instruments which should give a great volume of sound, so that the priests should be able to say, "Better buy Stradivari's instruments, for four of his give as much sound as six of any other makers', and we shall save the hire of two musicians." It is worthy of notice that old original Italian instruments are heavy, and scale over a pound—i.e., when untouched by improvers.

There is a point I have not observed touched on so far, which I believe to exist in all old Italians, and that is, that the measurement from the upper bout to the edge of the finger-board is invariably less on the E string side than on the G string side.

Regarding the point advanced by Mr. Pickering about thinning certain portions of the wood with sandpaper after stringing the instrument, for many years I possessed a Paolo Grancino, guaranteed by one of the best London dealers, and in this instrument it was easy to see in certain lights, on the back, the marks of the tool used in shaping it. Evidently the maker did not devote unnecessary time in fining down this portion of his handiwork. This, I think, goes against Mr. Pickering's idea.

May I implore gentlemen to make new instruments, and not tinker at old ones? There are some highly interesting remarks on the tone of violins in Meyer's work on Sound, which show the physiological reason why no modern maker can ever succeed in constructing a new instrument having the tone of old ones. **Harris-Tothill.**

[33168.]—WILL Mr. Monk explain the following? Take a bad-toned violin with the upper bouts of any reasonable size, and sound, say, G in the first position on the E string; then take a good-toned viola with, of course, larger bouts and air-mass, and sound the same note, and you will get a better tone. Or reverse it; take a good violin and a bad viola, when the former will give the best tone. This proves, I think, that good makers do not alter the sizes of their upper bouts for the sake of air-mass, but for the sake of leverage; air-mass has little or nothing to do with the quality or power of tone.

I may inform Mr. Monk that a hard, firm soundpost would be the best for a sluggish instrument that does not speak quickly in the treble, and that a more elastic post would be the best for a harsh, loud treble. The same may be said about the lining. A stiff elastic lining of wood like American walnut would brace up and improve an instrument made of soft, sloppy wood, and vice versâ. What does Mr. Monk mean by saying that "pine is the best *conductor* of sound of any wood known"? I have found that many of the harder woods were very much better conductors of sound. Copper wires are splendid conductors of sound when used in a telephone; but metal would make but a poor violin breast or linings.

Dublin, Feb. 6. **Chas. Forrest.**

[33169.]—FIRST as to the soundholes. The shape and position of these are by some held to be purely arbitrary, but I submit that the reverse is the case. If we examine the belly of a violin, and draw imaginary lines from the upper to the lower bouts, and parallel to centre line of belly, we shall find that we get the greatest possible number of different lengths of the lengthways grain of the wood, from the shortest (between the outside of *f* holes and bend of C's) to the longest, comprising whole length of belly.

Now, as different lengths of wood fibre must naturally reinforce certain notes in preference to others, it would seem that these holes have been cu in this fashion so as to get the different lengths, and yet to preserve the beauty and symmetry of the belly as a whole.

Now, as to function of soundpost. I think Mr. Monk (33117, p. 510) is a little adrift in his conclusions. It must be remembered that the soundboard of a violin—i.e., the belly—vibrates in a direction at right angles to its surface, and to produce these vibrations in their greatest amplitude we must apply the impulse (as nearly as possible) in the same direction. Now, bowing across the strings in the ordinary manner on a violin without a soundpost would be about equivalent to pounding a big drum on the hoop at the edge of the sheepskin in a direction parallel to surface of head of drum. But place soundpost in usual position, and the whole thing is altered at once. Thus the post stands under one foot of bridge, and renders it practically a fixed point or fulcrum, while the other foot is free to move up and down with vibrations of belly. Now if we bow across a string, the bridge acts as a lever, in which the vibrations of the string represent the power, the foot under the first string (and over the soundpost) the fulcrum, and the belly of the violin under the G string the weight to be moved, and please note that owing to arch of belly it is moved in a direction fairly at right angles to its surface. So far so good; but the action of such a small surface as the foot of the bridge on so thin a body as the belly of a violin would be too local, and would probably result in a series of small waves, which would mutually interfere with each other, so what do we find? Why, just underneath this foot is a rib or strengthening piece (the base bar) running the whole length of the belly and serving to convey the impulse of the foot of the bridge in one great vibration from one end of the soundboard to the other. All very simple, but also very beautiful in its perfect adaptation to the purpose in view.

As regards decrease in depth of ribs towards the head, I think with Mr. J. Rae (33093, p. 488). Just try to fancy what a violin would look like in which the ribs increased in depth towards the head, or that had its neck shipped on the other end. Those old masters had a keen eye for beauty, and a good ear for tone. Fiddle makers, cultivate both, and ye shall prosper. **Mij.**

PROJECTILES AND THE ROTATION OF THE EARTH.

[33170.]—IN reply to Mr. H. Wake, letter 33138, I must confess that I have made one mistake, but in a contrary direction to that indicated by him, and that instead of making the deviation half the amount it really is, I have in fact made it twice too much. It is evident that a ball shot vertically upwards will fall a little to the west of the point of departure; but if a ball be dropped from the top of a high tower, it will fall a little to the *east* of the point vertically beneath the point of departure. This latter fact I ignored in my last letter. If this should meet the eye of "J. R. C.," I should like to have his opinion on my reasoning, as it must be confessed that the subject is somewhat puzzling, although it makes a very neat problem in kinematics.

Now to treat the matter analytically, adopting the notation of my last letter, when the ball is fired vertically, I have already explained that at any height x on its upward flight, the deviation, which I will call y, is $\frac{ctx}{R}$, t being time in seconds that the ball takes to reach x; c is the distance in feet which the surface of the earth at the equator revolves in one second, and R the radius of the earth in feet. Now I will calculate by the diff. calculus what is the horizontal velocity of the ball when it gets to its extreme height h; the text-books give us the formula $x = ut - \frac{1}{2}gt^2$, where u is the velocity of the ball when it is fired off, and is the same as the velocity acquired by falling from h; u will be found $= \sqrt{2hg}$. Substitute the value for x in the equation for y, and we get—

$$y = \frac{c}{R}\left[\sqrt{2hy}\,.\,t^2 - \frac{1}{2}gt^3\right].$$

Now the horizontal velocity at any time t will be represented by $\frac{dy}{dt}$, therefore differentiate the last equation, and we get—

$$\frac{dy}{dt} = v = \frac{c}{R}\left\{2\sqrt{2hg}.t - \frac{3}{2}gt^2\right\}$$

But when the ball reaches h, $t = \sqrt{\frac{2h}{g}}$. Substitute this value of t in the last equation, and we get $v = \frac{ch}{R}$. The upward flight, therefore, gives us a deviation of $\frac{cth}{R}$ at h, and a horizontal velocity at that point of $\frac{ch}{R}$. If the ball were not moving horizontally at h, and allowed to fall, it would, as I said above, fall at a point $\frac{cth}{R}$ *east* of the foot of the vertical from h—that is, it would fall on the point from which it was fired; but as it is moving westwards with a velocity $\frac{ch}{R}$, it will fall at a point $\frac{cth}{R}$ west of the point from which it was fired; or, substituting the value of t in terms of h, the deviation will be $\frac{c}{R}\sqrt{\frac{2}{g}}.h^{\frac{3}{2}}$.

Bath. **M.I.C.E.**

VACCINATION.

[33171.]—THIS is not an "anti-vaccination" letter, and I hope that if you find room for it our energetic friends, the anti-vaccinators, will not take the opportunity of opening the question of repeal of the law, since we all know that you have no room for that subject.

A lengthy and careful study of the past history and present position of vaccination has led me to desire strongly that we could examine the question on modern scientific grounds, leaving statistics and the original claims of Jenner, neither of which are really of use, since Jenner founded his claims on the results of experiments which to-day would be utterly insufficient for the profession, and the vaccination of to-day is not the system proposed by Jenner, whilst statistics seem so plastic that anything may be proved by them.

Amidst all the wild and erratic opinions which the new science of bacteriology has started, there are one or two results which seem worthy of the position of "law facts," and which have a practical bearing upon this great question of preventive inoculation. A close relation between the presence of bacilli in the blood and zymotic disease has been fairly well proved, and though we cannot say that the bacilli are the actual cause of the disease, yet we know that they are the vehicles of the poison, for an animal may be infected with the disease by injecting bacilli into its blood.

Far more important is the fact that the process o recovery from diseases of this type is also closely connected with certain changes and activities of the bacilli, for, during the struggle between the organism and the disease process, a toxic principle is formed by the bacilli, the full elaboration of which is coincident with the death of the bacilli which had produced it, and with the recovery of the patient from the disorder. The symptoms evidenced during this battle are the indications as to what movements are going on in the organism in its struggle towards recovery, and as they are produced by the action of this poison formed by the bacilli, probably other poisons which produce the same symptoms will act in the same way in the body; that is, they will, like the toxic principles of the bacilli, lead to the death of these germs and the recovery of the patient. (This is, as is well known, the basis of "homœopathy.")

If the toxic substance, which is the suicidal product of the bacilli, can be isolated from the bacilli themselves, it is found to be curative and protective against the particular disease which gave it origin. But it is exceedingly difficult to thus isolate these poisons, and many are the disastrous results of the failure (vide Pasteur and Koch). Bacilli of the disease, or of some modification of it, have been injected along with the poison, and the patient has been killed thereby, whilst fresh foci of the disease have been started (the increase of mortality from hydrophobia in France since Pasteur's labours may be connected with these facts). But when it has been isolated, this poison is found to resemble the vegetable alkaloids in its nature, and the question arises: May there not be, in the vegetable kingdom, substances which are analogous to these curative and protective poisons which might be safely used in their place?

Most certainly there are substances in nature which produce all the symptoms of various disorders when taken into the body, and some of them are known to imitate the action of the zymotic bacilli, even to the production of a rash. Thus belladonna produces the symptoms of scarlet fever, and antimony those of small-pox, rash and all. Personally, I am satisfied that belladonna prevents and rapidly cures, or even aborts, scarlet fever, whilst I can see no difference between the appearance of the vesicles produced by "vaccination" with tartarised antimony, and those of vaccine lymph, and all cases of small-pox which I have treated with antimony have made remarkably rapid recoveries.

In view of the great difficulty experienced in isolating the preventive poisons of the bacilli, even with our refined and laborious appliances in expensively fitted physiological laboratories, and seeing how often disease has been conferred instead of cured or prevented by inoculation of such preparations as can thus be obtained, I would remark that our present methods of procuring and using what is called "vaccine lymph" are very *crude*, *unscientific*, and *dangerous*. I am of opinion that the bacilli of disease are sometimes implanted with vaccine lymph, both the bovine and the humanised. We are not using the toxine, which bacteriology would indicate as preventive or curative of small-pox; or, if our vaccine lymph does contain an analogue to such a poison, we do not take the necessary precautions to isolate the inorganic substance which our experiments have indicated.

Further, laboratory experiments have taught us that by inoculation with animal fluids, not only immunity may at times be conferred, but that receptivity in other directions may also be produced; that is to say, that some of the special characteristics of the blood of one animal may be conferred upon another by artificial inoculation.

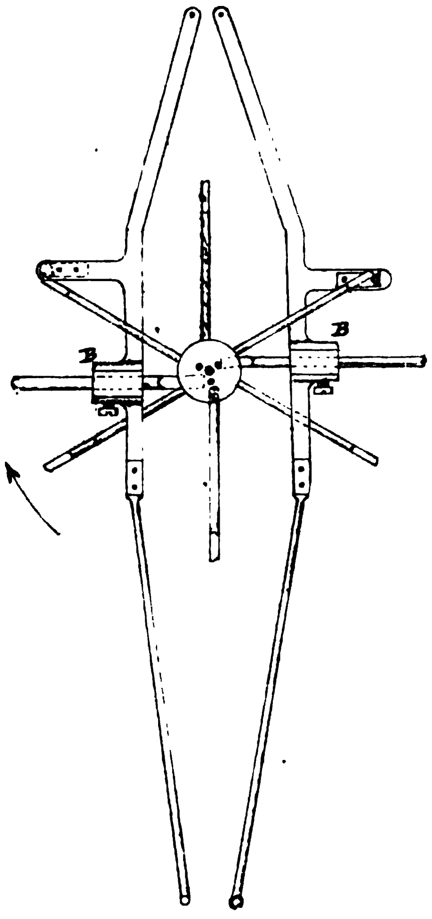
All these are serious facts, and have their bearing upon vaccination. We should not allow so crude a proceeding as is our present method of vaccination to be pursued with any new artificial inoculation with an animal fluid, and it may be that we are on the wrong track in using an animal fluid at all, for the vegetable alkaloids may perhaps be identical in their value, or there may be similar analogues in the mineral kingdom. Meanwhile, in my medical practice, I am unable to put any of these facts to trial, since a law exists compelling me to use a certain animal fluid for vaccination,. In spite of the fact that I have not confidence in its utility or its safety, and in spite of the varying results of its use, our vaccine lymph is not a fixed and stable substance. During the artificial production of this fluid by inoculation from one animal to another through a long series, it has become modified, and is not the same thing as it was at first. Fresh and spontaneous outbreaks of cowpox do not occur now, as dairies are cleaner than in Jenner's time. We have dropped Jenner's original method, on which he insisted, the inoculation of calves from the matter from the "grease" of horses' heels, since so dangerous and filthy a proceeding is inadmissible. We are trying to use pure calf lymph, the discovery, not of Jenner, but of the dairymaids, and of old Benjamin Jesty, the farmer, before Jenner's time; but it was this calf lymph which Jenner condemned as useless, and we have so modified it by long dilution through animal bodies that it is not even the same as it was when he so discarded it. It is proving a variable and often dangerous substance; and it is not what modern science would indicate as protective against small-pox. If any such substance exists, it is the toxic principle produced in the blood by the small-pox bacillus, isolated from contamination of the bacilli themselves; or it is the analogue of this, in the vegetable and mineral kingdom.

I am inclined, before I vaccinate any more babies, to demand that some such substance as this shall be provided for my use by the Government, with guarantees of its purity; otherwise, to demand that I be permitted to use antimony, which produces the same results on the body as vaccine lymph, without its dangers; and it is quite as probably protective as is our very unstable fluid, which is known as "vaccine lymph."

Upper Clapton, Feb. 6th. **Gerard Smith.**

AN EASILY CONSTRUCTED GRAVITY ESCAPEMENT.

[33172.]—I inclose sketch of a gravity escapement, which, I think, presents some advantages in simplicity of construction as compared with the ordinary type of such escapements, and a very brief description will suffice to explain its features. The arms may be cast in gunmetal or malleable iron, the light wire tails be afterwards riveted on as shown. The lifting pieces are secured by set screws in the flattened bosses B B, and consist of round steel wires, flattened and properly shaped and hardened at their acting ends. This arrangement gives great facility in adjusting the lift. The stops may be screwed on to the projecting portions of the arms as shown. The escape wheels are made by screwing (and afterwards soldering, if thought necessary) light wires into the central discs or bosses, the ends of the wires being flattened and properly shaped and hardened. This construction probably secures the lightest wheel possible.



15, Foulden-road, N. **W. A. Granger.**

PREVENTION OF FLEXURE IN SPECULA.

[33173.]—"Ztirf," in letter 33137, p. 531, asks if it is possible to attach a mirror to an iron plate. Sir Henry Bessemer gave, in these columns, a method of doing this several years ago, but whether it has been tried by anyone I cannot say. It was a spiral groove turned on the face of a flat iron plate made rigid by stiffening, such as "Ztirf" suggests; the speculum ground a close fit to plate, and held thereto by means of atmospheric pressure; a central hole at end of spiral groove drilled through plate, and an exhausted state of the air maintained thereby, so holding the mirror on its face.

I have also given a method of supporting, which your correspondent may find worth while referring to, in Vol. LII., No. 1350, p. 509, of this paper. A full description is given, showing how a mirror can be supported in all required positions, without any conceivable distortion; at the same time the atmosphere having free access to back of mirror as well as front, so adjusting itself to any varying state of temperature—a considerable item in distortion.

As a supplement to what I have previously said concerning this method, I would just say here that the speculum can be ground and figured on this same observing support, providing the end weights there mentioned are immersed in pitch, and set so as to be unyielding to the forces required in the manipulation of grinding and figuring.

61, Walton-road, Liverpool. **Geo. Whittle.**

[33174.]—On page 532 of your last issue, a correspondent asks how flexure is to be prevented in large mirrors. I question does flexure ever take place to the alteration of figure in a mirror? I have never found it, and I have had very thin mirrors.

When the makers test their mirrors, while on the tool, the mirror is placed vertically, when flexure would be most effective. Also, when Mr. Wassell tested the lot of mirrors at my house, as stated in a former volume, he placed them all nearly in a vertical position, and flexure was not thought of. Mr. Linscott also tested several mirrors at my house two years ago, and all were similarly placed. No flexure was thought of.

Now, when a mirror is in use in the telescope, it is mostly lying on its back, and there can then be but little tendency to flexure. I doubt its influence in the performance of a telescope.

Philip Vallance.

THE HUMBERSTONE ROAD ACCIDENT. TO "NUN DOR."

[33175.]—In this case (letter 33154, p. 534), a waggon being shunted upon a side-line was thrown across just in front of the express train which left St. Pancras at 4 p.m. Under such cir- no possible appliances could avert a the only wonder is that the results more serious. **Clement E. Stret**

40, Saxe-Coburg-street, Leicester, F

LATHE MATTERS: CONE FITTINGS FOR CENTRES.

[33176.]—I trust "A. H. S." will pardon my attempting to answer his queries; and that my doing so may be of assistance to him. The faults he complains of in the lathes might not have occurred had he carefully specified that the taper sockets were to be of such or such a taper, well-made and true. I have lately bought a lathe, in which I took for granted that certain things would, of course, be as usual, and took the maker's word that certain others would be. Several serious errors have been committed where there was nothing specified; but the truth of spindle hole is A 1—it *was* specified.

(1) The best possible angle for taper sockets for lathe centres is hardly a possible thing at all. In large lathes the tapers should not be so long as the Morse, because the great end-pressure the centres are subject to, especially with the stupidly obtuse angles of some centres of large lathes, would cause troublesome jamming-in of the centres. In all lathes that do not carry work, or such tools as "end mills," by the taper socket, the sockets *may* be a quicker taper than Morse.

In small lathes, and those that carry much work, &c., by the taper socket, socket might be a slower taper, to obviate so hard driving home as the Morse requires when carrying heavy work. In a lathe under 3⅛in. I would prefer ½in. to the foot instead of ⅝in. (Morse). But, as "F.A.M." says, we have the Morse, and it is well to use it as far as possible for lathes from 3⅛in. to 6in. centres.

(2) Perhaps the best way of producing a uniform or any desired taper in a socket would be on a special form of "universal grinder," which would have duplicate bushes of all the sizes of lathes the manufacturer makes, in which bushes he would run the spindles while grinding out the socket. He would thereby insure that the grinding is done at centre height in all cases, and the fine adjustment of swinging bed would insure exact placing of his line of traverse. Of course, the same machine could grind the external fittings at same setting if desired.

Possibly, however, that is not what "A. H. S." desires. If he is about to make a lathe spindle, he will succeed very well by first finishing the socket for centres, then fitting spindle on a plug. He will carry in, say, a bell chuck, a perfect fit to said socket, and true. Then make a new centre in tail end, and finish both bearings while so running it. If he has an untrue spindle hole to true, he may bore as near as possible to size, then ream, or grind with an emery attachment carried on his slide-rest; but it will be very difficult to hit any desired taper.

3. Taper reamers are made by all the leading twist-drill makers, and are sold by the large dealers. Don't have any without a good maker's name. These are the same taper as the shanks of drills they are intended to ream for; but the sizes differ slightly in their tapers. They will, if one takes care

to leave as little as possible to ream, make a hole true enough for nearly every purpose, but only by chance perfectly true. British Bulldog.

[33177.]—I WAS troubled with a spindle bored out of truth. I made a taper rimer, and could not get the centre to run true. I forged a tool to turn the hole out inside, setting slide-rest to desired taper. This greatly improved matters; but there were still hard spots that "bothered" the tool, however sharp and hard. I then fitted a brass bit into a drilling spindle, cast a small cone of lead on the brass, set spindle in slide-rest to desired angle, put on emery and oil, constantly renewed, ran the spindle in and out many times while going at a high speed, and got an exquisitely true job. I forget what the taper was; but it worked well. Will "F.A.M." tell us what is the exact proportion of the "Morse taper"? Also, does he mean that of the drill shanks, or that of the spindles to carry self-centring chucks?—are they the same?

T. F. S. T.

HEATING-SURFACE OF SMALL VERTICAL BOILERS.

[33178.]—I SEE "F. A. M." asks (page 489) my opinion of his modification of the rule I gave on page 36 of Vol. XLV. and page 565, Vol. XXXIX. I must first point out that my share in the matter was confined to an attempt to express clearly the method described somewhat obscurely by another correspondent—"Sunlight."

It is interesting to hear that the rule fits the cases tested by "F. A. M." so well, and it appears to me that his assumption as to the equality of value of small boilers per unit of heating-surface is likely to be near the truth. He is mistaken, however, in saying it will require three times as much steam at 60lb. to fill a given cylinder as it will if pressure is 20lb. This would be very true if pressure were *absolute*; but if the atmospheric pressure is taken at 15lb., the real ratio is $\left(\frac{60 + 15}{20 + 15} = \right) 2{\cdot}14$, or about twice instead of three times. Reducing the rule I gave to cubic inches of cylinder *during admission*, it becomes $\frac{15}{{\cdot}7854} = 19{\cdot}1$sq in. of heating surface per cubic inch of steam admitted before cut-off.

To get his 20in. per cubic inch of cylinder (presumably measured by the area multiplied by the stroke), he must cut off at $\frac{20}{19{\cdot}1} = 1{\cdot}05$, or 5 per cent. after piston has reached the end of the stroke! This is *rather* late, even for a model; and if the cut-off is taken at three-fourths of the stroke, "F. A. M.'s" rule becomes $\frac{15}{{\cdot}7854} \times \frac{3}{4} = 14{\cdot}325$, or, say, 15sq.in. of heating surface for each cubic inch of cylinder when revolutions and steam pressure are at about the average rates. "F. A. M." takes 200 revolutions and 20lb. steam as the average ratio, and, though I am not able to say if they are or not, I see no reason to doubt it.

To sum up, I understand he is under the impression that his rule gives the same results as the one I published. It will, however, always give from a third to a half more heating surface. This is a good fault—if fault it is—but is it necessary, as he has found the original rule agrees so well with existing practice?

If "F. A. M." would publish the result of his examination of designs for boilers in the form of a table, giving volume and page where they are described, size, and revolutions of engine (and "cut-off" if possible), steam-pressure, type of boiler, and the heating surface which he has calculated from the published dimensions, it would be very interesting and far more useful than any rule.

Glatton.

DEAFNESS AND OTHER AILMENTS.

[33179.]—MY letter (76141) of Jan. 8th on the above subject, which you kindly inserted in your valuable paper, brought me a great many anxious inquiries; but it is hardly possible to explain in a letter the many systems and laws of nature which have to be considered, and therefore I ask you to assist the many suffering by inserting in your widespread paper the whole explanation and the results obtained thereby. Should only a few read and act on the advice given, I am sure that few will be very thankful to you for inserting this letter.

To recover from any ailments or sufferings of the body, it is of the highest importance to have or to get the blood in as pure state as possible, so that the new particle employed in building up or repairing the old or decayed may be of a healthy nature. To bring the body to this condition persons ought to be very cautious as to what they eat or drink, to masticate their food thoroughly, so that it is properly mixed with the saliva in the mouth, and thereby give the stomach as little work as possible. Obtaining as much fresh air as possible, for a healthy blood ought to contain 10 per cent. of oxygen, and bearing in mind to breathe through the nose, thus preventing the fine dust and germs in the atmosphere getting into the lungs. To rigidly avoid all fermented drinks, and to get rid in course of time of all the fungi and other matters contained in them. Roast pork and other rich food ought to be avoided. The next matter to consider is the circulation of the blood over the whole body, thereby to give it new life and strength, and to collect all the died-off particles. A healthy child moves very quickly in all its actions, because all its organs and acting parts are in their full strength and health, whereby its blood flows and circulates over the whole body in about two minutes. But when he arrives to manhood he has to sit or stand for long periods, and his brain, in consequence of his thinking, requires more blood. Thus the body begins to get neglected, and as years roll on this neglect is increased, especially when unwholesome air is inhaled or the necessary exercise in fresh air is not taken. Then the blood becomes gradually sluggish, and does not reach the outside of the body, but remains too much in the interior. Thus it causes too much heat, which upsets the nervous system. This tells very much on old people—in fact, so much so that the organs begin to lose their acuteness, and those that cannot fulfil their functions die off. It is, therefore, of the highest importance when the natural laws, owing either to neglect or old age, begin to fail in their activity to produce proper circulation of the blood, that artificial means must be adopted. This can easily be accomplished by friction or strong rubbing of the skin of the whole body by the hands and hard towels or brushes. The result of friction—the most important of all—causes electricity, which is the essence of our lives. When a person is rubbing any part of his or her body very strongly, that part gets quite red and hot, the cause being that fresh blood is continually drawn to that part. And if this part has any defect or ailments, it is certain that the new blood drawn there will absorb any decayed matter present, and in course of time renew that part, and by degrees form totally new tissues, thereby removing the pain caused by such defects. For instance, if anyone has the toothache, we know it is not the tooth, but the nerves in the gums. Well, let that person rub the outside of the jaw or chin with their flat hand until it is quite hot, and repeat the process. It is certain that the new blood drawn to the nerve will soothe it, and thereby lessen the pain, and often remove the pain altogether. The friction of the skin of the whole body renews the same, and produces tenacity. It also, in course of time removes the wrinkles in the skin, and at the same time the outside scales are removed and the pores opened which let out the poisoned vapours accumulated by the died-off particles, and so ease the lungs, which are liable to destruction if the pores remain closed, besides keeping the body in better health. Also, by this frictioning of the body we inhale more fresh air, which naturally keeps the blood purer. I will now explain what friction has done for me. It has cured rheumatism. This was brought about in the following way. About 30 years ago my right shoulder was for three years almost immovable; it was impossible for me without pain to bring my hand to my mouth. Well, attending Prof. Huxley's lectures to working men, I heard him state that when a limb was to be moved a duct was opened containing strong acid which draws the sinews together and so form the ball of the muscle. Now, I had learned that when nature had used a material, such matter must be got rid of through the pores, or be absorbed by the blood. If not, the limb will become stiff and useless, so I brushed the skin of the shoulder very strongly, until I had renewed almost the entire skin, and thus the acid was got rid of. Secondly, it has driven away many colds, and what is of more importance, partially renewed my brain, as my memory is now considerably better than it formerly was. But some two years ago, I had a very severe cold; both the spleen and the liver were out of order, and I could hardly breathe. Add to this congestion of the lungs (in consequence of which I had to sit up in bed, or the phlegm would have choked me), and a slight attack of bronchitis. I cured myself of all this by friction of the affected parts—face, neck, chest, and throat, in a warm room—in the space of three weeks, without the aid of a doctor, and at the end of four weeks I could go out for a short time without any danger; the object of my friction being to draw the inflammation from the interior to the exterior (outside). I may also mention that my ears naturally got some friction, and I soon noticed that there was now and then a ring in the left or better ear, and from that time I paid more attention to my right or deaf ear (which for about twelve years was entirely useless to me), and after about three or four months the hearing was completely restored.

Some people may doubt the accuracy of the above statement, but now I will say something which everybody can see for themselves. Up to a few years ago I had only a few straggling hairs left on the side of my head, and now I have more than ten times as much, but the colour has changed from pure white to a tint near the colour of my youth. What is still more remarkable is that for thirty years I was quite bald, and now, in my old age, I get a new crop of hair again. Of this, to the best of my belief, there is no precedent by the faculty.

One more proof I should like to give that my statement—i.e., that rubbing of the skin produces circulation of the blood and forms new life—is true. I had been accustomed to rub my arms, from the wrists to the elbows, and afterwards from the shoulders to the upper arm, every morning regularly. After continuing this for about a year I found that my finger-nails got quite brittle. My reason soon told me that in rubbing my arms I had omitted to rub the outside of my hands. Well, after rubbing them for a few weeks, new life and tenacity returned to the nails, and they soon became as strong as when I was a young man. In concluding this matter, I add that about a fortnight ago I and everyone in my house had the influenza, consisting of a slight headache, aching of the limbs, bones, &c., but principally an awful running at the nose—so much so that I was obliged to hold my handkerchief to it as I went to business. In consequence of this attack I frictioned myself with extra force, so that in about eight or ten days I was so far recovered that I thought it had completely left me. But, unfortunately, a strong fever set in, and I guessed the result: my throat got sore, and I expected the chest would soon be in a like condition. However, I frictioned myself stronger than ever, having someone for my back, and when I was in a great heat went quickly to bed. By the next morning the fever had entirely left me, and remembering the old proverb "feed the cold and starve the fever," I avoided all solid food for 36 hours, which gave a good result. Having now drawn the inflammation from the interior to the exterior, the bronchitis and congestion of the lungs was stopped, there being very little phlegm left on the chest. Still I kept indoors for five or six days, but did not have any pain.

In conclusion, I must mention that the rubbing of the stomach and back acts towards the liver the same way as a ride on horseback would. Thus the liver is shaken and recovers, and in the course of time might perform its functions regularly again. This is of the highest importance for the digestion of food. Old people in particular are often affected by irregular action of the liver, thus producing in its turn irregularities of the bowels. Perhaps it is here not out of place to say again that by continual friction and proper circulation of the blood, the pores of the skin are kept open, and so no foul or decayed matter can collect in the body. Further, that by continually inhaling fresh air, the microbes or bacilli cannot take root, as it is well-known that any germs or bacillus can only live where foul or decayed matter are in existence. On the whole, I may state that nothing pays so well as the studying and obeying the laws of nature: our comforts, health, and the very existence of our lives depend upon them. Also the wonderful and beautiful arrangements which we meet with in the study of nature is many times more profitable to us than the pursuit of any other pleasure.

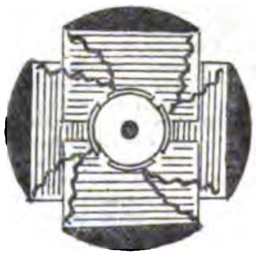
Remembering "that activity is life and rest is decay." A. C. Engert.

3, Mill-lane, Bromley-by-Bow, E.

A SUGGESTION FOR A SMALL DYNAMO FOR ACCUMULATOR CHARGING.

[33180.]—JUDGING from the many queries in your columns for a small dynamo for charging, it would seem that it is a want not successfully supplied, as an H armature is unfitted, and small drums and rings are difficult to get to work at all. I therefore wish to submit this suggestion to the criticism of our readers, hoping that Mr. Bottone will notice and give an opinion as to its merits or otherwise.

My idea is to use two H armatures at right angles, as proposed some time back in "Ours" for a self-starting motor; but instead of two commutators, only one four-part commutator, either between the two A.'s, or at the outer end of one of them. Each A. has two equal coils, one each side of the spindle, and all four coils are connected up in a closed circuit like a ring armature, the beginning of No. 1 coil on No. 1 armature connected to the end of No. 1 coil on No. 2 armature; the beginning of No. 1 on No. 2 A. to the end of No. 2 on No. 1 A., &c. I hope the sketch will make this



clear. If the commutator is on the outside, the ends of the further coils will have to be brought through the windings of the nearer ones. The A.'s could be run in two separate F.M.'s; but I should think it possible to make one long F.M. of them.

L. W. (Apprentice).

USEFUL AND SCIENTIFIC NOTES.

Artificial Marble.—Artificial marble is produced by M. Maard by the following process:—Ten parts of burnt gypsum and one part of alum are mixed together in a little water, calcined, and then reduced to a powder. To 25 parts of the powder is added 22 parts of talc, 5 parts of chloride of magnesium, 44 parts of clay, and 1 part of potassic alum. The mixture can be worked, polished, or painted like marble.

The *Western Morning News* says that a certain Herr Paul Riehm has invented a mist, or fog ball, with which to envelop your enemy in a deep mist, nay, even a thick fog, which shall not be surpassed, claims the inventor, even by a London particular. These fog balls are easily-broken spheres, containing ammonia and acids, which, upon escaping, create a fog that envelops all around it, until blown away by the wind. Battles, though, are not always fought on windless, calm days. But, says the inventor, with this fog around them, it will be impossible for the enemy to find the range, or reply to the fire of the attack.

Rubber versus Leather Belting.—There is much discussion of late as to the relative merit of belts and the conditions which influence their value as a coefficient in the transmission of power. Leather seems to be fickle, doing better at one time than another; but, as a rule, with one or two exceptions, the rubber belt is by far the more satisfactory. The principal exception is in dynamo-work, where a great deal of oil is used. This softens rubber, and renders its use impracticable. In the usual use the rubber is flexible, a coefficient sought among the differences in leather-belting. Its friction is greater, and it does not slip. Again, it is not affected so much by moisture, which makes the leather belt vary so much in its work done at times. For outdoor work it is for this reason especially advantageous. There is one point, however, and that is, get a good one; one of the other sort made of everything except which its name would signify is no better than leather, if so good.—*Indiarubber World.*

To Keep Iron Pipes from Rusting.—A simple and economical way of tarring sheet-iron pipes, to keep them from rusting, is as follows:—The sections as made should be coated with a coal tar, and then filled with light wood shavings, and the latter set on fire. It is declared that the effect of this treatment will be to render the iron practically proof against rust for an indefinite period, rendering future painting unnecessary. In proof of this assertion, the writer cites the example of a chimney of sheet-iron erected in 1866, and which, through being treated as he describes, is as bright and sound to-day as when erected, though it has never had a brushful of paint applied to it since. It is suggested that by strongly heating the iron after the tar is laid on the outside, the latter is literally burned into the metal, closing the pores and rendering it rust-proof in a far more complete manner than if the tar itself was first made hot and applied to cold iron, according to the usual practice. It is important, of course, that the iron should not be made too hot, or kept too hot for too long a time, lest the tar should be burned off. Hence the direction for the use of light shavings instead of any other means of heating.

Prolonged Sleep.—The *Times* of Tuesday, February 2, contains an account of a very peculiar case of prolonged sleep which, on January 31, was occupying the attention of medical circles in Germany. It seems that a miner named Johann Latus, an inmate of the hospital at Myslowitz, in Silesia, has been there 4½ months, and during that time all attempts that have been made to wake him have been fruitless. The doctor attending him, Dr. Albers, thinks that catalepsy is the real cause of his condition, although no previous record of so prolonged a sleep has ever been made in medical science. The fact which has led Dr. Albers to this conclusion is that all the limbs are absolutely rigid. In other respects the appearance of the man betrays no sign of this. The body remains quite still, breathing takes place regularly, and the appearance of the face is quite normal, the cheeks being of a healthy colour. Lately the body has been less rigid, and the patient has even made some slight movement; but the eyes have still been kept closed, and the condition of apparent sleep in no way disturbed. During this long sleep the hair on the head has increased in length, but the beard has remained stationary. In order to supply the patient with food, a tube has been inserted into the throat, and by means of it two or three litres of milk have been administered daily. [The patient awoke on Feb. 9.]

REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75180.]—**Cement for Lamps.**—I used to fix the brass sockets on glass-lamp fonts by melting alum in the brass socket, and squeezing the glass into the melted alum. It made a good joint, paraffin-proof.

T. F. S. T.

[75219.]—**Rope-Gear (U.Q.)**—Manilla would stretch too much. A special rope is made for the purpose, of strands of iron or steel wire (the latter is best) round a hemp core. I do not know if galvanising has been tried; but I have reason to believe that the strength would not be so much affected as is generally supposed.

Glatton.

[75226.]—**Bronzing Brass.**—1 part oxide of iron, 1 part white arsenic, 12 parts hydrochloric acid. Clean the brass well to get rid of lacquer or grease, and apply with a brush until the desired colour is obtained. Stop the process by oiling well, when it may be varnished or clear-lacquered. (From "Spon's Workshop Receipts.")

Glatton.

[75231.]—**Model Steam-Port.**—Dovetail a piece of brass in between port and cylinder, and fix with solder. Soft solder will do, but hard is better.

Glatton.

[75232.]—**Hydraulic Press.**—Mr. Chas. Hopkinson, in a paper to be found on p. 275, Vol. XCIX., *Min. Proc.* Institution of Civil Engineers, says that twenty-five years previously the pressure was 2¼ to 3 tons per square inch. The resulting stress was too great on the cast-iron cylinders, and they often gave way. I believe the porosity of the cast iron gave great trouble also. With steel cylinders the pressures were increased in the proportion 700 to 460, or, say, to 4½ tons per square inch. It may be of interest to add that Mr. Tweddle uses a pressure of 1,500lb. for his riveting machine.

Glatton.

[75233.]—**Folding Metre Rules (U.Q.)**—Those I have seen are made like the penny folding yard measures, in about ten short pieces, riveted together.

Glatton.

[75336.]—**Engine (U.Q.)**—Make diameter of flywheel 3 to 4 times stroke, according to fancy. Paraffin requires special burners, to insure all the air for combustion coming from below flame, and in close contact with it. Examine lamps in a magic-lantern. By rule referred to in a recent letter, (p. 488), a boiler with heating-surface of (15 × 1½in. = 22½, or say) 23sq.in. should do if cut-off is at ¾-stroke. I cannot spare time to design boiler; but with the heating-surface given you should be able to do this for yourself.

Glatton.

[75346.]—**Engine for Lift (U.Q.)**—

$$\frac{3\text{cwt.} \times 112 \times 135\text{ft. per minute}}{33{,}000} = 1\cdot372$$

theoretical horse-power. To allow for friction, it would be well to provide about 2½ indicated H.P. The rest of the query cannot be answered as it stands. What is pulled 5ft. when lift moves 1ft.—the belt leading to engine or what? How many revolutions must the shaft driven by engine make to move lift, say, 10ft.? A steam-engine will be very wasteful for such a purpose, as boiler must keep on burning coal while engine is lying idle. An hydraulic lift would be more economical, if your water company can supply enough pressure.

Glatton.

[75430.]—**Overshot Water-Wheel (U.Q.)**—The larger the wheel (within reasonable limits, and so long as it is lightly built), the less loss there will be from friction at bearings. I should make it 3ft. to 3ft. 6in. diameter, in riveted thin sheet-iron, well painted.

Glatton.

[75750.]—**Query in Arithmetic (U.Q.)**—When I replied to this query, I had not seen "Mistral's" solution. I wish to note what appeared to me errors in it as given on p. 490. Passing over three or four errors of detail in the first part of the solution, the second part of the answer is incorrect both in the figures (three out of four) and in theory. As to the figures: for 1,344s. 5d. read 1,210s., for 2,397s. read 2,339s., and for 2,389s. 8½d. read 2,351s. nearly. These changes dispose of the evidence for a second maximum. It may easily be shown that there is no second maximum, for net value in x years is

$$1\text{s.} + (x-4)\times\frac{4840}{2x} = \frac{x-4}{x}\times 2420 = \left(1-\frac{4}{x}\right)\times 2420.$$

i.e., the subtrahend decreasing as x increases, the result on the whole period continually increases. This view of the problem leads to the conclusion that if the time x be indefinitely long (i.e. if the trees should never be cut down), the annual income would be greatest—a result which the venerable Euclid would politely characterise as "absurd." "Mistral" has somehow overlooked the caution which he himself calls attention to—viz., that the result per acre is required. Take, say, the results for 100 years. Planting 100 acres so as to cut one yearly gives an annual return of 2,323s. for the one acre cut down; but the other 99 give no return in that year, so that the entire return (net) of the 100 acres for each year is 2,323s., whence the return per acre is 2,323 ÷ 100, i.e. 23·23s., an amount far below the eight-year maximum.

Max Parr.

[75925.]—**Foundations (U.Q.)**—Although I should be very pleased to answer "Sydney's" question fully, I regret that I am unable to do so, for, as it stands, it is almost as indefinite as asking how big a lump of chalk is. For instance: if the ground the tank is to be erected on is solid rock, no foundation at all is necessary. Even if the ground is softer than rock, it is hard to say how much foundation to give. I have put down a lathe weighing fifteen tons on loose made-ground on a foundation very little larger than the lathe itself, and this simply by digging a hole and filling it with broken stone, and flooding the whole with plaster of Paris. Again, in Holland, to carry a machine weighing a ton, and only requiring about a H.P. to drive it, I did not think it prudent to use a lighter foundation than a heavy block of cement concrete, which itself was not laid until I had driven into the bottom of the hole (which was only 4ft. square) twelve piles each 30ft. long and 12in. square. The whole question, therefore, is one of the solidity of the ground the tank is to be erected on, the principal being to make such a foundation that the columns of the tank cannot move sideways by spreading or slipping, and cannot sink in under the pressure. As to brick or concrete, the question is simply one to have either strong enough not to crush under the strain. The main point is to do work "judgmatically," and to be quite sure of solidity. As a last instance, in Paris, where the limestone rock usually appears at the bottom of the foundation excavations, it would appear perfectl right to build on it at once. Yet, before bu it is usual to sink a deep well, perhap or 40ft. deep, at one or more corners vation, the reason being that the rock combed by the catacombs of unknown d extent, that the apparently solid rock might y be a thin crust, and in spite of this precaution I have twice seen houses that had sunk bodily almost, without warning, into the ground.

Mistral.

[75927.]—**Small Biunial.**—Might I trouble Mr. Parker to glance at this query, which appeared in No. 1392, as this lantern would be handier to me than a larger one, as described by him in his excellent articles now appearing. Would my jets for 2¼in. condensers have to be smaller, or should I have to use full-size ones? Blow-through, of course. What size orifices?

L. W.

[75935.]—**Electro-Magnet.**—It is the best to have the diameter of iron core of full size, providing there is no friction. The gauge of wire would depend upon the voltage of the current which actuates it. I do not know of any battery which will work powerfully for half an hour and then recover itself. The Leclanché has this recuperative power in greatest excellence, but does not long hold out for continuous currents. Of course, you might use a bichromate bottle battery, and lift the zinc out of the solution when done with.

A. E. B.

[76042.]—**Wheel-Valve.**—The principal objection to admitting the steam from boiler above instead of below screw-down valve has not been mentioned—that is, that in case of over-pressure of steam, and anything going wrong with the valve-spindle, the steam keeps the valve down instead of assisting to lift it, and the valve is thus under the control of the steam instead of in that of the engineer.

T. F. S. T.

[76064.]—**Steam-Jet Cupola (U.Q.)**—Woodward's steam-jet cupola was mentioned in *Engineering* as long ago as Nov. 8, 1867, as appearing to be the best in use. The makers wrote the following week to say 1cwt. of coal was used per ton of iron melted to supply the steam, and the coke used for melting was from 1cwt. to 1¼cwt. per ton of iron melted. They are again mentioned—Nov. 29, 1867—in an article which states they had been working since April, 1865, upwards of sixty having been erected. The makers' statement about fuel consumption is corroborated from experience, and the rate of melting stated to be about 15cwt. per hour per foot of diameter of outside casing. A sketch of a steam-jet cupola is given on p. 521, Vol. XXXII. of English Mechanic. See also a letter by "Tubal Kain," p. 17, Vol. XXXIII., and one by "Invicta," p. 482, Vol. XL., and sketch, p. 218, Vol. XLI. An interesting letter by "Cupola" on the heat generated and used in cupolas generally will be found, p. 658, Vol. XXVII. I am under the impression that "Sunlight" gave a description of a cupola with steam jet some time ago in the "E. M.," but have not been able to find it. Can anyone tell me where it occurs?

Glatton.

[76164.]—**Speed (U.Q.)**—"Vulcan" will please excuse me for attempting to answer this query, now that it has reached the U.Q. stage, but it is

like No. 75906, also a very vague one. To begin, you do not state if the armature is a drum or ring, and in the former case it will probably require very much more power than in the latter; neither do you give any indication as to the probable output. Besides, you do not even give the number of revolutions per minute that the shaft makes. As the principal point in dynamo running is a steady speed, and the pulley of the dynamo is usually small, it is well to use the thinnest belt procurable, and with plenty of width. In my opinion, "there is nothing like leather," and I should not care to try canvas hose. Presuming you have 1H.P. or 2H.P. to transmit, I should use a 3in. or 4in. leather belt, as slack as is consistent with proper running. The crossing of the belt should be an advantage if the dynamo pulley is very small, as it increases the area of contact of the belt on the pulley, if the joint is smooth, so that there is no jar.
MISTRAL.

[76183.]—**New Optical Glass.**—The paragraph referred to as appearing on p. 223, Vol. LIII., is there distinctly stated as given on the authority of the *Lancet*; but if the statements made are true, no doubt some reader could give particulars, and answer the query on p. 426 (Jan. 1); but possibly there may have been some mistake. T. L. Y.

[76186.]—**Serpollet Steam Generator.**—This query is practically answered in the following number on p. 431, in which the latest account of the Serpollet boiler is given. It is scarcely likely that any of the defects which may have been discovered would be made known until the inventors had removed them, which they appear to have done by the improvements described. The water, or steam, prevents the tube becoming red hot.
M. T.

[76194.]—**Safety Bicycle.**—It seems to me that the querist had better get a new gear-wheel; but how comes it that the "cogs are all worn off the hub"? A little explanation would be interesting.
J. O.

[76195.]—**Harmonium Manual Coupler.**—The querist must please himself. I should use one stop to throw the coupler into action throughout the manual. As to reeds, a 16ft. set and a 4ft. set should be added. ORGANON.

[76196.]—**Gilding Resist.**—Perhaps this querist will give some more definite idea of what he wants to do. Good copal varnish is a useful "resist" where common shellac or pattern varnish will not answer. It is not quite clear whether he means the engraved plates or proofs printed from them, the word "re-transfer" confusing the query.
GARNAULT.

[76205.]—**Gas-Governors.**—It seems to me that this querist should consult the makers, as they can be easily found in Fleet-street, and will no doubt tell him what is the matter with his governor. Perhaps it only wants a little cleaning. W. T.

[76209.]—**Chicken Rearer.**—Make a shallow sort of box having a section something like a >, and line it with sheepskin. Does not require a lamp, if it is kept in a warm place. INCUBANS.

[76210.]—**Torsion Balance.**—I had noticed the error in the reply of "Iota Dash" with regard to Coulomb's experiment, but as it did not touch the point in question, I considered it somewhat immaterial. However, in this week's number he kindly comes to my assistance again, and quotes an example in which I perceive he notices the same difficulty as I have myself observed. His remark that the sines of angles when small are equal (should be proportional) to the angles themselves does not lessen the difficulty, because there is no such reservation in any of the balance experiments; and I think, too, that angles of 36°, 20°, and 17° would not be included in this term, "small angles." Evidently "Iota Dash" sees the point, and I should be glad if he would kindly solve the question, which I will repeat by a balance experiment pure and simple. It is as follows:—A bar-magnet suspended by a fine wire points north and south (magnetic) when the wire is not twisted. When the upper end of the wire is turned through 100°, the magnet is deflected 30° from the meridian. Show how much the upper end of the wire must be turned to deflect the magnet 90° from the meridian. It appears to me to come solely under the consideration that the earth's power is so much for y°, represented by the torsion of the wire. How much is it for x°, as in the latter part of "Iota Dash's" remarks? There is, of course, no magnet in the case besides the one in the stirrup. STUDENT.

[76212.]—**Selenium Cell.**—This querist should refer to his back volumes. It is impossible to understand what he means, as he first of all speaks of a glass cell, but apparently means a selenium cell. He will find much about the latter in back volumes, including some account of Mr. Shelford Bidwell's experiments. T. R.

[76228.]—**Cataract.**—I am glad to be able to assure "J. C." that suitable homœopathic medicines can, and frequently do, relieve, and even cure, genuine cataract—opacity of the crystalline lens. Dr. J. C. Burnett, in his "Curability of Cataract," says:—"We have seen that the lens is *differentiated* skin, a dermoido-epithelial structure; and hence cataract may well be conceived as being metastatic, or primitive, psoric expression. This I conceive to be the Hahnemannic pathology and etiology of cataract. On this line cataract is curable with medicines." He elsewhere says: "A specific for cataract, in the very nature of things, cannot be found, because there are no two cases of cataract exactly alike." Dr. J. H. Clarke, in "The Prescriber," after giving concise directions for the treatment of soft cataract, cataract from injury, and capsular opacity, prescribes for hard cataract in the early stage—concentric opaque laminæ:—Calcarea carbonica No. 6; afterwards, if necessary, phosphorus No. 3; and for the later stages, silica No. 6. Dr. R. Hughes, in his "Manual of Therapeutics," and in his "Manual of Pharmacodynamics"; Drs. Boericke and Dewey, in their edition of "The Twelve Tissue Remedies of Schüssler"; and the late Dr. E. A. Farrington, of Philadelphia, in his "Clinical Materia Medica," all give remedies for genuine cataract. Also, as indirectly bearing on the subject, see the latest Homœopathic League Tract, No. 38, "The Superiority of Homœopathic Medical Treatment in Chronic Forms of Disease," J. Bale and Sons, 1½d. post free. P. FERRUM.

[76296.]—**Prolapsus Ani.**—I suffered from this for nearly thirty years, complicated with severe eczema. Two years ago it became unbearable, and a surgeon warned me that at about fifty years of age the prolapse frequently becomes strangulated, cannot be returned, and thus mortifies. He unhesitatingly advised an operation. I underwent it, and am completely cured, and have better health than for twenty years. One astonishing thing he insisted on: to set aside, as absurd, all anxiety about the daily evacuation, and absolutely to avoid all aperients unless two days passed without relief. He was peremptory as to diet—stopped all sugar, coffee, potatoes, pastry, beer, and wine (of which last I always took very little); also advised very little meat, and no fruit. He ordered white bread, instead of "whole meal," and tea to drink. As circulation was slow, he ordered a dessert-spoonful of brandy mid-day and night, in water. If any sufferer desires more information and name of surgeon, my address is with the Editor, and I shall be happy to communicate. CURED.

[76297.]—**Cementing Glass and Metal.**—Try shellac dissolved in spirits of wine with enough plaster of Paris to make it as thick as cream.
REBMA.

[76308.]—**Type-writer Ribbons.**—See answer to No. 76080. REBMA.

[76316.]—**Fine-Art Casting.**—A paper by Mr. H. E. Outerbridge, Jr., was read before the Franklin Institute in April, 1887, upon the subject of the preparation of delicately-marked objects, in which it was desired to obtain their counterparts on metals: a number of castings were shown which were perfect. The castings were made from white pig-iron, but judge that the process would be applicable to other metals if melted thin enough to follow the intricacies of the pattern. The class of patterns used were leaves, laces, &c. The preparations after treatment were very flexible, could be folded and handled otherwise without injury; they were then placed in a mould and proceeded with in the usual method of making other castings. "The process of carbonising the delicate fabrics, leaves, grasses, &c., is as follows: The objects are placed in a cast-iron box, the bottom of which is covered with a layer of powdered charcoal or other form of carbon; then another layer of carbon dust (object being interposed) is sprinkled over them, and the box is covered with a close-fitting lid. The box is next heated gradually in an oven to drive off moisture, and the temperature slowly raised until the escape of blue smoke from under the lid ceases; the heat is then increased until the box becomes white hot; it is kept in this glowing condition for at least two hours; it is then removed from the fire, allowed to cool, and the contents are tested in a gas flame. If they have been thoroughly carbonised they will not glow when removed from the flame, and the fibres may be even heated white-hot before consuming. Of course, the method employed to carbonise the material is susceptible to variation; the scientific principles involved are unchangeable, viz.; 1. Partial exclusion of air, and substitution of carbon atmosphere. 2. Slow heating to drive off moisture and volatile elements. 3. Intense and prolonged heating of the partly-charred objects to eliminate remaining foreign elements, and to change the carbon from the combustible form of ordinary charcoal to a highly refractory condition." J. H. N.

[76327.]—**Electrical.**—With reference to this query, the transformers are tested to give 15 ampères each, and I am taking 15½ from it now, and I have ten 16c.p. lamps to put on it—Ed-Swan lamps. I think Mr. Bottone's reply, 76308, on p. 494, is intended for my query, which appeared on p. 474. E. J. H. H.

[76365.]—**Oxychloride, &c.**—The cements or materials of this class are quite useless for your purpose. When you have made one pattern, make a little moulding box of wood—iron is quite unnecessary for small work—and keep a small quantity of brass-moulder's sand, which, if damped with salt and water, and kept covered when not in use, will need very little trouble to keep it in order. Make the duplicate patterns from the original in common solder, melted in a small ladle over the fire. I may suggest that making six patterns of wood does not indicate much knowledge of the value of time, as the brass-moulder would have made the whole lot in tin or solder in half an hour.
THOS. FLETCHER.

[76373.]—**Insect.**—It would be difficult to name "Mico.'s" insects from the description given—viz., that of being very small and running fast. Are they larger or smaller than a little piece of chalk?—and what colour? If ⅛in. long, and of a silvery, metallic lustre, they would be the young or larvæ of the cockroach. If white, and very much smaller, they would probably be a louse that infests old and dirty furniture. In either case, their presence is due to want of cleanliness. Frequent dusting and cleaning of the secretaire, especially working into the corners with a small brush, such as used for aspinalling, will in time effect a cure. If young cockroaches, sprinkle a little powdered borax about the nooks and crannies; if lice, use Keating's insect powder, blowing it in with the bellows supplied for the purpose. As there are sure to be eggs unhatched, a continuance of the above will be needed for some time, till all are hatched and exterminated. ALFRED LLOYD.

[76380.]—**Gravity Escapement.**—I presume you have Lord Grimthorpe's book? If not, I recommend you to get it. The drawing of the double three-legged escapement is not quite correct; but it is easy to see what is intended. The acting faces of the pins on the right should be vertically over each other, the acting face of the pin on the left being level with the centre of the 'scape-wheel arbor. The acting faces of the lifting pieces should be straight, and in a line with the pallet arbors. The lifting pieces should be just clear of the arbor, to make sure of the pins not butting on the corners. This may be what is wrong with your escapement; or the pins may be in the wrong places. I do not know what else would cause the pallets to be lifted with a jerk, unless you are trying to do without a fly. The locking legs should not overlap the stops so much as shown in the drawing. If you make them to overlap a $\frac{1}{20}$in., it will be quite sufficient to prevent tripping. In a regulator with a pendulum not swinging much more than 2° from zero, the lifting pins should be much nearer the centre than a 36th of diameter of escapement. If you make the distance a fiftieth, you will find it quite sufficiently difficult to get the pallets light enough. If you make the outline of both pallets the same, they can be filed up together by putting pins in the holes at the top and bottom. You will see that the four-legged escapement is drawn in this way, and I think the escapement looks neater when the pallets are alike; but, of course, it is of no consequence mechanically. You will find it convenient to crank the beat-pins, as putting the escapement in beat by bending the pallet-legs is an awkward job, and the legs do not look nice when not straight. Let the banking pins be as low down as you can get them, and put them on cocks screwed to the back plate. Let the pallets come to rest just clear of the lifting pins, and when the clock is finished, carefully steady-pin the cocks in their places with two or more steady-pins. If this is done and the beat-pins are not disturbed, the clock may be taken down for cleaning without the adjustments being affected.
G. T. C.

[76382.] — **Heating House.** — In reply to querist, the amount of ⅛in. bore pipe generally used for the boiler is 10ft. to 12ft. per 100ft. of radiating pipes. Should recommend querist to have for 350ft. a circular or rectangular coil containing 50ft., or even 60ft. to work more economically and safer. As to the arrangement of the pipes, much depends on the general plans of the rooms; but as a rule the flow-water pipe should rise immediately from the boiler to the highest point of the apparatus, then returning through any coils or runs of pipes on its way back to boiler. All air must be got from the pipes, or they will not fill with water. This is done by pumping water through the whole system with a hydraulic pump and a special form of filling-cock. An expansion tube or reservoir is also necessary to allow of the expansion of the water when becoming heated. Care must also be taken to see that each socket is well screwed up till a thorough metallic joint between the ends (which are specially prepared) of the pipes is made. Should strongly recommend querist to adopt, in preference, the low-pressure system, it being so very simple to erect and manage, less dangerous, more healthy, and less expensive, while the high-pressure system is very difficult to erect by inexperienced persons; not easy to manage or control; by improper fixing and arrangement pipes would become hot enough to cause spontaneous com bustion; unhealthy, owing to the great temperature the pipes are raised to, which burns the dust, &c., that collects on the pipes; and more expensive than low-pressure heating. If you will send me your name and address I will explain to you a system of low-pressure heating I have now in use in my own house. (See address in Address Column.)

George Chasser.

[76385.]—**Rain-Gauge Measuring Glasses.**—I am much obliged to the friends who have kindly noticed this query; but, curiously, not one has answered it exactly as wished. I wanted to know if a glass 2½in. diameter and 2½in. deep, when full, represented 1in. of rain caught by a gauge 5in. diameter. "F. S." says it would fill a 4in. glass $\frac{9}{16}$in. deep. I can easily understand the plan suggested by "A. E. B." is the simplest—i.e., have the measuring glass same diameter as the rain-gauge; but when you come to divide 1in. into 100 parts, you would need a microscope to read it, especially as clean rain-water is nearly colourless.

Non-Mathematical.

[76388.]—**Force and Pressure.**—Your correspondent "A. E. B." appears to hold some strangely unique views on momentum and force. Instead of answering the querist directly, he makes a wrong statement and appends two utterly meaningless equations. Perhaps he would do well to read the extract which weekly heads your "Letters." Hoping that "Doubtful" has not wasted any time in attempting to work from such random statements, I hasten to remove his difficulty. Force is measured by its time-action. The time-action of a force on a body is completely represented by the momentum produced in that time. So that if the same or equal forces act on two bodies for the same time the changes of momenta in the bodies will be equal. Also the changes of momenta are directly proportional to the time through which the force is acting. By momentum we mean a quantity measured by the product of the mass into the velocity. Viewed in the light of these statements, we see that a unit mass at unit velocity does represent the same amount of force as half the mass at twice the velocity. Thus the first part of "Doubtful's" query is answered in the affirmative. Measured as above, we see that

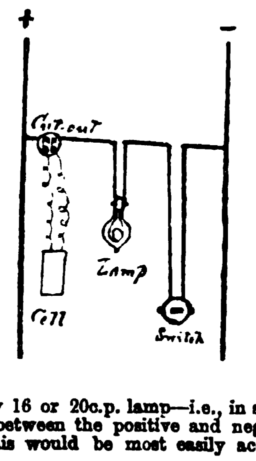
$$F = \frac{M(v_1 - v_0)}{t}$$

where the symbols have the usual meanings. If v_1 the final velocity, be less than v_0 the initial velocity, the change of momentum comes out negative, and the force has thus been employed in destroying momentum. But the method of measuring the force is unaltered. We see from the formula that if the change of momentum remains the same, while the time becomes very small, the force producing that change becomes very great. When, as in the case of blows or impacts, the time becomes immeasurably small (though not infinitely so) the force becomes very great; and, although we can measure the change of momentum, yet we cannot measure the force action, because we cannot measure the time of action. Such forces are known as "impulsive forces," and we have to content ourselves with merely measuring the whole change of momentum during their time of action. A cubic inch of steel, in falling 16ft., acquires a velocity of 32ft. per second, and assuming it to weigh ¼lb, its momentum will be—

$$32 \times 0.25 = 8 \text{ foot-second units.}$$

The mass now strikes a solid body; required, the pressure on the solid body. To find this, we should require to know the time which elapses before the body (steel) begins to rebound. Dividing 8 by this would give us the pressure in poundals. But since this time is, with our present means, immeasurably small, the problem is indeterminate. S. S. R.

[76390.]—**Charging Accumulator.**—The best and safest plan would be to charge the cell through an ordinary 16 or 20c.p. lamp—i.e., in series, with the lamp between the positive and negative lead wires. This would be most easily accomplished by selecting the cut-out or fuse belonging to a single light, and disconnecting the fuse-wire. Test the polarity of fuse terminals by connecting to two pieces of lead immersed in dilute sulphuric acid. The piece of lead assuming a rich chocolate colour is the positive pole. The cell should now be connected in place of the testing wires, coupling the positive pole of battery to positive terminal of cut-out. Sketch herewith shows connections. Care must be taken not to connect the cell across the mains direct, as the E.M.F. mentioned, 115 volts, would speedily destroy the battery.



J. H. Hindle.

[76392.]—**Pulleys.**—Speed of shaft A = 200 revolutions. If pinion A be made 8in. diam., and spur-wheel B = 40in. diam., then secondary shaft will make 40 revs. Strap G H travels in one revolution 2 × 5ft. + 2 (2in. × $3\frac{1}{7}$) = 132·571in. The number of revs. made by G or H in one rev. of strap G H = $\frac{132{\cdot}571}{12{\cdot}571}$ = 10·545 revs. If F be 6in. diam., then $\frac{40 \times 6}{10{\cdot}545}$ = 22·76in. = diam. of the larger bevel wheel. One rev. of strap E E = 2 × 8ft. + 2 (2in. × $3\frac{1}{7}$) = 204·571in. Five times speed of G H = 662·855in. Strap E E would make 3·24 revs. The 4in. pulley E would revolve $\frac{662{\cdot}855}{12{\cdot}571}$ = 52·728 times. If D be 8in. diam., then $\frac{52{\cdot}728 \times 8}{40}$ = 10·545 = diam. of C. These sizes make no allowance for "slip." Should it be essential that the difference of speeds never vary, it would be necessary to adopt other arrangements than straps. Of course, larger or smaller diameters may be used, provided the same proportions are kept between each pair as given above. Georgius.

[76402.]—**Electric Lighting.**—Approximately a turbine of 3 to 4H.P. would be required. Dynamo to give 130 to 140 volts and 10 to 15 ampères. Accumulator plant of 58 or 60 cells giving a voltage of 115 to 120 volts at dynamo station. Loss in leads would allow standard lamps of 100 volts to be used at both houses. Automatic cut-in and cut-out between cells and dynamo in case of any breakdown or decrease in speed. An efficient plant could be erected to above specification, and the expense considerably modified by using lower electro-motive force and fewer accumulators, consequently involving greater loss in leads. As the installation would only be a small one, and power cheap, probably this would not be of much consequence.

J. H. Hindle.

[76403.]—**Size of Crucible.**—Without seeing the pattern of cylinder, or knowing more details, it is impossible to guess accurately; but supposing the cylinder is of ordinary design, should say from 7lb. to 12lb. of brass would be required. You want a 12lb. plumbago crucible. W. Martin.

[76403.]—**Size of Crucible.**—You would want about 10lb. of brass to cast the cylinder.

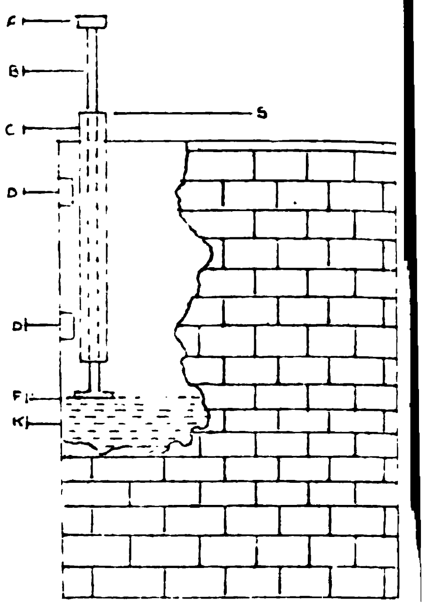
W. W.

[76405.]—**Lunar Photography.**—Certainly, photos. of the moon can be taken with 3½in. telescope. Mr. Parks's want of success appears to be because the visual and actinic foci of the telescope do not coincide. If he first focus as usual, and then shorten the focus until the object be slightly indistinct, and then take his photo., he will most likely find the detail sharply defined in his negative.

H. E. H.

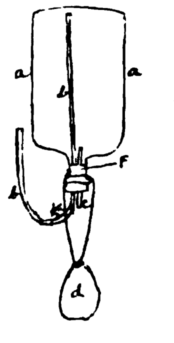
[76412.]—**Batteries and Dynamos.**—I am much obliged by the replies to this inquiry, which has made it quite clear to me. If not troubling too much, may I further ask how the fine wire with which induction coils are wound (and also the armature coils of dynamos) can carry a current of such high tension without being melted, as if the spark from an electrical jar is passed through a piece of very fine wire it will melt it, and I have understood the sparks from an induction coil are much stronger when of the length of an inch or two than those from a Leyden jar? J. C. S.

[76415.]—**Water Indicator.**—I forward a sketch of the apparatus I should use if I were in your position; in fact, I think you will find it exactly what you want. It is an idea which occurred to me, and having tried it with a model, I find it answer the purpose very well. In your well fix a case, C (which is square in shape), by blocks of wood nailed on to the case, which are marked D in sketch, to the brickwork, so that a small portion of the case shows above the well. In your case slides a square rod, B, with a float at the bottom, which rests on the water line, so that when your water in the well drops the rod will drop also. The space (or rod) above the case must correspond exactly with the depth of the well from the highest water line. If your well be very deep, it must correspond with the space between the highest water line and the depth which you think your water sinks. Mark your rod off in inches, beginning at the top of the case when your water is at its highest. If your water drops an inch, the rod will drop an inch, and you will find on looking at the top of the case inch of rod which ought to be above the case be covered. Of course, your rod in the first must be 120yds. long from the top of the case to highest water line. The letters mean as follows: A, slight weight at the top of rod; B, part of marked off in inches; C, case which rod slides in



D, blocks on case fastened in brickwo at the bottom of rod; K, water; S, where you must start measuring off. in case loosely, as you must have as littl possible. I run mine on wheels fastened I shall be pleased to answer any questions on the subject. C. G. M. Bennett.

[76415.]—**Water Indicator.**—First prepare a bottle as in Fig. 1, where A A is a pint bottle, F a rubber stopper with two holes in it, into which the two glass tubes C and *b b* are put, while *d* is a weight sufficient to sink it and attached with wire to the neck of the bottle. Now make a U-tube of glass about $\frac{3}{16}$in. internal diameter, and about 45in. long. That is taking it for granted the well will never be more than about 40ft. If it should be more, add 1in. for every foot more. Now mount the U-tube on a board, paste a strip of paper along side one arm for the scale, and to the other attach a piece of rubber tubing sufficient to reach to the bottom of the well. The other end of the tubing is attached to the tube *b*. Now fill the U-tube with mercury till it rises in each arm to about half-way, and let the bottle and weight down into the well. Now make a mark on the paper where the mercury was when it was first poured in, and from this point make marks ⅜in. apart going upwards to the top of the scale. These marks will show the number of feet of water in the well, counting the bottom mark 0, the next 1, and so on. See that the joining between the rubber tubing and glass tubing is bound with copper wire and quite air-tight. Bacchus.



[76421.]—**Gas-Burner for Lantern.**—I have used, in a small lantern with 1¾in. condensers, a gas light, by passing the gas through a bottle packed with cotton wool, saturated with benzine or benzole. The light is very much more brilliant, for the size of the flame, than the ordinary gas flame. The bottle stands behind the lantern, and the gas is led to the bottom, and taken off at the top by brass tubes. I have also a by-pass tap to let pure gas pass when it smokes through being overcharged with benzine. Black rubber tubing very soon softens and dissolves with the vapour, especially of benzole, but on the common white tubing it has no effect. The light is very hot, although only a No. 1 Bray's burner is used, so I had to line the top and sides of lantern with asbestos sheeting. This might suit you, and I should think two or more burners might be used. L. W.

[76422.]—**Ringing all Bells but Your Own.**—To Mr. Bottone.—There are two modes by which any number of bells on a line can be rung simultaneously without ringing the one at which the operator stands. They consist essentially in having as many Morse keys (connected electrically together by their pillars) as there are bells to be rung. Fig. 1 is best adapted for cases in which the distances are small. Here each battery is placed between a bell and a key, care being taken that every battery presents the same element to the bell. All the bells are connected to one wire, which returns to make contact with the "off" contact-piece of the key. On depressing any one key, its battery is cut out of circuit, while every other is thrown in circuit with its respective bell, and consequently they ring. Fig. 2 is adapted to long distances. For either case, if code signals are to be transmitted, the bells should be single stroke. S. Bottone.

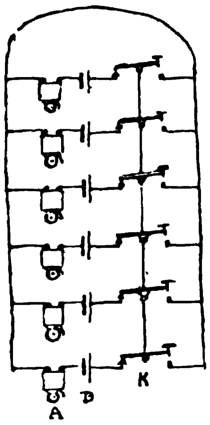


Fig. 1.

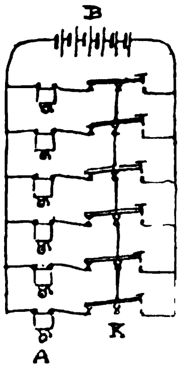


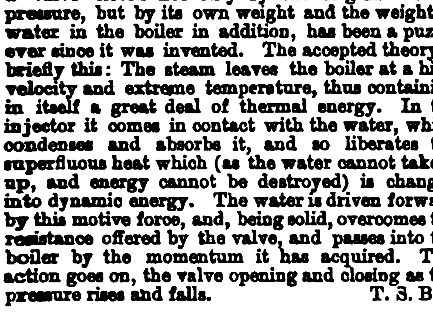
Fig. 2.

[76423.]—**Steam Injector.**—The seeming paradox of the action of the injector, by which a jet of steam lifts a quantity of water and forces it through a valve closed not only by the original steam-pressure, but by its own weight and the weight of water in the boiler in addition, has been a puzzle ever since it was invented. The accepted theory is briefly this: The steam leaves the boiler at a high velocity and extreme temperature, thus containing in itself a great deal of thermal energy. In the injector it comes in contact with the water, which condenses and absorbs it, and so liberates the superfluous heat which (as the water cannot take it up, and energy cannot be destroyed) is changed into dynamic energy. The water is driven forward by this motive force, and, being solid, overcomes the resistance offered by the valve, and passes into the boiler by the momentum it has acquired. This action goes on, the valve opening and closing as the pressure rises and falls. T. S. B.

[76432.]—**Brass Castings.**—I am inclined to think your trouble lies either in having sand too wet, and not venting the mould sufficiently, or in the cores not being quite dry. If possible, the cores should not be placed in position till just before casting, as they absorb the moisture from sand, and are thus liable to cause blowholes. If the brass or gunmetal borings are quite free from iron and steel filings, &c., put them in a crucible after the other metal is melted. Use a little borax as a flux, and carefully skim off all dross; then pour, and if the mould is properly made you should get good sound castings.

75, East-road, West Ham. W. Martin.

[76433.]—**Testing Internal Resistance of Battery.**—To "J. T. S."—Unless you have instruments to measure E and C, you cannot arrive at R. I append Mr. Desmond Fitzgerard's method, which I think you will find as good and easy as any. You must first make a resistance that is equal to the sum of all resistances you have in circuit, including all connections and the galvanometer (any galvo. will do), which you use as shunt. Connect as shown in sketch, so that the current divides through the two equal resistances—(1) the shunt S, and (2) the galvanometer resistance coils R. Note the deflection carefully, and then disconnect the shunt. The whole of the current will now pass through the other circuit, and the deflection of galvo. increased. The external R is now doubled, but the internal remains the same. Now you must insert additional resistance in your R coils, until your deflection is the same as before. This extra resistance is exactly equal to the internal resistance of the battery; because it has doubled the internal resistance, just as the removal of the shunt doubled the external.



Sheffield. J. T. S.

[76437.]—**Battery.**—Two Leclanché cells will be found to work your coil well, and require no re-charging for several months. F. Askew.

[76437.]—**Battery.**—"Anxious Lad," you try the E.S. or Gassner dry cell, and don't be bothered with wet cells for your purpose. I am sure you will be pleased with the result. No cleaning or messing with these cells—always ready.

Lewisham. S. Robert Bonney.

[76437.]—**Battery.**—The Grenet battery would answer very well if you take the care of lifting the ring plate as soon as you have done with the current. There is an improved battery made by the Tecnomasio, of Milan, in which the carbon plates are lifted as well: this to avoid the deposit of the green chromic oxide on the carbons. P. Infante.

[76437.]—**Battery.**—Either a bichromate bottle battery (small size recommended), lifting the zinc out of solution when done with, or two largest ordinary size Leclanchés, fitted with circular zincs and connected in parallel, which arrangement will last a great while with care, and is very convenient. A. E. B.

[76437.]—**Battery.**—A chloride of silver cell is generally recommended for the purpose. The cell is water-tight, and less than half-full of liquid. The elements project half-way down. Hence by turning elements downwards the solution covers them, and the battery is in action. Turning all round again puts them out of action, as the liquid cannot reach up to them. Glatton.

[76437.]—**Batteries for Medical Coil.**—There are really only three good batteries for portable medical coils. These are, in order of portability and size, the Mariè Davy, the dry cell, and the single-fluid chromic-acid cell. The Mariè Davy (of which two cells are generally required) consists in a square ebonite box, the bottom of which is paved with a thin sheet of graphite about 1½in. square, to which one terminal is attached. About ⅛in. above the carbon is a square plate of zinc, of the same size, resting on a ledge inside the box. To this the other terminal is attached. The exciting fluid is a thick paste of sulphate of mercury in water. The dry cells can be purchased anywhere for about 3s. each. I prefer the "E.S." Two of these will run a coil for 20 minutes a day for 6 months. The chromic-acid cell, which is the most powerful, consists in any conveniently-shaped glass or ebonite vessel fitted with acid-proof lid, to which is fixed a carbon plate. A zinc rod, attached to a hinged brass bar for facility of withdrawal, completes the arrangement. S. Bottone.

[76438.]—**Lantern Microscope.**—Unless "Silly Billy" has some knowledge of optics, and can grind fine lenses, or get them ground true to special curves, it would be nearly as easy to make the moon as a lantern microscope. Ordinary selected objectives are used; but not the eyepiece. If he will examine a lantern microscope, he will find it anything but a simple thing to make. 999.

[76438.]—**Lantern Microscope.**—A condenser is needed, and an achromatic object-glass. I have never known of six lenses being employed. The eyepiece is not used. I do not think the heat of a lamp would injure the balsam. With the electric light, I believe a slide containing a solution of alum is used, placed between the light and the slide, this being highly absorbent of heat-rays.

A. E. B.

[76439.]—**Electric Bell to Clock.**—You want your clock fitted like one that I have just fitted for a gentleman who required to be rung up at various times. Being a cheap job, I made four spirals (from hard-drawn brass wire, No. 24 B.W.G., silver plated). These were made on wire ⅛in. diameter, each spiral having seven turns. These were bushed with boxwood, and a hole drilled through centre. Solder on to dial near rim, so as to clear minute hand; at 12, 3, 6, and 9 pass a wire through the holes in boxwood bush long enough to complete circle on dial; solder ends together. Now make, of the same wire, a spring clip long enough to come in contact with hour-hand, and to clear minute-hand. The end of this clip that has to come in contact with hour-hand should have a thin piece of platinum foil soldered to it, also a piece to hour-hand where contact is made. This spring clip can be fixed anywhere on the wire circle, the hour-hand to complete circuit at a fixed time. Attach wires from battery, one to metal of clock, the other to the wire circle. This last is done by drilling a hole through dial, so as not to come in contact with works inside clock. Drill another in clock-case, bush these with boxwood tube, pass a wire through, and solder to circle wire on dial-plate. The clock that I have done in this manner is an 8-day metal-case lever, with painted metal face. The clock is fitted to a mahogany box containing the battery (which is a Gassner dry cell). On the side of this battery-box, behind the clock, there are two conical brass tubes connected to battery, one to each pole. The clock has two plugs connected to wires leading from hand and dial wires, arranged so as to fit in these conical sockets when clock is hung on battery-box. Futher details and sketch, if necessary.

Lewisham. S. R. Bonney.

[76440.]—**Desiccator.**—A desiccator is required in connection with mercury pumps, in order to keep the interior free from water vapour. Newly-made vacuum tubes generally contain moisture, and chemicals and salts of many kinds give off a trace of water vapour when exposed to a vacuum. For a moderate exhaustion this does not much matter, but it is fatal to success when a really good vacuum is required, because it cannot be pumped out like the air. Phosphoric anhydride very effectually removes the difficulty by absorbing the moisture as it comes in contact with it. It is very troublesome to make, and I don't advise you to attempt it; but if you specially wish to do so, I will send sketch of simple apparatus for the purpose. Becker's, Hatton-wall, and doubtless other large chemists, supply it in 2oz. bottles, one of which would probably last you twelve months, for if care is taken, it should only want renewing once or twice a year. It is known as anhydrous phosphoric acid; if you ask for phosphoric anhydride, they probably won't know what you mean. The tap for starting and stopping is merely a simple arrangement for pinching the india-rubber tube, and so stopping the flow. Any kind of tap with ground surfaces should never be used in pumps, and an ordinary brass gas tap would be specially unsuitable, as mercury speedily penetrates and destroys brass.

Leicester. E. E. B.

[76442.]—**Twist Drills.**—If "Corkonian" will obtain a printed table, or a set of gauges, he will learn the difference. To print the tables would take up about half a page of the "E. M.," and as they are so well known, it is not likely this will be done. The difference in the prices of the drills with shanks different to the sizes of the drills themselves is simply a question of weight of steel and labour in turning and finishing. Thos. Fletcher.

[76442.]—**Twist Drills.**—The straight shank drills are made from straight steel wire, and are not turned, but have their shank same diam. as drill. Those in first col. are of the inch measurements stated. Those in second col. to the letter gauge range from Z, ·413in. to A, ·243in., letter E being ·25in. or ¼in. The third col. contains sizes from 1 (·227in.) to 60 (·039in.), or possibly to 80 (·013in.) It will be seen that the average fall from size to size is ·003in., and for fine work this is an extremely useful set of drills. The fourth column refers to drills that are not of their stated sizes, but to drill such a hole as would tap with a Whitworth tap of the stated size of drill. They and the drills in col. five (which are of stated size) are turned from steel large enough to make the shanks, which is Morse taper or 3°, or approximately ⅝in. per foot. The size of large end of not taper shank is about ½in. British Bulldog.

[76443.]—**Pressure through Pipe.**—The height of a column of water giving 20lb. pressure at base = pressure × 2·307, the latter being a constant; hence $H = 20 \times 2{\cdot}307 = 46{\cdot}14$ft. This rule applies to any sized pipe. W. Strafford.

[76443.]—**Pressure through Pipes.**—About 45ft. head of water gives 20lb. pressure per square inch. Diameter of pipe makes no difference in pressure, but only in the quantity delivered through it. F. G. Ll.

[76443.]—**Pressure through Pipe.**—If water is not flowing, pressure is unaffected by size of pipe. If flowing, pressure cannot be correctly calculated; and unless current is slow, I do not think it can be correctly ascertained by experiment even. Glatton.

[76443.]—**Pressure through Pipe.**—About 40ft. fall of water would give a pressure of 20lb. per square inch. The diameter of the pipe does not affect this so long as you do not draw any water off—that is to say, the static pressure of 40 perpendicular feet of water is 20lb., irrespective of horizontal dimensions. A. E. B.

[76447.]—**Horse-power.**—There is no way of calculating the loss from the back thrust alone, although it might be found by experiment for a given machine. The loss depends on the work done by friction, and this is again dependent on the thrust, the diameter of step-bearing, the number of revolutions, the lubrication, and the nature and conditions of the rubbing surfaces. The Research Committee of the Institute of Mechanical Engineers, published an extremely interesting report on the friction of end pivots, which was republished in *Engineering*, Vol. LI. p. 478. GLATTON.

[76446.]—**Polygons.**—The second point is always chosen, because it gives a result in some cases correct, and in others very nearly so. If θ be half the first angle of the polygon formed by this method, its value is—

$$\tan.\,\theta = \frac{n - 4 + \sqrt{n^2 + 16n - 32}}{4\sqrt{3}}$$

where n is the number of sides in polygon. Comparing the values of θ from this formula with the correct values for an n-gon. we get :—

			Correct value.
For equilateral triangle,	$n = 3$,	$\theta = 30°$	$= 30°$
,, square............	$n = 4$,	$\theta = 45°$	$= 45°$
,, regular pentagon..	$n = 5$,	$\theta = 54°\ 1'$	$= 54°$
,, hexagon..........	$n = 6$,	$\theta = 60°$	$= 60°$
,, heptagon	$n = 7$,	$\theta = 64°\,14\tfrac{1}{4}'$	$= 64°\,17\tfrac{1}{7}'$
,, octagon	$n = 8$,	$\theta = 67°\ 23'$	$= 67°\ 30'$
,, nonagon	$n = 9$,	$\theta = 69°51\tfrac{1}{2}'$	$= 70°$
,, decagon	$n = 10$,	$\theta = 71°\ 49'$	$= 72°$
,, undecagon	$n = 11$,	$\theta = 73°\ 26'$	$= 73°38\tfrac{2}{11}'$
,, dodecagon	$n = 12$,	$\theta = 74°\ 46'$	$= 75°$

Thus this method is correct for the triangle, square, and hexagon; but for the others the angle obtained, and therefore the side is a little too small, the error increasing with the number of sides. D. S. B.

[76449.]—**Paint on Glass.**—The failure is most probably caused by the glass not being thoroughly clean and dry. If you will be careful on this point, any varnish paint will stand. Probably the best is ordinary black Japan; but if the glass is not absolutely dry, nothing will stand. THOS. FLETCHER.

[76450.]—**Plaster on Hot-Water Pipes.**—When the pipes can be kept cold for a few days, cover them with Portland cement. The difficulty is usually caused by expansion of the pipes breaking the cement away, and if this is the cause, they should be boxed with wood and the space filled with slag, wool, or dry sand. THOS. FLETCHER.

[76451.]—**Laminated Armature Winding.**—To MR. BOTTONE.—If made correctly, there should be only one nut, and that at the commutator end, the laminations being held at the other end by a shoulder left on the spindle. However, you can yet make a good job of it by binding the two first and two last laminations inwards towards the spindle, so as to form a wide V at each end. Then warm some guttapercha and fill in the spaces at the sides, between the sides of the nuts and the bent laminations smoothly. Dress as usual, then wind in one side of the spindle as full as you can; then cross over to the empty side, and always winding in the same direction, fill in that. Finally bind the wire tightly in place by a few turns of "wax-end," passing crosswise between the laminæ.

S. BOTTONE.

[76452.]—**Resistance**.—You will not require 30 cells to measure up to 50 ohms. If your galvanometer is only finely delicate, one or two good bichromate cells will be all you will need. Make up a bridge as described in my book "Electrical Instruments," p. 138, or that described by Mr. Allsop. Then connect the resistance you wish to test with one of the gaps of the bridge. Connect up battery and galvanometer to their respective binding screws (or mercury cups). Now insert different known resistances from the box into the other gap. Tap the contact key, and watch the galvanometer, and alter the known resistance till you get the needle of galvanometer to stand perfectly at zero, even when the key is standing on the zero of the bridge's scale.

S. BOTTONE.

[76456.]—**Jupiter.**—I think Sir R. Ball means in this case the "radius of gyration," which can be calculated in the case of a sphere of known density revolving about its diameter. Its value being ·6324 ∟ per ∟ radius. IOTA DASH.

[76457.]—**Mathematical.**—In the first sale, equal numbers of oranges are bought at each rate. In the second, twenty-four oranges are bought at the higher rate, and thirty-six at the cheaper rate.

GLATTON.

[76457.]—**Mathematical.**—If "Puzzled" will again examine his puzzle, he will find that to mix two lots of oranges of different values he must take a quantity of each of the same value, not of the same number :—

30 at 3 for 1d.	=	0s. 10d.
20 at 2 for 1d.	=	0 10
		1s. 8d.
50 at 5 for 2d.	=	1 8

THOS. FLETCHER.

[76457.]—**Mathematical.**—The explanation of "Puzzled's" difficulty is that 30 oranges at three a penny and 30 at two a penny do not make 60 at five for twopence, but only 50 at that rate, and the remainder at two a penny. Thus, the 30 at three a penny make only ten lots of three, but 30 at two a penny make fifteen lots of two. Now, ten lots of two added to the ten lots of three make ten lots of five, and these at twopence cost 1s. 8d. The remaining lots are of the two a penny sort, cost 5d., and the whole, therefore, 2s. 1d. THORNFIELD.

[76457.]—**Mathematical.**—The rule that produces this result is a very simple one. It is that you cannot purchase 60 articles worth 2s. 1d. for 2s. 30 oranges at ½d., and 30 oranges at ⅓d. each, do not cost the same as 60 oranges at ⅖d. each, because 30 oranges at ½d. = 1s. 3d., and this exceeds by 1d. the difference in favour of the cheaper oranges. But if you notice the catch lies in the false idea conveyed in the words "half the oranges at two a penny and half at three a penny, instead of half the value of oranges at two a penny and half the value at three a penny, which, of course, comes out 28 at ½d., and 30 at ⅓d. S. BOTTONE.

[76460.]—**Ivory Brushes.**—When brighter weather reaches us, expose to rays of sun behind glass—inside a window, for instance. GLATTON.

[76460.]—**Ivory Brushes.**—I think the simplest method would be to get a sheet of medium glass-paper to take the worst of stain out, finishing with a finer sheet. Then, to repolish, take a piece of flannel or felt soaked with whiting and water, rubbing brushes well till polished. E. P.

[76463.]—**Arc Light.**—The reason for using so coarse a wire will be evident after a moment's consideration. The arc light is best fed by a series-wound dynamo, and in the series-wound machine the whole of the current generated must pass round the field-magnets; hence the wire must be of sufficiently heavy gauge to carry that current without heating. About 8 ampères at 50 volts will give 1,000c.p. in a good arc lamp. If fitted with a luminated H armature, the little dynamo can be run continuously without getting hot; if with a solid H armature, 20 minutes is as long as it is safe to run it. S. BOTTONE.

[76464.]—**Lighting Jewellers' Shops.**—To MR. BOTTONE AND OTHERS.—I have seen several such lighted by one arc light outside (Brockie-Pell type), 1,000c.p. taking 8 to 10 ampères at 50 volts, and two or three smaller arc lights (Beaumonts) taking 3 ampères at 50 volts. These seemed to give every satisfaction. The price of fitting up and wiring, including the lamps themselves, came to about £25. What you would have to pay for current to work them I don't know—probably about 7d. per unit of 1,000 watts. The arc light is much cheaper than the glow. S. BOTTONE.

[76464.]—**Arc or Glow Lamps.**—The arc lamp could be used either for outside or inside illumination, or both; but it is certainly not to be recommended. The glow lamp is especially suitable for interior lighting. In my opinion, about eight 16-candle lamps inside, and a "Sunbeam" incandescent lamp of 150c.p. outside, will give a splendid light. As to cost of fitting, this will depend on who you get to do the work, and the way in which the same is done—probably 10s. per light. The cost per week for working will depend on the number of hours your lamps are burning, and the price per unit charged for the current. As to its superiority over gas, I need hardly say that its slight extra cost is nothing compared with the saving through non-deterioration of stock. Then, again, it is more effective, showing contents of window to better advantage. An idea is gaining ground amongst the jewellers that the current affects their watches; but this is purely a fallacy.

F. ASKEW.

[76465.]—**Cutting Retort Carbons.**—You will find nothing better than an old saw (keep the teeth wide set, so as to get plenty of clearance), fine sand, plenty of water, elbow-grease, and patience. I have cut many a hundredweight in my time, and a nice job it is. Once, when very hard pushed for large plates, I was assailed by a number of gentlemen singing, "We've got no work to do-o-o." So I offered them 3s. a day, and food, to saw up some plates for me. By 12 o'clock they all "struck," took 1s. 6d., and renounced the dinner, rather than continue. Only one poor man stuck to the job.

S. BOTTONE.

[76466.]—**Engineering Arithmetic.**—Cotterell's "Applied Mechanics" (Macmillan), 13s. 6d., is the book you require.

A. D. SOUTHAM.

[76467.]—**Workable Distemper Colours.**—If for outdoor work, add to your whiting and size-wash some (?) bichromate of potash in solution. This, when exposed to light, renders the gelatine insoluble (as photographers well know); therefore the pigment is not washed off by rain. I have used it on galvanised roofs, also greenhouse. For finer internal work, I have used as a vehicle an aqueous solution of shellac in borax—5 lac, 1 borax, 20 water; boil till dissolved. This can be filtered, if required, till as bright as port wine. This, I believe, is the basis of the so-called sanitary washable wall-papers. They all have the tint of it, when once dry; water will not wash it off; but alkali or soa "fetch it." F. G. L

[76468.]—**Haydon's Cutter-Bar.**—The must make 55° with the horizontal line. The in which it lies is rectangular, or just a shade le that in the sling, which is a separate affair is al right angle. In the number Dec. 10, '69, Vol. is Haydon's own drawing of sling and bar. It h appeared several times since. Thickness of sh is, as supposed, that of height of centres above surface of rest. Sorry I have not time to-day give a brief *résumé* of the plan for setting out b but perhaps the reply now given to the special q tions will suffice. O. J. L.

[76469.]—**Neptune.**—The first satellite Neptune, discovered in October, 1846, by Mr. La revolves round its primary in 5 days 21 ho approximately; its motion is retrograde, as are al the satellites of Uranus, and the orbit is inclined the ecliptic at an angle of 35°. H. S. P.

[76470.]—**Enlarged Measuring Glass.**— doubt if this can be done. But please say wh is to be the value of the spaces—an ounce, a drach or what? Do I understand the whole apparatus is be not more than 6in. high? Something mig be done, perhaps, by adding a displacing body some sort, the height of which could be adjust Would this be admissible? Is it for a rain-gauge?

GLATTON.

[76473.]—**Lathe.**—See Molesworth, p. 434; al Calvert's "Screw-Cutting," 2s. 6d.

W. STRAFFORD.

[76473.]—**Lathe.**—Divide the threads per inch in the screw to be cut by the threads per inch in the leading screw. This number must be equal to the result of dividing the product of the numbers of teeth in all the driven wheels by the product of the number of teeth in all the driving wheels. If the threads per inch in required screw ar

times the number per inch in leading

train of wheels must be used. It is

convenient to do so if they are more

[76474.]—**Electric Light.**—Of the Jablochkoff candle itself I do not know of any disadvantage beyond that it necessitates in use an alternating current. It appears to be not so much used as it was 10 years ago, though why I fail to see, as it dispenses with the intricate mechanism of ordinary arc lamps. They are not placed in a vacuum—first, because in practice such would be impossible; secondly, there would probably be no advantage, even if it were possible. Compare the brilliant electric spark in air with the nebulous glow of vacuum tubes. A. E. B.

[76474.]—**Electric Light.**—To MR. BOTTONE.—The disadvantages of the Jablochkoff candle are:—1st, When burning it is apt to go out either through inequality in the two carbons or small variations in the current. 2nd, As there is no adjustment, there is no means of starting the arc again short of again placing a bridging piece across the two carbons. 3rd, It can be worked by alternating currents only. It is not extensively used now. The light is not so good in a vacuum, and no good purpose would be served by placing the candles therein.

S. BOTTONE.

[76474.]—**Jablochkoff Candles.**—The above are not so efficient as arc lamps, the light given by them as compared with the arc lamps being, it is said, as 8 to 7. Again, the positive carbon is consumed twice as fast as the negative, this being a great disadvantage, one carbon having to be thicker than the other. Alternating currents have to be used, and so, on the whole, are nowhere equal to the regulator lamp. F. ASKEW.

[76475.]—**Hydraulic Formula Wanted.**—If h = height in inches, $H = \frac{h}{12}$, hence formula becomes—

$$C = 2{\cdot}54\sqrt{\left(\frac{h}{12}\right)^3}$$

$$= \frac{2{\cdot}54}{\sqrt{248832}}\sqrt{h^3}$$

$$= {\cdot}005095\sqrt{h^3}$$

or— $$= \frac{\sqrt{h^3}}{19{\cdot}62}$$

GLATTON.

[76475.]—**Hydraulic Formula Wanted.**—Beardmore's formula, giving cube feet per minute falling over each foot in width of weir :—

$$Q = 214\sqrt{h^3 + {\cdot}035\,v^2\,h^2}$$

Where—

h = observed depth of water falling over gauge

v = velocity of approach in feet per second.

Example: Let h measure 1ft. 6in., and v = 3ft. per second. Then by formula—

$$214\sqrt{3{\cdot}375 + {\cdot}70875} = 214\sqrt{4{\cdot}08375}$$
$$= 214 \times 2{\cdot}02, \text{ say, } 432\text{c.ft. per min.}$$

Multiply by 9,600 to get number of gallons in 24 sure. I give table of discharge of water over uge board 1ft. wide.

pth in inches.	Gall. per min.	Gall. per diem.
⅛	1·319	1,899
¼	3·731	5·372
⅜	6·855	9·871
½	10·274	14·749
⅝	14·750	21·240
¾	19·390	27·921
⅞	24·435	35·186
1	29·853	42·986
1¼	41·853	60·268
1½	55·017	79·224
1¾	69·239	99·833
2	84·709	121·970
2¼	101·072	145·543
2½	118·376	170·461
2¾	136·570	196·660
3	155·612	224·081

J. H. A.

[76476.]—**Compound Principle.**—If the second cylinder cuts off before the end of stroke, the steam which completely fills the first cylinder at commencement of exhaust, has to be compressed into a smaller space in the second one. Here is loss of work at once. There would be no more expansion with the two cylinders than with one: hence the range of temperature and the loss by condensation would be no less than with one,—indeed, the loss by initial condensation would almost certainly be greater with the two. There would also be more friction with the two cylinders than one, without the compensating gain in power which is obtained by the ordinary arrangement. GLATTON.

[76476.]—**Compound Principle.**—In order to obtain the full amount of useful effect from the expansive property of steam, it is the practice to employ a certain number of expansions—i.e., the number of times the steam increases its original volume; and during the period of such expansions it is allowed to act upon, perhaps, two or three pistons. Now, as the increase of volume necessitates a proportionate decrease of pressure, the second piston must be relatively larger than the first, in order to equalise the pressure upon the rods, and to balance the engine. The query asked by "A. E. B." has taken many years and infinite labour to solve, and I should advise the querist to purchase a textbook on the compound engine.

WALTER STRAFFORD.

[76477.]—**Moulding Celluloid.**—This is done by pressure and heat; no solvent must be used. Warm a piece of celluloid slowly, and you will find it becomes soft. THOS. FLETCHER.

[76480.]—**Water Motor: Transmission of Power.**—A wooden water-wheel will probably be the cheapest motor. You must gauge your stream, and ascertain the quantity flowing per minute before the power, &c., can be estimated. Probably wire-rope transmission would answer, or an underground shaft in a well-drained, covered trench. Dynamo should be near wheel, if possible.

GLATTON.

[76480.]—**Water Motor: Transmission of Power.**—The following formula give the approx. horse-power that can be obtained by means of a turbine from any given water supply:—

$$H.P. = \frac{Q\,H}{13}.$$

Where Q = quantity of water in cubic feet per sec.
H = head of water in feet.
H.P. = indicated horse-power.

This formula is from Holmes's "Practical Electric Lighting." Molesworth gives several; but it is necessary to calculate discharge in cubic feet. Efficiency of turbines about 70 per cent.

A. D. SOUTHAM.

[76481.]—**Battery.** — Charge: Chromic acid, 3oz.; water, 1 pint; and when cold, 3oz. sulphuric acid. If your plates are close together, you may get 10 ampères on the short-circuit, and be able to light well for three hours a 20-volt 10c.p. lamp, taking about 2·5 ampère. F. ASKEW.

[76481.]—**Battery.**—Your battery of 10 cells single fluid chromic acid will give about 20 volts, and 10 to 12 ampères on the short-circuit; with lamp and wire in circuit 2 or 3 ampères at 20 volts pressure. Hence you might reasonably expect to light well an 8c.p. lamp of about 20v., taking 2 or 3 ampères of current. The best exciting fluid is, as I have so often written:—Chromic acid 3oz., chlorate of potash ¼oz., water 1 pint, sulphuric acid 3oz.

S. BOTTONE.

[76482.]—**Workshop.**—"Young Beginner" no doubt meant to say 3H.P. indicated. If his large lathe is 7in. or 8in. centres, he should have ample power for the machines he now has. His 1⅜in. shaft will also do, but if he may add to his machines ⅜in. or ¼in. larger shaft would be advisable, unless they are to be small ones. I find a 1½in. shaft to run well and steadily carrying 14 pulleys. The shaft is 18ft., has 4 hangers, and runs at 156. "Y. B." will save future annoyance if he uses split pulleys, excepting the main drive.

BRITISH BULLDOG.

[76484.]—**Gas-Engine.**—Arrange for less gas and more air; also more compression, if possible.

GLATTON.

[76486.]—**Analysing Solder.** — If "J. L." wants to analyse tinmen's solder, a determination of the percentage of tin will be quite sufficient. The amount of lead can be then calculated. To find the amount of tin proceed thus: Take about 2gr. (30grns.) of the finely-powdered solder, dissolve in HNO_3 at gentle heat in a beaker until red fumes have ceased to come off; then add about three times the amount of water as you have fluid already in your vessel, and raise to the boil with continual stirring. This latter treatment is most important. Allow to settle until fluid is clear, and decant on to a filter. Repeat digestion for one hour with HNO_3 (1 : 6). Filter, wash five times with boiling water, dry at 100° C. in bath, and ignite the precipitate very strongly for 15 minutes in a porcelain crucible (not platinum. (This treatment gives the tin as tin oxide, *i.e.*, SnO_2.) Cool in desiccator and weigh. From the increased weight of the crucible the amount of SnO_2 is known, and thus the percentage of tin may be calculated. An actual example may assist:

Weight of solder = 2·293
Por. crucible + SnO_2 = 8·976
" " = 7·585
∴ SnO_2 = 1·391

$$\text{Tin} = \frac{117{\cdot}8 \times 1{\cdot}391 \times 100}{149{\cdot}72 \quad \times \quad 2{\cdot}293} = 47{\cdot}429 \text{ per cent.}$$

Lead (by difference) = 52·571 per cent.

IOTA DASH.

[76487.]—**Staining Sections.**—"Lucida" will find method for preparing a good stain in "E. M.," July 24, 1891. IOTA DASH.

[76489.]—**Electric Lighting.**—You will need a ½H.P. motor. Ask Mr. Bailey, of Salford, about this, giving him full details as to water-pressure, &c., you have. The dynamo should be a so-called 100c.p. shunt-wound drum armature machine. This would light well five or six lamps of 16c.p., 50 volts. S. BOTTONE.

[76492.]—**Electric Lamps.**—I am afraid "P. T. Jim" will find rather troublesome the repairing or manufacturing of incandescent lamps. He can can consult Dr. Alfred Von Urbanitzky's Treatise on Electricity. I believe there is an English version of this work. P. INFANTE.

[76492.]—**Electric Lamps.**—If you are prepared to lay down a plant for the construction of glow lamps, you can make them for your own use, and your own use only, for they are the subject of a patent. As to repairing them, this is little short of making them, and you would certainly require most of the apparatus for so doing.

F. ASKEW.

[76493.]—**Artificial Plant Barometer.**—Use a solution of pure chloride of cobalt for the flowers, and a solution of a mixture of chloride of cobalt and nickel for the leaves. S. BOTTONE.

[76494.]—**Zinc.**—Make the plates as hot as the hand can bear, and bend over a wooden cylinder to the required size. Much better than casting them.

F. ASKEW.

[76494.]—**Zinc Castings for Bunsen Cells.**—If the querist will turn to page 443, Vol. XLIX., he will find a simple method designed by me that produces a nice smooth casting, without using copes or sand. Unless "Photo." has a lot of spare zinc, I should strongly advise him to buy new rolled zinc cylinders. NON-MATHEMATICAL.

[76495.]—**Filter for Rain Water.**—Employ two barrels connected near the bottom of each by a pipe. Plug the pipe of No. 1 loosely with a sponge, or tie over it two or three thicknesses of asbestos cloth. Draw off from No. 2, or get a small tub to fit the top of your barrel. Drill hole in the centre of the bottom of same, and plug with sponge, cover with cloth, or both, if necessary. A. E. B.

[76495.]—**Filter for Rain Water.**—If your correspondent, "F. M.," will employ granular silicated carbon in his filter, he will doubtless get the result he desires, and he can obtain the material from 3d. to 4d. per pound. The aperture of 18in. by 1½in. appears to be small for even a limited area of rainfall, and it would be wise to provide an overflow for storm water. He should get the silicated carbon in different grains, placing a layer of fine carbon between two layers of coarse.

BRIGHTON.

[76495.]—**Filter for Rain Water.**—If "F. M." could arrange to fix a barrel at a higher level than his rain-tub, leading the down-pipe into it, and fixing a perforated board or zinc plate on the inside about 12in. or 18in. from the bottom, covering it with a layer of charcoal 12in. thick, above that the same thickness of coarse sand, and on top a similar quantity of gravel, it would, I think, meet all his requirements. A pipe should be fitted at bottom of filter to connect it to the rain-tub. The charcoal, sand, and gravel should be washed before being used. CESTRIAN.

[76495.]—**Rain-Water Filter.**—Powdered coke is best. Water will run through quicker than through sand. LINCOLN.

[76496.]—**Charcoal.**—I think you might manage this with a slow-combustion stove. Pack your branches (sawn into small logs) in the stove, light, and only allow sufficient air to enter to generate heat sufficient to volatilise the vaporisable matters, and when this is accomplished, which point you must watch, close all openings, if necessary, with clay, and allow to cool down. A. E. B.

[76496.]—**Charcoal.**—To burn charcoal, a piece of ground is levelled; a thick pole is placed upright in the centre. Round this logs or faggots are placed vertically, afterwards at an inclination. This secures a current of air through the heap to the chimney (which is formed by drawing out the central pole previous to lighting the fire). The large wood should be placed first, and the smaller on the outside, which should be closely packed. The heap is then covered with brushwood, and afterwards with turf, clay, or sand. The material for lighting, having previously been placed at the bottom of the heap before piling the logs, is now ignited. Holes in the earth covering at the bottom having been made, air is admitted till the fire spreads through the heap. Should this not do so, a new hole made in the covering will soon remedy it. When the smoke and white flame cease to escape at the vent, all the bottom holes are closed, and lastly the chimney. The charcoal then smoulders till it cools and is ready to be drawn. CESTRIAN.

[76499.]—**Gold Lacquer.**—Rectified spirits of wine 332 parts, shellac 16 parts, dragon's blood 4 parts, turmeric 1 part, crushed glass 16 parts—all by weight. Powder the resins in a clean mortar along with the glass; place in a narrow-mouthed, glass-stoppered bottle; add the spirit, and agitate two or three times every day for a week. Allow to settle, then decant the clear portion for use.

S. BOTTONE.

[76499.]—**Lacquers.**—For a pale lacquer: 1oz. gamboge, 2oz. Cape aloes, powdered, 1lb. pale yellow shellac. Pale-gold lacquer: 8oz. shellac, 2oz. sandarach, 8oz. turmeric, 2oz. anatto, ¼oz. dragon's blood, 1 gallon spirits of wine. Stand 10 days in warm place, shaking bottle frequently. Tried. F. ASKEW.

[76500.]—**Accumulators.**—You will find full description of the best way to make these at pages 189 to 197 of my book, "Electrical Instruments"; also in ENG. MECH., in several of the recent volumes. S. BOTTONE.

[76500.]—**Accumulator.**—A good accumulator is formed by a glass cylinder containing a porous pot, both filled with a mass of leaden dust. In the outer cylinder there is placed the (−) leaden narrow plate, and in the porous pot the (+) one. The two divisions of the leaden mass are immersed in dilute sulphuric acid. P. INFANTE.

UNANSWERED QUERIES.

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

Since our last "Glatton" has replied to 75219, 75283, 75336, 75430, 76064; "Max Paris," 75750; "Mistral," 75925, 76164.

75988. Phosphor Bronze, p. 339.
75996. Triangle, 339.
76006. Small Hooks, 339.
76009. Deviation of Compass, 339.
76010. Wire Spinning for Pianofortes, 339.
76017. Generator for Gas Furnace, 339.
76021. Spiral Steel Springs, 339.
76033. Steel Tube and Casting, 340.
76035. Telephone Construction, 340.

76188. Violoncello, p. 426.
76189. Roof, 426.
76190. Resilvering Glass, 426.
76191. Portable Telescope, 426.
76206. Arc Lamp, 427.

THERE are at least two hairless horses in the United States, one of which has a silky, smooth skin of a black colour. It has neither tail, mane, nor body hairs, and is of a heavy build. The other specimen does not seem to perspire through the skin, but rather through the mouth and nose.

IT is stated that a German firm has perfected a means of making a profitable disposition of sawdust by which it is applied to a mechanical use, and has thus far been attended with success. An acid is mixed with the sawdust, and the whole mass moulded into blocks or any other form, resulting in a fine material for building purposes. The blocks assume extreme hardness of surface, and are practically non-combustible. The material in the moulded forms is said to be much stronger than timber in these forms, and much lighter than either iron or steel, and can be prepared cheaply.

QUERIES.

[76503.]—**Wells.**—Wanted, reference to books on; or private water supply by gravitation—H. W.

[76504.]—**Bell Circuit.**—I have two shops about 60yds. apart, and want to fix a bell circuit just to indicate, and to ring in opposite directions, namely, right-hand push to ring left-hand bell, and left-hand push to ring right-hand bell. How many cells should I require? I must of necessity have two wires, and believe outdoor twin would suit. Could I possibly make earth the return wire by connecting to gas-pipe? Please state a better and cheaper method of indicating or communication.—Tradesman.

[76505.]—**Spectroscope.**—I wish to make a spectroscope, and shall be glad of advice on the following points: I possess a quartz prism of 1½in. base. (1) What size lens will do for o.g. of telescope, and what eyepiece shall I use? (2) What ought the telescope to magnify? (3) What must be length of collimator and size of glass for paralizer? (4) Ought paralizer to be an achromatic glass, and what diameter and focus? (5) How can I make a slit, and what ought to be the size of opening? (6) How can I tell when prism, telescope, and collimator are properly adjusted? Any hint that will help me I shall be thankful to receive. Is there any elementary work with description of spectra published? I have Proctor's book.—Spectrum.

[76506.]—**Ring Armature.**—Would Mr. Bottone kindly tell me the proportions for a small dynamo suitable for a ring which I have? It is soft cast iron, turned all over, 2¼in. outside, 1 5-16in. inside, 1in. wide. I should like to light a 10c.p. lamp. As low a voltage as possible, so that it will be suitable for charging accumulators.—Ring Armature.

[76507.]—**Electrical.**—Sir D. Salomons, in his "Management of Light Installation," gives the ampères given by each square foot of surface in the secondary cell. What I want is a simple explanation similar to this of the ampères given by the different sorts of primary batteries? Also can Mr. Bottone tell me how to make a switch to reverse the double-pole boat motor described by you some time ago?—No Name.

[76508.]—**Hansom Cab.**—Could some kind reader give me a few dimensions of a hansom cab, as I wish to make a drawing to send abroad to my brother, who wishes to have one made there? Any of the ordinary cabs will do, preferably the square or oblong ones—Experimenter.

[76509.]—**Optical Illusion.**—I have noticed in several publichouse lamps with purple glass in them a reddish halo round the flame, which often disappears on closer approach. Can anyone explain this? I may add that I wear concave eyeglasses.—J. H. A.

[76510.]—**Raising Large Weights in Water.**—A friend of mine tells me that an appliance was made by which large weights could be raised in water; it was made of stout tin in the shape of a beer-barrel, about 2ft. long by 1ft. across centre, to which was attached a flexible tube. By blowing through this tube with the mouth 2cwt. could be raised to the surface of the water. I believe it was exhibited at the Aquarium some time ago. If any reader could explain working of same should feel obliged.—Hydraulic.

[76511.]—**Water-Motor.**—Would the supply from a ¾in. house water-main in a main road with constant-supply system be large enough to work a h.p. water-motor? If not, what size pipe would be necessary? The water is supplied by the Vauxhall Water Co. Shall be much obliged for any information as to cost of working, &c.—R. W.

[76512.]—**The Sun and Earth.**—Will "F.R.A.S." or other correspondent inform me whether I am correct in my conclusion that supposing the earth were replaced by a sun having the same mass and volume as the sun of our system, and the two revolved around a common centre of gravity, their distance apart being the same as that separating the sun and earth, they would have a period of about 129-136 days?—L.

[76513.]—**Induction Coil for Telephone.**—To Mr. F. C. Allsop.—I have constructed a Gower-Bell telephone by your instructions given in this paper about a year ago. I wish to have an induction-coil in it which I want to be suitable for a distance of from half to two miles. Kindly say what weight of No. 33 B.W.G. double silk-covered copper wire should be used to form the primary coil of each instrument, and also of No. 28 to form the secondary-coil in each? Is the No. 28 to be single or double silk-covered, and what must be the length and diameter of the soft iron core? You say its having an exposed diaphragm is an objection. Would it be an advantage to have it covered in by some such arrangement as the Johnston telephone is? Should the diaphragm be secured by cork-pads at the angles only, or by strips of wood all round, or ends only?—Herbert Hall.

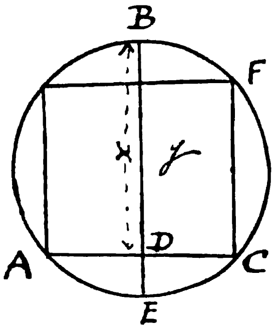
[76514.]—**To Opticians and Lanternists.**—Connected with an optical lantern I have three plano-convex lenses, which, as near as I can make out, are respectively of 10in., 11in., and 13in. focal length. Each of these lenses slide into a brass tube, and are fixed in position by a series of flat brass rings which slide backwards and forwards inside the aforesaid tube. Will any of your readers kindly answer me the following queries respecting the working of the lenses, as the instructions issued with the lantern are lost? 1. Will two lenses, each of different focal length, when mounted in one tube act in conjunction with each other and produce a sharp picture—as these are apparently intended to do? 2. In using them as doublets, what would be the proper distances the respective lenses should be apart from each other to produce the best result? 3. How ought the lenses to be placed inside tube? Should the convex or plane sides be placed next the condensers, and should the convex sides of both lenses when used together face the same way?—Inquirer.

[76515.]—**Accumulators.**—I have 51 cells in series, F.C.C.Ld. × W. type. When first charged, the hydronote rose to 1209; it has gradually sunk till now it is 1175. Should I put more acid to raise them to 1200 again? I have been told that the acid does not evaporate. Please state if that is so. My cells have been in use 20 months.—Electric.

[76516.]—**Telescope.**—I have a 3½in. Tully telescope, which I bought lately. The performance not being good, I wish to know if the o.g. is in the right way. There are two lenses in it: one a thin lens, the other thick; it is 5ft. 6in. focal length. In trying to reverse the o.g. I unluckily got it fast in the cell, which is too small. How can I get it out without injury to the o.g.? I do not wish to cut the cell.—Star Gazer.

[76517.]—**To Mr. Bottone.**—In building a ring armature of laminations, is it quite necessary to use bolts of other metal than iron? Will you kindly let me know the amount and size of wire to give 50 volts on a ring armature 5in. in diameter and 4in. long at 1,900 revs per minute? How many 16c.p. lamps of that voltage may I expect to light? F.M. wound with 11¾lb. of No. 20 B.W.G.—Electric.

[76518.]—**Differential Calculus.**—Would you kindly tell me if I am right, or where I am wrong, in the following problem? I wish to find the length, B D, so that the area of the rectangle A F shall be as great as



possible in the circle A B C. r=radius of circle, x=B D. Then D C will be a mean proportional between B D and D E. That is, D C $=\sqrt{x\,(2r-x)}$, and A C$=2\sqrt{x\,(2r-x)}$, and F C $= 2\,(x-r)$. Then y the area of rectangle$=2\,(x-r) \times 2\sqrt{x\,(2r-x)}$. I should like to know if I am right so far? Then, if $y=(2x-2r)\,[2\,(2rx-x^2)^{\frac{1}{2}}]$, Does $\frac{dy}{dx} = 4\,(2rx-x^2)^{\frac{1}{2}}+\frac{(2r-2x)\,(2x-2r)}{(2rx-x^2)^{\frac{1}{2}}}$? I should be glad to have any errors in the above pointed out, and I should be further obliged if you would kindly name the best book on the Differential Calculus to follow the lessons lately given in the "E. M."—Stany.

[76519.]—**To Telephonists.**—I have two telephones with switch bells, distance 50 yards, two Leclanché cells No. 2 at each end, no induction coil, a carbon transmitter, a relay at each end for ringing bells. I wish to extend to another room distance 70 yards, and to put them like those on the railroad cabins, three in series to ring up by signals, one for No. 1, and two for No. 2, and so on. I wish for some one to kindly sketch inside of switches the connections for same. Is it possible with the relays to be worked on this principle? What puzzles me, when two are talking, won't the other bell be ringing by the current passing? Also would two cells in addition to the four be sufficient?—Young.

[76520.]—**Hunnings Transmitter.**—Can any reader tell me if ferrotype plate would do instead of platinum, or if there is anything that would come in cheaper than platinum and answer as well? Also is the back plate made fast round its edges the same as front plate? What is the size of plates and distance between back and front for the granulated carbon?—Slater.

[76521.]—**Photographic Tent.**—I require a portable tent for developing and changing plates, in size 5ft. high by 4ft. square, so that I can take number of photos on the spot and develop them if required. I want this so that it will fold up for travelling. Can anyone give me a hint or two what to make it of, and how to make it—quite light proof?—W. A. T.

[76522.]—**Shooting Stars.**—Can "F.R.A.S." or any of your readers give me any information regarding the following:—Last night, at 11.20 p.m., as I was looking at Capella I saw what appeared to be a star pass below that star (Capella), and disappear in Orion. It appeared brighter than Procyon, and seemed to move something after the manner of a fire-balloon, but with a greater apparent velocity; it remained in view an appreciable space of time, and did not appear to fall as it moved. I see in your "Astronomical Notes for February," the first is given as a date to look for shooting stars; but as this one is altogether different from any I have hitherto seen, I should like to know if it is a common occurrence, and if it may be looked for on the 15th. Perhaps some of your correspondents can also enlighten me as to what part of the heavens Saturn may be looked for at present?—Curious.

[76523.]—**Dynamo.**—Will any one kindly explain to a novice why, when two strips of lead immersed in dilute sulphuric acid, one attached to positive and other to negative of dynamo whilst running the cause of the one from positive turning brown, and negative remaining nearly the colour? An explanation of the above will oblige.—C. J.

[76524.]—**Joining Tinfoil.**—Can any of our readers inform me of a substance that will join the foil together? It is too thin to solder, and I want some substance that will join it firmly.—J. B. W.

[76525.]—**Oil-Gas.**—Can any one inform me how to make oil-gas to light up small house, say, three burners at once? I have heard of the Helios gas-making machine. Could any reader give me information respecting it, or give me some cheap method of lighting small house?—W. W.

[76526.]—**Bronze Casting.**—To Mr. Fletcher.—Having one of your No. 3 furnaces I intend to try bronze casting beetles, &c., by the burning-out process. Will you please give the proportions of metals to make a good bronze for this work? Also, whether gold or silver are sometimes added to bronze—in what proportions, and do they improve the colour? Also a receipt to bronze the castings to give them the dark colour of old bronze? Some works say sulphate of copper, verdigris, and vinegar; but do not say proportions, or if used hot or cold. Also, what proportion of plaster of Paris and Bath brick will stand a bright red heat to burn out the beetles, &c.?—J. J. H.

[76527.]—**Chamber Organ.**—Can any of our readers interested in musical instruments help me by giving me specification for a small pipe-organ for a drawing-room, the size of which is 15ft. long by 12ft. 3in. by 8ft. 7in. high? I have got a book on "Organ Building," by Mark Wicks, and I shall carry out his directions for making paper pipes. Can I, with a height of 8ft. 7in. make a small instrument with two manuals and pedals, or would the pedal-organ be too loud for the size room? I should like to be able to construct the organ in the smallest possible space, so as not to make a large bit of cumbersome furniture. What would be the best arrangement of stops for the great and swell organs? At page 14 in Mark Wick's book on "Organ Building for Amateurs" a small two-manual is described comprising—(Great organ): Open diapason, 44 pipes; stopt diapason bass, 12 pipes. (Swell organ): Lieblich Gedact, 44 pipes; flute (for principal, small scale), 44 pipes; total, 144 pipes. Couplers: Swell to great unison, swell to great octave, octave on great. Now, what would be size of the foregoing without the case, making it as compact as possible? Could the Keraulophon to tenor C, 44 pipes, be added to the swell, without making it more than 4in. or 5in. broader? As I am a shipwright, I shall be quite at home on a job of this sort; but I shall have to study economy as much as possible. In conclusion, I may say that I have made with satisfactory results a paper pipe at a cost of ½d.—Chorister.

[76528.]—**Electrical.**—I have a number of carbon plates, taken from old Leclanche cells. Will these plates be suitable for a bichromate or any other battery I may make up? Also, will they want any preparing? Also, I have eight horseshoe magnets, each wound with about 5lb. of No. 18 cotton-covered wire, which I want exciting to saturation all at once. The length of the core is 4in., diameter about 1¼in. What battery must I use, and how many cells of one pint each?—H. P.

[76529.]—**Swing Bridges.**—Will — information of the construction of railw over the river Humber at Goole and How and width of swing opening?—Engineer.

[76530.]—**Voltmeter.**—Will Mr. Bott the following information: In the "E. —, Oct. 10, 1890, p. 150, are particulars of voltmeter to read to 50 volts. I propose constructing myself two—one to read to 10 volts, the other to 25. What alteration would be necessary in the sketch given to bring out a good 10 and 25 volt as above? Would not the grading of quadrant be better done by the aid of a dynamo and first-class voltmeter? I think I can have the use of both. I see also from sketch the sucking solenoid dimensions are given as 1½in. long × ⅝in. internal diameter. Would a slot, say, 3-16 × ⅝in. or 1in. × 1⅛in. long be better than the ⅝in. round hole?—there being to me scarcely room for hanging pieces B to clear.—Volta.

[76531.]—**Magnetising Steel Plates.**—I wish to magnetise a number of thin steel plates ⅝in. × ⅛in. for a belt. Will a correspondent tell me how I can permanently magnetise them? I cannot get them to retain the magnetism for many weeks, and for my appliance this is no use. Does the quality of steel used matter? I have carefully fixed them with north pole downwards, but the magnetism disappears in six or eight weeks.—J. S. B.

[76532.]—**Revolving Stereoscope.**—I am anxious to make a revolving stereoscope to hold from 50 to 100 slides, and to show transparencies as well as ordinary slides?—J. Johnson.

[76533.]—**Microphone.**—Can Mr. Bottone or Mr. Allsop help me in the following? I wish to use a microphone to hear sounds produced inside a closed box through the sides with the greatest increase of loudness possible. What form of microphone would be best—the possibility of the battery clicking or making other sounds must be reduced to a minimum? I have two Bell magnets for telephone, bobbins wound to 70 ohms. Could these be utilised to render battery unnecessary? I should think a bi-aural arrangement, similar to that used for phonograph, would greatly help to shut out exterior sounds. I wish to test sounds in various portions of the surface, say about 2in. at a time. A sketch of the arrangement would much oblige.—G. M.

[76534.]—**Ramsden Eyepiece.**—In a Ramsden eyepiece consisting of two plano-convex lenses, each 1½in. focus, separated by a distance of ¾in., what should be the diameters of field and eye-lenses respectively; the aperture, and position of stop? Also, what sized opening should be provided in front of eyelens to look through. The e.p. as at present mounted by myself is unsatisfactory, and I think the apertures are not proportioned correctly.—C. Canwell.

[76535.]—**Eye Disease.**—For some year or two past after reading or writing too much by artificial light I have seen, when looking at a bright, naked light or flame, a ring of light consisting of bands of red, orange, yellow, and green, forming a kind of halo round the flame, and sometimes this has been followed by a partial blindness of the left eye, which, however, has always passed away in a few hours' time, after sleep or resting the eye. But a fortnight ago an attack of this same blindness came on suddenly, and has not passed off. The doctor says it is "glaucoma," and an operation, consisting of cutting away a portion of the iris, among other things, is necessary to restore the sight. This naturally terrifies me, and I would be glad to know whether there is any need for such operation; and what other treatment would be beneficial. My doctor, in the meanwhile, has given me a lotion, and the sight of the eye seems daily improving, though very gradually. If this lotion or any other simple treatment would in time cure the eye without the necessity of an operation, I should be only too glad.—Sufferer.

[76536.]—**Cleaning Leclanche Zincs.**—I have some sealed cells that have been laid aside and neglected, the result is the solution has evaporated and formed almost insoluble crystals on the zincs. Will some one please suggest the best solution to run in to dissolve these and the same time not to attack the zincs? I have tried soaking with clean cold water (as advised in back numbers), but it is no good, and in trying to get the zinc plates out I have broken two of the vulcanite cells, so it seems as if the zincs will have to be cleaned by passing through a solution. How would warm water with a little muriatic acid do? Perhaps Mr. Bottone, or some one who knows exactly the chemical nature of these crystals, can tell me what will dissolve them, and much oblige—F.R.Met.Soc.

[76537.]—**Insulating Soft Iron Discs.**—Is it necessary to insert a diamagnetic substance between the spindle and the soft iron discs in a drum armature of the Edison-Hopkinson type? If so, what is the best substance, and is a good thick varnish not sufficient? This substance is apparently sufficient to insulate magnetically the soft iron discs, one from another.—A. T.

[76538.]—**Phonograph.**—To Mr. Suggett.—I am making a phonograph, and would like to try lever styluses mentioned by you in reply to query 76254. Will you please describe this form of stylus? also what you mean by careful cooling of wax cylinders? Is micro glass that used for microscope objects? Will you kindly explain the process of thinning down the same with fluoric acid? Also are the recording and reproducing diaphragms alike in thickness?—A. N.

[76539.]—**Faulty O.G.**—I have an o.g. said to be by Peter Dolland, but its performance is not at all satisfactory. It is 8in. aperture, and about 48in. focus. With a power of 40, lunar detail seems to be sharp enough, but a planet can scarcely be focussed at all. This power of 40 is about the highest that the o.g. will bear even on the moon. The eyepieces are not at fault, as they work all right on my 6in. reflector. I shall be very glad if some practical hand can advise me in this matter.—Lens.

[76540.]—**Dynamo.**—I have castings for dynamo (Edison-Hopkinson type) of following dimensions:—Field-magnet cores, 4⅝in. long, 1½in. diameter; pole pieces, 2in. square; tunnel for armature, 2¼in. The cores are united by massive yoke. What amount of wire on field-magnets (to be shunt wound) to give 50 volts? How much current will it give at above pressure? How many revolutions? Commutator to be of 18 sections. Any information will be greatly valued.—E. M.

[76541.]—**Velocities of Falling Bodies.**—In conversation with some brother engineers the other day, the following statement was put forth as an axiom—viz., that solid bodies of identical shape and dimensions, but of different specific gravities, would fall through the air at the same velocity. Thus, a ball of gold, a ball of cast iron, and a ball of aluminium, each 3in. dia. would, if liberated simultaneously from a height of 100ft., reach the ground at the same moment. This seems to me absurd, but a textbook named Adcock's was produced, in which there appeared to be a formula somewhat bearing out the above views; but the words mentioned in the formula appear to relate to the falling of given bodies through space, and not through the air, whereas in the position set up, falling through the air was one of the elements of the discussion. As an old reader of your journal, I should be obliged if someone would state the respective velocities at which each of the above metals would fall, as I have no data for such calculations, and the formula given in Molesworth does not apply. It would certainly seem to me that if the falling velocities of each of the above metals were identical, you might go on adding others, as a ball of chalk, one of wood, and so forth, which would render the comparison more ridiculous.—J. Wilde.

[76542.]—**Accumulator.**—To Mr. Bottone.—I am desirous of making a small pocket accumulator as described in your book "Electrical Instrument Making for Amateurs," with the following modifications, and shall be glad if you will tell me whether it will be satisfactory for use with a 4 volt lamp. I wish to make containing cell 4in. by 4in. by 1in., the internal division for the two cells to be parallel to the ends, making two cells 4in. by 2in. by 1in., the lead plates being cut to fit them. (2) Would ten cell chromic acid battery, with plates 6in. by 2in., be sufficient for three 8c.p. 15-volt lamps in parallel? My idea was to connect eight cells in series, and the next two in parallel. (3) Is there any difference in light, of a 5c.p. lamp, of 6, 8, or 10 volts respectively?—G. C. Newland.

[76543.]—**Paper.**—(1) Will any reader inform how to reduce old paper to pulp? (2) Are chemicals required to dissolve it? (3) What should do to get its consistency in the form of a paste. (4) Is it possible to mould pulp into different shapes by pressure? If so, how?—Paper.

[76544.]—**Cracked Bell.**—I have dropped a large bell, and cracked it. I can solder it if I can find the crack; but at present that is beyond me. Will some friend give me a hint how to proceed to find out where the crack is?—Amateur.

[76545.]—**Lens-Grinding.**—To Mr. Linscott.—Like "F. J. G.," in a recent issue, I should be glad to have a few hints from practical correspondents as to polishing, &c. Perhaps "Boro Silicate Crown" or "Flint" will respond? By means of rouge and pitch I get good polish in time, but it takes weeks, only working evenings. Is there no substance that cuts more quickly? How is putty-powder used? I should much like to know how long a 3in. lens ought to take to polish by hand. Some time since, Mr. Linscott stated that he had watched the process of polishing plate glass; I should be much obliged to him if he would state what polishing material is used, also the method, and time it took.—C. Canwell.

[76546.]—**Clock Wheels.**—I have a clock wheel cutting engine which cuts a straight tooth. Will someone kindly give the best method of putting curve on tooth without the expense of a rounding-up machine? The old method of rounding with a file is not sufficiently accurate.—S. Kip.

[76547.]—**Grease.**—I have been experimenting to find a substance to which grease will not stick. Up to now I have failed. Can any reader assist me?—A Novice.

[76548.]—**Electrophorus.**—To Mr. Bottone.—Seeking directions for making this in back numbers, I found (no thanks to index, though!) your paper in No. 1081, in which you give precise limits for thickness of zinc; but through a fault in the printing the denominators of the fractions are left blank. Would you kindly say what they ought to be?—Mu Nu.

[76549.]—**Chloride of Lead.**—I have read that this substance greatly facilitates soldering, obviates the necessity of filing and tinning the bit, and enables pure lead to be used as solder. Can anyone tell me what are its drawbacks? Is it corrosive like chloride of zinc? Is it easily made?—Mu Nu.

[76550.]—**Fuller Battery.**—Will Mr. Bottone kindly tell me how long a Fuller battery, 5¾in. by 7¼in. high, will run a motor straight off; and how long it will take to regain its strength, and when will it require to be recharged?—Fuller.

[76551.]—**Screw Propulsion.**—Could any reader give us any information where the loss of power occurs in screw-propulsion, and at what ratio?—Scott and Dunn.

[76552.]—**Xylonite Ring on Glass Bottle.**—Can any of your readers inform me how I am to get a ring or collar of Xylonite over a glass cylinder of a larger diam. than the collar itself, without cutting or splitting it? Could a sufficient expansion be effected by heat? The inside diameter of the collar is about 1in., and that of the outside of the cylinder is 1 3-16in. Consequently, the collar would have to expand 3·16in.—Birmingham.

[76553.]—**Boiler.**—Can any correspondent tell me the size of boiler for a 1½ by 2½ horizontal engine? I want to work at 60lb. per square inch, and have plenty of steam; cut-off at about ¾ of stroke.—W. T.

[76554.]—**Hard Coal.**—Can any reader say whether there is any English coal corresponding to the American hard coals—the kind known as "Peach Orchard," for instance? American stoves can be got in England, but the difficulty is to get the coal to burn in them to give the same results. Americans complain bitterly of our cold houses, soft coal, and hard water. They are accustomed to warm houses, soft water, and hard coal.—Qwerty.

[76555.]—**Accumulator.**—I have 51 E.C C.Ld. + W. cells in series, 31 plates. 110 volts. Will some of our readers tell me the amount of ampère hours they contain when fully charged; and also how many hours you could with safety keep 50 16c.p. lamps lighted from them?—Engine-Driver.

[76556.]—**Small Motor.**—Will someone who knows kindly give their opinion as to the best motor to work a Singer's sewing-machine for a lady in India, in a temperature rising to 90° Fahr.? The choice seems to be between steam, electricity, benzoline, and hot air; gas out of the question. I am a practical engineer, so would understand working; but engine must be quick to start, safe, inexpensive (though this might be subordinate), and not take up too much room. A sketch in section would oblige.—N. W. La Touche.

[76557.]—**Bunions.**—Will anyone kindly suggest a remedy? I have been troubled with a bunion for more than half a year, caused by wearing a short, not a tight, boot. I have poulticed it, used different plasters and lotion. It is better; but has kept the same for four or five weeks, painful, swollen, and exceedingly tender.—M. S.

[76558.]—**Metallurgical.**—Has nickel or any other metal the power of taking up a larger percentage of carbon than iron, either free or combined?—Richard Brown.

[76559.]—**Electric Lighting.**—To Mr. Bottone.—Arc lights and incandescent lights are drawn, I believe, from the same circuit. I understand how this is done with alternating currents; but not details with continuous. I shall be glad if, with your usual courtesy, you will enlighten me on the subject?—A. E. B.

[76560.]—**Fireclay.**—Would any reader kindly oblige by giving the name of the mixture used instead of water for mixing up fireclay? It has very much the appearance of grey soap, and will readily remove dirt from one's fingers.—Nine Years' Subscriber.

[76561.]—**Cheap Battery.**—I have somewhere read of a cell composed of iron filings and zinc clippings, separated, I suppose, by porous pot, with solution of caustic potash in outer vessel with filings. Can any of your readers give fuller particulars; also E.M.F., internal resistance, and general usefulness?—Barnes.

[76562.]—**Current for Lamp.**—Will Mr. Bottone say if he can tell me what current is required to light a small 4-volt lamp, the c.p. of which I believe to be about 2½?—Marshall.

[76563.]—**Ebonising Deal Sticks.**—I have a lot of pieces of deal, ¾in. square and round, about 2ft. or 3ft. long, which I want to make black and smooth. Will some kind reader help me in some good way of doing this so that they will have a hard, glossy face? I have tried Brunswick black, but it does not leave a smooth face, and with the warmth of the hand it is sticky.—G. G.

[76564.]—**Silvering Dial.**—I have a small aneroid, the dial of which has got very much tarnished. Would some of "ours" inform me how to re-silver it? I can silver ordinary dials; but this one has the appearance commonly known as "frosted," and I would like to give it the same look when finished.—Bon-accord.

[76565.]—**Arc Lamp.**—Will Mr. Bottone or others be kind enough to answer the following?—1. In running arc lamps in series requiring 55 volts, and about 18 amps, with series-wound dynamo, what resistance would be necessary to put in the circuit if one lamp required to be cut out? 2. What would be the probable resistance of the shunt coil of above lamp?—Marshall.

[76566.]—**Telescopes.**—To A. Gadd.—Referring to your letter in "E. M." January 8th, you include the effect of eye-lens. Can you give a rule for determining the equivalent focal length of the combined mirrors when only the focal lengths (for parallel rays) of the two mirrors are known? This would be for the Cassegrain and Gregorian forms.—A. S. L.

[76567.]—**Object-Glasses of Telescopes, &c.**—I shall feel obliged for information on the following points from some of "ours." 1. How to find the focus of a photo. lens, and of the object-glass taken out of an ordinary telescope or binocular? 2. Would the object-glasses above alluded to do for camera work, and also for enlarging from a ¼-plate to 10 by 8 or 12 by 10, composed, as they generally are, of two lenses cemented together, one being convex both sides, and the other convex one side and slightly concave the other side? 3. If these lenses were separated, could either of them be used for camera work, or for enlarging? 4. What is the nomenclature of the said object-glass in its original cemented state, and of each of the lenses when separated? 5. Given a perfectly dark room for enlarging, and a ¼ plate negative stuck in the pane of a window, with a white screen opposite it, will any lens that can project an image on the screen make an enlargement? 6. Amongst the cheap lenses in the market (price being *an* object), which is the most suitable for enlarging from a ¼-plate? A short article explaining the nomenclature of different lenses and their construction would probably be of interest to many readers of the "E.M.," as well as myself; as also a lucid explanation of the new style of defining the working aperture of "stops." For instance, I notice in the "Year-Book for 1891," in Ross and Co.'s advertisement, as follows:—

U.S. numbers..	1	2	4	8	16	32, &c.
	f	*f*	*f*	*f*	*f*	*f*
Ratio of stops .	4	5·657	8	11·3	16	22·6, &c.

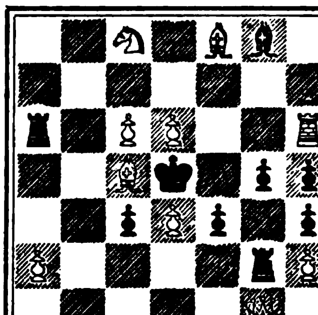
How are the lower quantities arrived at?—Ignoramus.

CHESS.

All communications for this column to be sent to the Chess Editor, at the office, 332, Strand.

PROBLEM MCCXCIII.—By P. H. Williams.

Black.



White. [12 + 9.

White to play and mate in two moves.

Solution to 1291.

White.	*Black.*
1. R-K 6.	1. Any.
2. Q, R, B or Kt.	

Mates accordingly.

NOTICES TO CORRESPONDENTS.

Correct solutions to 1291 by T. Guest (a bright little problem, and pure, good chess); F. H. Guest, W. T. Hurley, F. Slade (but no name appended); J. F. Moon (bright and ingenious); Anon (postmark, Wolverhampton); T. H. Billington, J. Kistruck, W. L. Smith; to 1290 by G. H. Moon (one dual and two solutions); F. H. Guest (one dual sent, not "three"); T. Guest (two duals), T. H. Billington (two duals), A. Anderson (second solution), W. L. Smith, and R. W. Houghton (two duals).

J. F. Moon.—There *are* two solutions to 1290.

G. H. Mason.—Sorry for omission; but you only gave one dual to 1286. This you are now credited with.

A. L. Butler Tindall.—You have overlooked in 1291 that after 1. P-Q B 5, 2. Q-Q Kt 5, K can take P.

J. Dormer.—In 1290, if 1. $\frac{\text{Kt takes B}}{\text{Q-Kt 4}}$, 2. $\frac{\text{Q takes Kt (ch.)}}{\text{K-R 5}}$ 3. Q-Q 5 (ch.), K escapes at Kt 6.

T. H. Billington and J. Kistruck.—In 1288, if 1. $\frac{\quad}{\text{K-B 4}}$ 2. Q-Kt 4, or Kt-QB 6; if 1. $\frac{\quad}{\text{B takes P}}$ 2. $\frac{\text{Q-Kt 4 or Q takes B}}{\quad}$, if 1 $\frac{\quad}{\text{B Kt sq.}}$ 2. $\frac{\text{Kt Q 3 or Q-Kt 4.}}{\quad}$

R. W. Houghton.—It was a slip. You were credited with three duals to 1288.

A portrait of the famous French player, M. St. Amant, whose name is intimately associated with Mr. Staunton's, is given in the Feb. number of the *B.C.M.* His brief biography will not be without interest to its readers. Mr. Tomlinson continues his amusing "Vacation Ramble," with promise of a further instalment. Among others, four games, with copious notes by Mr. Mason, between Steinitz and Tschigorin, in their present match at the Havana, head the game department. An analytical table of the games played in the Sixth American Chess Congress gives the number of games played in the different openings; also the number won by first player and those by the second. Out of 430 games the first player won 173, the second 154, and 103 were drawn. This gives a ratio of number won by first to that by second player, a little in excess of 9 to 7; but the numbers are not large enough to base any conclusions on. In King's Gambit the numbers are 13 to 2; In French's defence, 11 to 6; Evans, 16 to 8; and Ruy Lopez, 44 to 43. There are eight more Tourney Problems, all three movers, and three sui-mates by Mrs. Baird.

ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, *if* not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, February 10, and unacknowledged elsewhere:—

H. A.—Fixed.—Whitby.—A. Midland.—Amateur.—H. A.—Plumber.—R. C. Royle.—Montmartre.—T. W. Reaveley.—C. E. Peek.—John Dormer.—A Fellow of the Royal Astronomical Society.—J. G. B.—J. H. Truscott.—G. Calver.—Self Help.—Fairfield.—S. R. Bottone.—S. Hagues.

J. W. Taylor. (Better consult Dr. Allinson, the Medical Editor of the *Weekly Times and Echo*. What you mention may readily yield to simple treatment, but it *may* point to stone in the bladder.)—Futura. (The question of lighting rooms by electricity has been answered many times in the back, and even in recent, numbers. To light by means of batteries is very expensive; but the chromic-acid cell is probably the best, all things considered, to use for the purpose. There is an illustrated article on the subject in the number for May 22, 1891.)—Electric Bell. (Probably it was the Leclanché cell you saw, as that is sealed and a small hole left; but for dry batteries refer to back numbers. One was described on p. 255, May 15, 1891.)—Hy. Jordan. (The numbers and the volumes containing the series of articles are out of print. "Organ Building for Amateurs," by Mark Wicks, published by Ward, Lock, and Co., would very likely suit. "Ours" is the name applied to this paper by its readers and contributors.)—Ransom. (Glass can be drilled with an ordinary drill lubricated with water; but for china it is, perhaps, better to use a diamond spark. If you wish to do china riveting, see the number for Sept. 22, 1882, and that for Aug. 18, 1883.)—M. R. (Mr. Hanbury, we think, for one. The engines are built at different places. Letters to the respective loco. superintendents would, no doubt, elicit the information.)—Patternmaker. (The resistance of the line is too great.)—M. S. W. (There are several books of the kind. Procure the list issued by Mr. Calvert, of Great Jackson-street, Hulme, Manchester. Molesworth's Pocket-Book, E. and F. N. Spon, and Templeton's works, Crosby Lockwood and Son, contain information of the kind required.)—C. P. (Expands as a rule, but you do not say whether pure rubber or the vulcanised manufacture. To mould it into shapes it is necessary to use pressure as well as heat.)—Crolly Biss. (For exactly the same reason as the Moon was presumably originally separated from the Earth. See many articles, &c., on the subject in the back volumes.)—Ajax. (Recipes have been given several times in back volumes. There is nothing special about it: simply peel the oranges thinly in strips, which should be chopped up, mixed with pulp—using some sweet oranges as well—and the whole boiled with sufficient sugar.)—E. T. (See many replies under the head of Dynamo. The question has been answered scores of times.)—Stone. (It is impossible to name it without seeing it; but it is, perhaps, a bit of amber.)—Tyro. (The lamp could be worked by batteries, but it would be very expensive. An electrician could probably guess the meaning of the figures, or the information could be obtained from the makers.)—G. H. Lanchester. (Bunsens or chromic-acid cells. The current forms an "arc" between the two carbons: hence the name. See indices.)—John Solomon. (No; the telegraph is.)—C. Morrell. (Depends on the quality of the gas—say from 16 to 20 candle-power for ordinary gas supplied in towns.)—H. T. A. J. (There are regulators which reduce the supply as the temperature rises. Some have been recently illustrated in connection with the descriptions of incubators.)—Inquirer. (We do not know. Perhaps from the "various periodicals" in which it has been referred to, as you say.)—Sufferer. (It is a case for a surgeon to examine. No one can answer definitely without examination.)—Hypo. (See papers on "Practical Photography for Amateurs," commenced in number for June 5, 1891. There are also many handbooks on the subject. A "Handbook of Technical Terms" is published by Piper and Carter, Furnival-street, Holborn, W.C.)—Rover. (Obviously depends to some extent on the amount of usage, and the care taken of them; from two to five years in fair condition. Something may be done by using a covered flat-iron on them, so as to warm them up gently. To dye ivory balls red, make a solution of cochineal in liquor ammoniæ. "Quick" the balls by immersing them for a minute or so in a weak solution of nitric acid, and then soak in the dye as long as required. They may be boiled in it; but it is better to soak.)—J. Scott. (Do you mean the skin or the fur, or both? Suitable plant will be required to do them properly; but there are some recipes in back volumes. Perhaps decoction of logwood, followed by a solution of acetate of iron, will do.)—Housekeeper. (If the door can be taken off, submit the other side to similar treatment; but if a new panel is needed, it would be better to let a cabinet-maker do the work.)—Rabbie Burns. ("Graham's Brassfounders' Manual," Crosby Lockwood and Son, Stationers' Hall-court, London, E.C.)—W. Naylor. (We cannot. That is a matter you must search for yourself at the Patent Office, or employ a patent agent to do so for you.)—Geo. C. Wildman. (Too late and too long. A few lines at the time might have found space.)—R. Cunningham. (We know nothing of him; communicate with the Liverpool police. We advise you and all others who cannot get goods from advertisers which you have paid for to do this at once. We are glad to know the police have one party in their hands just now who, under various aliases, has been defrauding readers for some time.)—J. M. Boraston. (In type.)

Mr. Crowe's Remarkable Case.—He obtained one of Harness' Electropathic Belts, which completely cured him in a few days. Writing from The Hill, Wickham Market, he says:—"I have been free from pain since the first week of wearing your belt. The original of his and thousands of other similar reports may be personally inspected, and the belts may be seen scientifically tested, at the Electropathic and Zander Institute, 52, Oxford-street, London, W., where the Medical Battery Company's officers may be consulted daily without charge, either personally or by letter. Pamphlet and book of testimonials free.

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Wanted, 5in. Foot Lathe, or parts for same; screw-cutting preferred. Exchange new ball-head Diamond Safety and cash.—Grace, 49, Buckingham-street, Leicester.

Boiler wanted, with fittings, upright, for 2H.P. upright engine. Exchange anything in a Watchmaker and Jeweller's Store.—Macmillan, 41, Castle-street, Inverness.

Juvenile **Safety Bicycle,** good condition, balls both wheels and bottom bracket. Exchange for dynamo and lights, or what offers value £4?—Cleverley, 68, Malva-road, Wandsworth, S.W.

½-H.P. **Gas Engine** in perfect working order. Will exchange for engine and boiler, about ¾ to 1H.P., must be in good condition.—J. E. Brown, 38, Herbert-road, Plumstead, Kent.

New Exhaust Condenser, by eminent maker, will largely increase power of 12 to 20-horse engine without cost, or enable steam pressure to be reduced, cost £15. Exchange for back-geared 4in. Foot-Lathe, slide-rest, &c., of similar value or offers.—Peck, 9, St. John-street, Hull.

4H.P. **Boiler,** wants repair and fittings for 500 gal. galvanised tank.—Moorhead, Cootehill, Ireland.

Banjo, cost two guineas. Exchange Bench Lathe, part cash if required.—H., 111, Kilravock-street, Queen's Park, London, W.

Ornamental **Drill Spindle.** Will exchange for ¼ or ½-plate camera and slide.—A. Cook, 107, York-road, Montpelier, Bristol.

New Ediswan **Lamps,** holders, wire, switches, &c., bought for cash or exchanged.—Bowron.

Several Bottone **Motors** and **Dynamos** cheap. Ca or exchange,

Hot air **Engine,** drives sewing machine. Stea hand bells, medical coils, &c. Cash or exchange.

6in. Woodturner's **Lathe,** all iron; two Arc Lamp —G. Bowron, 93, Praed-street, London, W.

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Dynamo, 40c.p., Medical Coil, Magneto, Lamp switches, wires, batteries, 9 vols. English Mechanic, &c. Exchang Safety Bicycle.—H., 58, Fenwick road, East Dulwich.

Wanted, a direct-vision **Spectroscope.** Exchan ½-plate RR. Lens by Hunter and Sands, new.—J. W. Barry, Clarence-road, Clapton, N.E.

"**Treatise on the Steam Engine,**" by Ra quite new, cost 15s. Exchange Electrical Books.—Mellor, Grane-road, Haslingden, Lancashire.

Engines.—Vertical, 3in. stroke; two horizontal, stroke; two Copper Boilers, 24 by 9in., six tubes, internal fire Offers. Particulars, stamp.—T. E., 69, Gresham-street, Leicester.

Dynamo, 50c.p. shunt wound, by Jones, perfect, 6c.p. 16-volt brass-capped lamp, by Edison-Swan, also two 16-volt lamps, value 50s. Wanted, Castings Dynamo, Manchester type, 120c.p.—Caldwell, Eastham, Cheshire.

Steel vertical **Boiler,** 14½in. by 10in. internal 3-16 plates, with fittings as follows: safety-valve, screw-down stop valve, water gauge, mud cock, lately tested 250lb. hydraulic, 2½in. steam gauge (150lb.). What offers? Viewed by appointment or returnable photo.—Halsey, Womersley House, Crouch Hill,

Wanted, Hand Camera, ½-plate, in exchange for 120c.p. Edison Dynamo Casting, planed and bored, ready for winding.—W. W. P., 46, Whitegate-lane, Blackpool, Lanc.

Quantity of Pure **Zincs,** not amalgamated, and quite new, cable, wire terminals, mercury, galvanometer, &c. Exchange.—E. Hodgson, Whitcliffe, Cleckheaton.

Kelly's "**Engineer's Directory**" '91, quite clean, and "Architecture of Scotland," for small dynamo, motor, or other parts of lighting apparatus.—Whitehead, Carlton, Notts.

Wanted, second-hand, a 4ft. planed Lathe Bed, with gap fitted. Exchange Cycle, Dynamo, Induction Coil.—Co Oundle.

Berlin Porcelain **Basin,** eight inches, 1lb. bottle Johnson's Sulphite Soda, bottle Enamel Collodion, Folding Lamp, Practical Photographer, 1891. Offers.—E. B Nook, Oldham.

"**Boy's Own Paper,**" year 1888, vol. X., bound, 4s., or exchange for 1lb. of covered wire No. about 3 Lechmere-crescent, Henwick, Worcester.

Wanted Taper and Plug Taps to suit hole 15-16in. Exchange Breast Drill and Fretsaw, or part cash.—W. W Daisymere, Fairfield, Buxton.

"**Graphic,**" first 16 volumes, Nos. 1 and 2 bound, good condition. Exchange.—W., 14, Wills-street, Birmingham.

Organ Parts, principal, spotted metal, Clarabella, Double-Bellows, Soundboard, Keys.—Barker, 3, Alexandra-square, Shipley, Yorks.

Fretsaw Machine for screwing on table; also the Invincible Typewriter; also George III. Guinea, with ornamental ring on top for albert. Offers.—Below.

Fox Terrier Dog, twelve months old, good house dog; also Spaniel Bitch, used to children. Exchange anything useful.—Muckle, 2, Bowles-place, Whetstone, N.

Electric **Pocket Lamp,** electric pocket-pen, electric carte photo. frame, other electric apparatus. Exchange, or separately.—Rigby, University College, Liverpool.

120 candle-power Gramme **Dynamo Castings,** finished ready for winding, also wire for winding, value £5.—Below.

Model **Electro-Motor,** quite new, drive sewing-machine, all metal parts silver-plated. Awarded silver medal and diploma, Industrial Exhibition, Grantham, 1882. Value 45s.—Below.

Medical **Induction Coil** and **Battery** in Walnut case, complete with handles and accessories, value 30s.—Below.

2½in. **Electric Bell,** in Walnut case, quite new, value 5s.—Below.

Will **Exchange** above for a 3½ or 4in. centre **Lathe,** with slide-rest, or offers.—W. H. Jackson, 64, Norton-street, Grantham.

Bench Vice (iron) wanted. Will exchange a Trotman's two-guinea folding perambulator for same.—C. Ross, 6, East Dulwich-grove, S.E.

Pulvermacher's **Chain Battery,** 120 cell, with handles and interrupter, in leather-covered case, cost 30s. What offers?—R. Parsons, 5, Mole-street, Sparkbrook, Birmingham.

Exchange for Engineer's Vice, Taps, and Cash, a very strong Launch Boiler, brass tubes, worked at 40lb., and horizontal engine, 3in. cylinder, 6in. stroke, never used.—31, Grange-road West, Birkenhead.

Magneto-Electric Machine, pocket size, splendid case, lock and key, nickel-plated handles, cog wheel for increasing speed, hardly soiled, cost 30s. Anything useful.—J. W. Dr The Mount, Matlock.

"**English Mechanic,**" unbound, Volume LIII., and odd numbers Volume LIV. to end of 1891. Exchange.—K., 185, Southampton-street, Reading.

Camera, complete with lens, enlarges negatives from ¼ to 10-8. Exchange for good ¼-plate set, printing plant or offers.—P. F. Hayden, Graigue, Kilkenny.

Pair of good **Skates,** only used about six hours, brass toe tips, blades 11in. long, cost 10s. Exchange books on Electricity by Bottone or others.—Below.

Horizontal **Slide Valve Engine** and Copper Boiler, cylinder 1in. bore, 2in stroke. Exchange electrical instruments, &c.—Dawson, Plumber, Northorpe, Mirfield.

Photographs of the Year, being 12 Woodbury-type reproductions, mounted, 15 by 12, of notable photographs. Excellent for framing. Offers.—P. F. Hayden, Graigue, Kilkenny.

Stamps.—Wanted any rare varieties or good collection. Exchange.—Address, with particulars, Edward W. Drury, 125, Coltman-street, Hull.

"**English Mechanics,**" from October, 1890 up till present date. Anything useful.—J. H. Constable, 103, Mayfield road, Seafield, Gosport, Hants.

Good **Violin,** Bow and Tutor, set extra strings, in perfect condition. Exchange lathe driving wheel.—A. Mason, 14, Tavistock-terrace, Upper Holloway, N.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, FEBRUARY 19, 1892.

LATHEWORK FOR AMATEURS.*—XII.

(*Continued from page* 477.)

Split Poppets with Movable Jaws.

IT is often necessary, when using the dead-centre lathe, to support long and slender work, which, under the pressure of the tool or of the treadle, might be bent and consequently prevented from being turned quite true. To guard against this inconvenience, several split poppets with movable jaws should be provided, see Fig. 137 and 138, which show front and side views.

To make a poppet of this kind, select a piece of hard, tough wood, such as ash or walnut. This poppet, which ordinarily has a mortised tenon for fixing it with a wedge, will be much slenderer than the cone-point poppet; principally at the place where it seats on the bench. And, as it is not capable of withstanding much strain, the tail and the mortise can be made to project less below the bench, so that the knee will not be incommoded when the treadle is elevated. The upper part of the poppet in question will be sawn off squarely, at 2in. or 3in. below the ordinary poppets, and split by two-saw kerfs which will be continued from the top to the mortise in the tail, leaving a space from ⅛in. to ¼in. wide, so as to make an elastic kind of vice in the upper part of the poppet. These two jaws forming the vice will be bored transversely through the middle, with a round hole threaded to take a clamping screw of iron, or of boxwood, if preferred. The head of this screw must have holes drilled for a "tommy," or may have a hexagonal nut to be moved by a spanner. The right-hand side need not be threaded, nor the screw near its head.

To make the movable jaw, Fig. 139, take a small strip of soft wood, trued up square, half as wide again as the space between the bench, and as thick as the space in poppet, Fig. 127, in which it is to be placed—that is to say, from ⅛in. to ¼in. The height of the jaw is determined by that given by the distance from the surface of the bench up to 1in. or 1¼in. above the cone points of the poppets. A slit is made exactly in the middle of this jaw and at one of its ends (see A, Fig. 139). This slit must be wide enough to allow the clamping screw to turn freely. This jaw will present itself edgeways on the lathe, and it has a semicircular notch, B, which corresponds exactly with the cone points. It is so constructed that the work, which it is intended to support and prevent from bending, bears against this notch, but is not forced out of shape, which would only change one defect for another. It is for this reason necessary to have two or three split poppets, and also a still larger number of the movable jaws, the notches of which are of various sizes. It is for these purposes that the advantages of the universal boring collars are particularly noticeable.

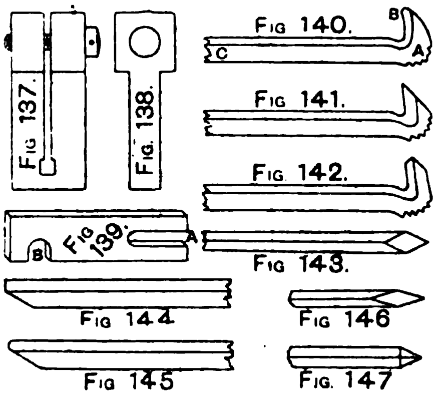
Remarks on Pulleys and Reels.

Our observations on the dead-centre lathe will not be concluded without making some remarks on the relationship of the diameters of the pulleys and of the reels to those of the work to be turned.

First, it must be remembered that whether the pole or the bow is used for turning, it is not possible to give the treadle an up-and-down motion which will move the driving-cord more than 10in. or 12in. at each stroke, even though the treadle be made from 4ft. to 5ft. long, which is its greatest possible length. Then, to turn quite truly, it is absolutely imperative that the work shall make at least two complete turns at one stroke. Therefore, from these bases the calculations should be made as to the relationship which should exist between the spring which causes the rotary motion and the diameter of the work to be turned.

It is obvious that a displacement of 12in. of cord to suffice to cause two complete turns of the work, can only fulfil its purpose when the reel on which it acts is not more than 2in. in diameter. Because multiplying this diameter by three, we get 6in. as the circumference, which gives the length of cord necessary to make one turn of the reel; and for two turns double that quantity, or 12in., is necessary, and this is the extreme length of cord put in action by the motion of the treadle and the reaction of the pole or the bow.

When it is wished to turn a piece of larger diameter than 2in., it will be necessary to make at one end a reel reduced to this diameter at most. If this part will not serve to form a portion of the work itself, it should be cut off. It is this same diameter which should serve as the pattern when making reels for jaw-chucks, arbor-chucks, &c., which have been previously mentioned, whenever the work placed upon them is large in diameter.



This principle must not, however, be pushed to the extreme, because if the work should be only small in diameter it would not be advisable to reduce the reel or the pulley to a diameter smaller than that of the work; because in this case the cord enfolding only a small circumference and running at a greater speed would soon become heated and useless. On the contrary, in this case it is necessary to make the reel larger in diameter than the work is, it being always understood that this may have two or three rotations to one stroke of the treadle. It is on this principle that we should act when turning even slender work on the clockmaker's lathe or with the bow.

What has been said of work of large diameter and of the reels of chucks can be applied relatively to the flywheel and the pulley. That is to say, when the latter is about 3in. in diameter, the former should be about 18in. in diameter, and so on in like proportion.

Turning Iron and Steel.

It is absolutely necessary that an amateur turner who desires to attain a measure of perfection should know how to turn iron. Without this knowledge he is continually stopped by trifles, and is often obliged to have recourse to other people. Therefore he is advised to practise turning iron as soon as he has acquired some confidence in the manipulation of the ordinary tools. He will appreciate every day the value of this advice.

Turning iron is, moreover, very pleasing; the work comes from the tool polished; the sharpness of the angles, the cleanness of the mouldings, all charm the eye as he cuts away the rough skin of the iron. Even the worst scrap of iron contains within it an elegant and polished ferrule, a turning arbor, or a precious chuck. Everyone does not turn iron. Even a number of clever locksmiths have not this talent, and amongst workmen he who possesses it enjoys a certain consideration among his equals; this results from a piece of turned iron being always of value. Some people file a ferrule on the lathe, and fancy that in so doing they are turning metal. Others entertain the same notions when they scrape it with cutters. Readers are cautioned against such ideas. Iron is really turned when the shavings come off in curls like boxwood when worked with either the hook tool or the graver.

Tools for Turning Iron and Steel.

The tools necessary for turning iron are few in number and easily made. Three tools are usually sufficient: a round-nose tool, a planisher, and a point tool.

The round-nose hook tool is shown by Fig. 140. It should be made of good cast steel, as should also all other tools of this kind, and as light as possible. Care should be taken in forging it not to heat it too much, because if the steel becomes white-hot it deteriorates, and if forged in this state it breaks under the hammer. Therefore it is to be forged at a cherry-red heat. The shape of the hook tool is not unimportant either. Some people elongate the noses of their hook tools, which they are content to curve, this is a bad method, and is liable to cause the tool to sting the fingers in working. It is in vain that those who practise this method shall show in justification of it handsome work turned with hook tools having long noses. Answer them with the assurance that they have expended much more strength and time to attain this result than they would have done with hook tools having short noses bent back.

It is proper, therefore, to make the round-nose hook tool to the shape shown in the illustration. By reckoning the point A as the fulcrum, the point of resistance B, and the power of the lever as distributed through the whole length of the handle C, it is easy to see that the way here indicated should be preferred to having long noses. The round-nose hook tool thus forged to shape is allowed to cool in the hot ashes of the forge. After, either with a file or on the grindstone, round it on its bevel and smooth it on its face. It is noticeable that the tool cuts better with a flat and straight face. In this way the smoothing may be finished either with an old, smooth file, or with a piece of Turkey oilstone.

Care is taken in making the circular bevel not to bring it quite to a cutting edge, at least not until the tool has been hardened and tempered. Experts will be surprised to hear me speak of filing cast steel without having completely resoftened it. Though in other cases this might be advantageous, yet in making this hook-tool it will suffice to allow it to cool slowly in the ashes of the forge. It is one heat spared to the material which is deteriorated by each heat, and too many precautions cannot be taken to secure the greatest hardness to the hook-tools. For this reason, for the little filing required on a well-forged tool, the use of old files or of the grindstone is advised.

The inclination of the circular bevel will be 50°, as has been stated when speaking of grinding tools; and it is advisable to slightly lengthen the elliptical part of the hook-tool rather than to flatten the nose as some people do. Fig. 140 will serve to show the proper amount of lengthening. After having thus prepared the hook-tool, it must have notches made at A, where it bears upon the T-rest, so that it imbeds itself, or at least holds firmly, in the material of which this is made.

After having made the hook-tool, make the planisher (Fig. 141), following the same

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* "Lathework for Amateurs" is mainly adapted from "L'Art du Tourneur," by Desormeaux; but deletions and additions are numerous and extensive. The illustrations are new, and the treatise entirely remodelled.

VOL. LIV.—No. 1404.

directions. The bevel must be slightly inclined in such a way that the left angle shall be slightly more acute than the right. The tool will then cut better. The same plan will be followed for the pointed hook-tool, Fig. 142.

The cutters are more varied in their shapes, and, to tell the truth, each amateur has some fashion of making which he affects more than all others. This makes a large variety in the forms of cutters, and even causes a want of agreement as to their names. To throw a little light on this subject, and to remove the confusion resulting from so many forms and names, the word "cutter" will be used uniformly for all straight tools in handles, and serving to cut iron and steel. These will be divided into two classes: square cutters and round cutters. In the former will be included lozenge, oblong, and flat sections; in the latter, half-rounds and others having the cutting parts rounded. Amongst this crowd of cutters two or three are in general use, the others are used only in special cases.

The graver, made in various sizes, is the best known. If it is not bought ready-made, it can be made from the first piece of square steel that comes to hand. It is ground as shown by Fig. 143.

The narrow flat-nose tool, Fig. 144, has somewhat the shape of the parting tool; it cuts well, and is the cutter which works quickest.

The round-nose cutter, Fig. 145, is, like the preceding, sharpened on the end. It serves to rough out the work and to make hollows. A narrow round-nose tool is used for roughing out.

The lozenge graver, Fig. 146, is used for cutting grooves which are deep and somewhat narrow.

The triangular-point tool, Fig. 147, is indispensable.

As to the shapes of cutters sometimes used, and which readers may use if they think fit to do so, no more will be said. The various cutters illustrated can all be made from small bars of cast steel. Their bevels will have an inclination of 50°, and care must be taken never to sharpen them on their flats, but always on the bevels. This is the only way to maintain a keen cutting edge.

Hardening and Tempering.

When the tools are made they must be hardened, and this is the method to follow: The tool is made red-hot in the forge, where it is placed so that an eye can be kept on it. It is heated slowly whilst held in the tongs, and when it is seen to be of a full red colour it is withdrawn, and immediately plunged into a trough of water, as cool as it can be obtained. In plunging the tool to the bottom of the trough, it should be given a circular motion, neither too slow nor too quick; excess either way harms the goodness of the hardening. When the tool is quite cooled, and the surface is quite clean—that is to say, when it shows a uniform whitish-grey surface, the hardening may be considered successful.

Attention is then given to tempering. To do this the object is first made bright by means of a gritstone, and next a bar of iron is heated to redness. The object is rested on this, turning it from time to time, and taking care not to put the cutting-edge itself on the hot iron. This cutting-edge is watched attentively, and when it is seen that the pale yellowish tint commences to fade, the hand is turned and the tool is allowed to fall into the cold water, which at once cools it and stops the tempering at this colour, which is that suited to tools to cut iron. Then the tools are sharpened, taking care that they are not heated by the grindstone if this is used dry. Perhaps small cracks may be seen on the cutting-edge; these are produced by the hardening, and must be got rid of. It is to guard against these cracks that advice was given not to make this edge quite sharp before hardening, because the thinner the edge the more likely are these cracks to appear. There was another reason for this advice. When the steel is withdrawn from the fire, the extreme angle of the cutting-edge, affording less substance than the other parts of the tool, is liable to lose more rapidly during the passage from the fire to the water a little of the heat requisite to harden perfectly. This is guarded against by leaving this cutting-edge rather thick; moreover, a thin edge is easily burned in the fire—another thing it is well to guard against.

When the tools are tempered, the cutters are ground according to the general rules already laid down for grinding. The hook-tools alone are beyond this rule, inasmuch as they are sharpened by causing the grindstone to rotate in the reverse direction. That is to say, by making it come towards the tool, as a piece of wood does when mounted on the lathe and in process of being turned.

Again it is repeated that, after having sharpened the cutters, care must be taken that the top surfaces shall be flat and polished, and that the round-nose hook tool shall be well rounded, and not formed, as too often happens, by several small facets. For this reason, it is well to present it sideways to the grindstone from time to time, describing a half-circle with the right hand, which holds the upper part of the handle. In this way the nose is rounded exactly. It must not be concluded from its chipping the first time it is used that a tool is tempered too hard; on the contrary, this is a sign of good tempering. Generally hardness is to be preferred to softness in all tempering. After being sharpened a few times, the tool will cut properly. A tool which whitens is good for nothing; a tool which chips becomes better day by day in use, and it can always be softened slightly if needed. It is not desired to make the cutting edge too brittle; but if the happy medium cannot be too readily attained when tempering, err rather in excessive hardness than in excessive softness.

How to Use the Tools.

Let it be supposed first that it is desired to turn a ferrule provided by a piece sawn from the end of a gun-barrel. It is driven on to the handle by means of a mallet, and is supposed to be smoothed on one end by a file or otherwise. It is not this which concerns us now. When it holds firmly, have before you a potful of water, with a little mop—or, better still, a little drip-can on a movable stand, by the aid of which the ferrule will be wetted; then the wheel is set in motion.

Then grasp the handle of the round-nose hook-tool, the left hand near the tool, the right hand above, holding the thumbs open and tightly pressed lengthways of the handle. Place the notched part A, Fig. 146, on the T-rest, which has been drawn as near as possible to the work. Now, slightly lowering the nose of the hook-tool by advancing the arms, this is made to touch the iron in motion at a point slightly above the centre, not precisely at the middle of the edge B, but a little to the right. Intermittent cutting will give warning that the ferrule is not round. A tight grip must be taken, always leaning the hands towards the right, so as to make the shaving fall on that side. After, replace the tool in its first position, and again incline it to the right, and so repeat the same motions till the work is made true.

Once this is done at one place, cut away the metal on the right of the groove already made, and afterwards cut away on the left by inclining the tool to this side in such a way that the shaving falls on the part just turned. The material will be wetted from time to time when it is seen to be dry, and hot chips fall on the hands. It is well even to dip the tool in the water often, and the fluid which adheres to it will, in damping the work being turned, prevent this becoming too hot. It is in this way, by successive grooves made near together, that the ferrule is finally turned true.

Next take the planisher, and, placing it obliquely, but in the same position, remove the ridges left by the round-nose tool. The planisher is not easy to manipulate; it often happens that it digs into the work, or covers it with "chatter" marks. Without repeating the geometrical details which have been already discussed in speaking of turning tools, the beginner who knows how to calculate will see at which point of the circumference he should work upon his iron ferrule—that is, a little above the level of the centre points. When the ferrule is nicely round and smooth, it only remains to true it upon its edge. The round-nose hook-tool will do this: it is rested upon the T-rest as though it were wished to turn the ferrule on its outside; but, by bearing upon the right side of the resting-point, the left side of the tool will be lifted by moving the hands to the right of the turner's body, in such a way as to cut the iron with the left side of the cutting edge of the round-nose hook-tool. In this way the chips will come away thick and clean. The pointed hook-tool can be used also, or even the planisher; but these are not so satisfactory.

For turning all cylinders, the foregoing is the way to go to work. It is quite certain that in working iron success will not be attained at the first attempt; but by not departing from the rules just laid down, and by accustoming the hand to the motions that these require, in less than a week the manipulation of hook-tools should be learned tolerably well.

Gravers are preferred by many amateurs. It cannot be denied that if they work slower, they make up for this disadvantage by giving greater precision to the work. They are more convenient for fashioning small objects, and all those in which mouldings, hollows, and grooves are most frequently found. Amateurs are advised to learn to use both forms of tool. They may rough out with hook tools, and finish with gravers, and in using the two tools in this way will attain a degree of perfection and of speed rarely reached by those who know but one method.

When work has been finished either with the graver or with the hook tool, and there remains any small ridges, a piece of Turkey stone may be used to remove them. If it is wished to replace the dull surface left by this, by a brilliant polish, use a little fine emery with oil on a piece of old linen, and rub the iron with this whilst it turns.

In turning iron, beginners are particularly advised to curb their taste for mouldings, which not only destroy the beauty of form, but get filled with dirt and rust, giving much trouble to keep clean the object overburdened with them. Mouldings are not entirely interdicted, but they should be used very sparingly. Nothing pleases so well as clean, squarely turned work; it is also the most difficult, and requires most skill; mouldings betray the tiro hand.

What has been said of iron is equally applicable to steel which is turned in the same way, after, however, having been most carefully annealed, so as to reduce its hardness as much as possible. Cast steel hardly comes from the tool in shavings, and its cut surface is always a dull, greyish white. It polishes better if first hardened.

Brass is less difficult to turn; when cast, it does not come off in shavings. Old files are used for turning it; they are ground with short bevels, and are made in the usual forms given to the various cutters already described, and gravers are also used. In regard to the manner of chucking it for turning on the running mandrel lathe, it will be advisable to see the information given later on in connection with ivory.

Brass, iron, and steel have moreover the property of being threaded with taps, and this can only be accomplished with great difficulty in ivory, which is much more subject to splitting. Brass is not wetted when turned; but care should be taken that the tools do not become over-heated, because they would thereby become softened.

(*To be continued.*)

REVIEWS.

The Metallurgy of Argentiferous Lead. By M. Eissler. London: Crosby Lockwood and Son.

For many years the smelting of lead was carried on without the slightest suspicion that many of the lead ores contained silver; but nowadays nearly every particle of silver is extracted from the ore, and this work by M. Eissler gives an account of the process as practised in various parts, and is to a certain extent a history of the silver-lead industry of the Pacific coast, an industry which has been developed during the past twenty years. The silver-lead ores of Nevada were discovered by a Mormon despatched by Brigham Young to Beaver county to obtain lead for bullets about 40 years ago, and since then the mines at Eureka, Nevada, and Leadville, Colorado, have been exploited to much advantage. In isolated mining districts the blast-furnace is still employed; but metallurgy has advanced by leaps and bounds on the Pacific Coast, and furnaces similar to the Castilian slag-hearth are now used in various parts, while the water-jacket furnaces are preferred, as a rule, in the United States. The standard work on lead smelting is Dr. Percy's "Metallurgy of Lead"; but since that work was written many improvements have been introduced, and not a few of the modern processes are described for the first time in print in Mr. Eissler's work. For that reason this volume, which is freely illustrated, is of especial value, and though it concerns only a limited circle of readers, the lead industry is of so much importance that everyone connected with it, or thinking of taking it up in new countries, will be glad of the information and detailed descriptions of processes given by Mr. Eissler. The appendix contains several reports by experts which should be useful to metallurgists and those engaged in lead smelting.

The Optics of Photography and Photographic Lenses. By J. Traill Taylor. London: Whittaker and Co.

In this work Mr. Traill Taylor has collated his papers on the subject of photographic lenses which he has contributed to various periodicals and the Transactions of societies; but he has also written several chapters for the purpose of bringing the matter up to date, and placing in the hands of users of lenses all the information available. The work is not intended for the makers of lenses, but for photographers, and the information is given in plain language, so that even a beginner may, with a little attention, soon grasp all the salient points of the subject, of which it need scarcely be said Mr. Traill Taylor is a master. After a few chapters introducing the elements of optics as connected with photography, the author proceeds to describe the properties of the different forms of lenses, and then deals with points which are of more purely technical interest. The chapter on the deterioration of lenses by light is one that will attract attention outside the photographic world, for Mr. Taylor says that the great cause of lenses becoming slower is not the balsam used in cementing, but the "deterioration of the glass itself by the action of light." Lenses formed of dense flint are, he says, more liable to become deteriorated by the action of light than those of light glass—why is not known, though Mr. Taylor gives the most probable reason assigned. A short chapter on lens-grinding will interest many who are not photographers; but it may be said that there is much in the work which will be useful to all who work with lenses, or wish to understand the elementary principles of practical optics.

Electric-Light Cables. By Stuart A. Russell. London: Whittaker and Co.

One of the most important points in connection with the utilisation of electric energy is the means of distributing or transmitting it to places more or less distant from the generator. Engines, dynamos, and lamps have been brought probably as near perfection as possible; but it is doubtful whether the best means of "leading" the current has been devised or discovered. So far as modern experience teaches, nothing answers better than a cable covered with indiarubber; but although some leads have been in use for about nine years carrying currents of comparatively high tension undergound without needing repairs, it must be remembered that a coat of indiarubber adds largely to the expense of an installation, especially when the cables have to be taken considerable distances. Coverings of fibrous material, such as hemp, cotton, &c., saturated with wax, bitumen, or other waterproofing substances have been tried with a fair measure of success; but taking into consideration their cost, it becomes a question whether bare wires are not more economical, provided they are properly supported and insulated at points of contact. The question is of great, though purely technical, interest, in connection with the distribution of current, and Mr. Russell has done electrical engineers a service by adding this volume to the "Specialists' Series," issued by Messrs. Whittaker, as, for obvious reasons, very little is known on the subject.

Annandale's Concise Dictionary of the English Language. London: Blackie and Son.

"Annandale's Concise Dictionary," which has, since its first publication, held a creditable place among one-volume English dictionaries, is now issued, in an extended form, at the low price of 5s. The general vocabulary is ample. It also explains clearly and accurately all important modern terms pertaining to science, technology, and the arts.

We have also received *Notes on Building Construction* (London: Longmans), which is Part IV. of the work that is the recognised textbook for students in the art of construction, and is specially adapted for those taking their course in honours, and requiring information on calculations for building structures. Simple graphic methods are adopted, and, as we have said, it is the best work of its kind.——*Machinery Pattern Making*, by P. S. Dingey (New York: John Wiley and Sons), is a work which has in substance appeared in one of our American contemporaries, and will commend itself to pattern makers who are still students of their craft. Elementary matter is omitted, as the author is writing only for those already skilled in, or, at least, acquainted with, the work of pattern making.——*The Art and Craft of Cabinet Making*, by David Denning (London: Whittaker and Co.), is intended to supply amateurs and young professional cabinet makers with a reliable guide to the construction of cabinet furniture, and it may be found useful by those who, having tools and leisure, like to make articles of what is known as cabinet-work, as the instructions are definite and to the point.——*Dynamics of Rotation*, by A. M. Worthington, M.A., F.R.A.S. (London: Longmans), is a work which will be found extremely useful by those who cannot dive deeply into mathematics, but who can understand an "experiment," even when it is only described in print. Mr. Worthington has done a service to students who cannot follow the mathematicians. His examples are remarkably well chosen, and with the questions and answers, his work may be recommended to all students who have not the advantage of a teacher.——*New Fragments*, by John Tyndall, F.R.S. (London: Longmans), is a collection of essays by the distinguished physicist—some of them not strictly scientific, but all readable and instructive. The volume includes Prof. Tyndall's last lecture in the Royal Institution—that on Thomas Young—and is one of those books which can be taken up at any time and be read and re-read with pleasure and advantage.——*Theory of Heat*, by J. Clerk-Maxwell, M.A. (London: Longmans), is the tenth edition of the well-known textbook in the series issued by the publishers. Corrections and additions have been made by Lord Rayleigh, and are indicated by the initial [R.] In many respects this is the best treatise on heat published.——*Himalayan Journals*, by Sir Joseph Dalton Hooker, F.R.S. (London: Ward, Lock, Bowden, and Co.), is a volume in the Minerva Library of famous books edited by G. T. Bettany, M.A., and is well known as an interesting description of a botanist's travels in the Himalayan regions.——*The Architect's and Builder's Pocket-Book*, by Frank Eugene Kidder, C.E. (New York: John Wiley and Sons; London: Gay and Bird), is the ninth edition of a work which is full of information useful to architects, builders, and others, the new edition being, in a measure, necessitated by the increasing use of steel in structures. In the United States it is a standard work, and occupies a place in the library of every architect and builder.——*Public Libraries*, by Thomas Greenwood, F.R.G.S. (London: Cassell and Co.), is the fourth edition of a work which comprises the whole history of the movement in favour of rate-supported libraries, and contains illustrations of many of the free libraries in this country and abroad.——*A Practical Introduction to the Elements of Chemistry*, by W. Marshall Watts, B.Sc. (London: James Nisbet and Co.), will be found very useful by those who can work at chemistry in the experimental manner; in fact, it aims at teaching through experiments, and seems excellently adapted to its purpose.——*A Practical Guide to the Testing of Insulated Wires and Cables*, by Herbert Laws Webb (New York: D. Van Nostrand Co.; London: E. and F. N. Spon), is a guide to the everyday work of the testing-room, and will be useful to those whose work is connected with telephony, telegraphy, and electric-lighting.——*The Practical Catechism*, by Robert Grimshaw, M.E., Ph.D. (New York: John Wiley and Sons), is a collection of questions and answers on technical subjects, and contains much useful information that is not to be found elsewhere in so handy a form.——*Chemical Calculations*, by R. Lloyd Whiteley, F.I.C. (London: Longmans), will be found a very useful work by students of chemistry engaged in the actual manipulations or laboratory work, as well as by those who are going up for the examinations of the Science and Art Department.——*The Mechanical Engineer's Pocket-Book*, by D. Kinnear Clark, M.Inst.C.E. (London: Crosby Lockwood and Son), is an addition to the "pocket-books" which will, no doubt have a long life, as it is just the kind of work that practical men require to have as near to them as is implied by the word "pocket."——*Manipulation of the Microscope*, by Edward Bausch (Rochester, N.Y.: Bausch and Lomb Co.; London: W. P. Collins) is a little work which may be recommended to beginners with the microscope, and those who wish to understand that instrument.——*Electricity Up to Date, for Light, Power, and Traction*, by **John B. Verity**, M.Inst.E.E. (London and New York: Frederick Warne and Co.), is a popular description of what has been done in the practical application of electricity in recent times, and will be useful to general readers.——*The Ilford Manual of Photography*, by **C. H. Bothamley** (Ilford: Britannia Works Company, Limited), is a work written for the manipulator or practical hand, which avoids theory and explanation, and goes straight to the subject of what has to be done and how to do it. A list of "Dealers and Dark Rooms" will be found useful by peripatetic amateurs in photography, and the book is an excellent little manual.——*Burton's Modern Photography* (London: Piper and Carter) is the tenth edition of a well-known handbook dealing mainly with gelatine dry-plate work and Printing.——*Technical Education in the Counties*, by **G. J. Michell**, B.A.Lond., and **Ernest Heber Smith**, Assoc.R.C.Sci.Lond. (London: George Philip and Son), is a book that should be read by those who are interested in technical education, as it is called.

THE LATE JAMES KENYON PEILE

("J. K. P.")

THE English Mechanic and its readers have lost another of their oldest and best friends in "J. K. P.," who died on the 9th inst. at his residence, 174, Adelaide-road, N.W. For more than twenty-one years "J. K. P." has been, above all others, the one to whom every correspondent interested in the lathe turned for help, and to him no appeal was ever made in vain. Over and beside this, the amount of priceless information contributed by him to our earlier volumes rendered us and our readers for ever his debtor. He was as modest as he was able and generous, and with the exception of the few correspondents with whom, from time to time, he consented to be put in private communication to solve their difficulties, few of our readers even knew his name.

Mr. James Kenyon Peile was born at Upper Clapton, Middlesex, on October 12th, 1824. The family moved, in 1827, to Stamford Hill, where he passed the next fourteen years of his life, going to school at the establishment of Mr. Francis Green, at Stoke Newington. His father had a taste for mechanics and some skill in ornamental turnery, and possessed what was, for those days, a very good amateur's lathe, by Holtzapffel, with a sufficient supply of tools and appliances. This lathe, it is true, had but a wooden bed; but it was gradually altered and improved by James, until it finally developed into the very perfect tool with which his beautiful work was subsequently executed.

In his very early boyhood James got to work in his father's shop, and soon acquired skill in the use of the tools. His first attempts at turning were made when, as yet, his head barely reached to the lathe's centre. When about sixteen years of age he was entered in the engineering classes of King's College, London, where his mathematical and mechanical tastes were expanded, and opportunities afforded, by access to appliances not previously within his reach, of becoming trained to the craft, and where was implanted in him that desire to attain to accuracy of execution by which all that he subsequently accomplished was eminently distinguished. He completed his terms at the College, and obtained his diploma as Associate—a distinction, at that date, of some value.

Naturally, James Peile was destined for the career of a civil engineer, and, with that end in view, was sent, for further practical training, to the shops of Messrs. Burg, Curtis, and Kennedy, at Liverpool. He had not been there many months when he was stricken by typhus fever, followed by some other ailments, which necessitated his removal from Liverpool, and it was not thought desirable for him to resume his work there. After some desultory employment in connection with the extension of railways in 1846-7, he engaged himself to a firm of engineers at Leicester, with whom he worked for about three years, when, the firm failing, he was again thrown back. Owing, perhaps to some extent, to discouragement at the failure of this second attempt at establishing himself, but more probably actuated by an increasing attachment to the out-turn of his own hands and to absorption in the surroundings of his own shop, he never again made a serious effort to obtain outside employment. Had he once secured a firm footing in the profession, there can be little doubt that his talents would have raised him to an eminent position, to the benefit of his country; but perhaps this might have been at the sacrifice of that affectionate regard entertained for him by a very wide circle of friends who indulged in similar tastes, and to whom he proved so useful an ally.

James Peile's intimate practical knowledge of all the minute intricacies of the mechanic's craft, and his finished skill, caused him to be sought out as the expounder of many a knotty problem. A friend writing of him to his family says:—"I looked up to him as *the* man who always gave a sound, reliable opinion on any mechanical question, and never would give an opinion at all in a matter with which he was not thoroughly acquainted." The effort to attain to accuracy was the touchstone of his life, and it was accompanied by an amiable desire, frequently exercised at the cost of considerable personal labour and inconvenience, to assist any who chose to apply to him in a difficulty. It is somewhat sad to know that the varied and valuable contents of the workshop in which he passed the greater part of his life, and which by long use and familiarity of touch had become dear to him to an extent which the skilled workman alone can fully realise, should now be scattered; but so it must be.

At its first inception, James Peile joined the volunteer movement, and enrolled himself as a member of the 1st Middlesex Engineers Volunteer Regiment, in which he rose to the rank of major, and from which he finally retired in 1883. He carried his love of accuracy into his military life, and enjoyed a deservedly high character for efficiency. He passed away, after a very short but severe illness, on the 9th of this month, deeply mourned by his family and by a very wide circle of relations and friends.

PRACTICAL ELECTRO-PLATING.—III.

By T. C. Smith.

THERE are certain classes of work, such as epergnes, &c., that it is very difficult, if not impossible, to scratch-brush, burnish, or polish after plating. When there is a quantity of this class of work to do, it is usual to use what is termed a "bright" solution, i.e., a solution from which a tolerably bright deposit of silver can be obtained without the necessity for scratch-brushing or burnishing. The "bright" solution is also useful for plating such cheap work as would not pay for burnishing, &c.

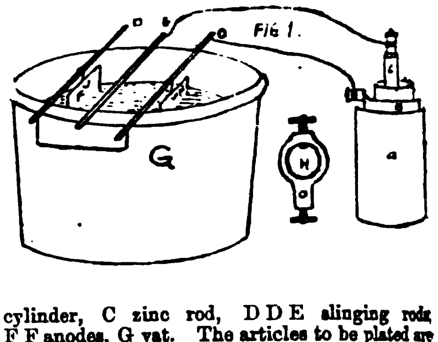
"Bright" solution: To half a pint of ordinary silver solution (which for this purpose should contain a moderate amount of free cyanide) add about half an ounce of carbon bisulphuret, decant, and tightly cork; well shake the bottle every few hours for two or three days, when it will be ready for use. If not wanted at once, this solution will be improved if kept for a few days.

Add the above solution in very small quantities to the vat until the silver is deposited sufficiently bright. Great care must be taken not to use more of the bisulphuret than is necessary, for an excess is very likely to spoil the solution. It is not advisable to use it at all except when absolutely necessary.

There are several metals, such as iron, lead, tin, &c., upon which it is very difficult to get a good, sound deposit of silver, though it is comparatively easy to plate them with other metals. It is usual in such cases to first plate with some other metal or alloy which will firmly adhere to them, and which will at the same time act as a good foundation for the silver. Some platers employ brass for this purpose, others (the majority) copper, which is much the simpler of the two to use, and as it is always useful, I should advise all platers to keep some ready for use? it costs very little to make, and only a small quantity (one or two gallons) is required.

Copper solution (cyanide): Dissolve half a pound of copper sulphate in about a quart of hot water; when cold, slowly add, stirring meanwhile, liquor ammoniæ (sp.gr. ·880) until the green precipitate at first formed becomes redissolved, and the solution assumes a dark blue colour. A strong solution of cyanide must now be added, until the blue colour entirely disappears; a slight excess should then be added. This solution should be worked at a temperature of from 120° to 150° F. A solution made as above, but with the chloride instead of sulphate of copper, may be used cold, but costs considerably more to make, and does not deposit so quickly as the former.

The arrangement of vat, battery, anodes, &c., is shown at Fig. 1—A being battery cell, B copper cylinder, C zinc rod, D D E slinging rods, F F anodes, G vat. The articles to be plated are hung from the central rod E by thin copper wires. As the anodes are dissolved fastest just at the surface of the solution, it is advisable to shift them from time to time, so that they may be evenly dissolved. The hooks by which the anodes are suspended should, if possible, be made of platinum, which, as it is insoluble in the solution, will allow of the anodes being completely submerged, if necessary. If copper or brass hooks are used, they must be carefully kept out of the solution, or it will, by dissolving them, acquire a certain amount of copper, which would be very detrimental. H, Fig. 1, shows a very useful form of rod connection or terminal which may be used either for slinging rods, or on a larger scale for battery zincs.



Preparation of Goods to be Plated.—If the work has been previously plated, all the silver that remains on it must be "stripped" (p. 434); it is best first to wash the article with strong soda or potash solution, so as to remove any grease which, were it left on, would to a certain extent protect it in places from the action of the acid.

All work must be dried before being placed in the "stripping" acid, as the addition of a very small quantity of water greatly decreases its efficiency; for the same reason it should be carefully covered up when not in use, as it absorbs moisture from the atmosphere. When all the silver is removed, well rinse and dry the article, and if rough, as it most likely will be, it must next be polished; this is done either by hand with emery-cloth, or on a leather or felt buff, driven at a high speed and fed with fine sand mixed with oil. The latter is of course the best and quickest way, but unless steam or other power is available, it is very hard work. I think it will be best, therefore, for all small work, to use emery, commencing with a coarse cloth (Oakey's F F), and finishing with the finest obtainable.

When the article is made as smooth as possible, well wash it in a strong, boiling solution of potash, to remove every trace of grease, perspiration, &c., which is seen to collect on it after handling; if made entirely of hard metal—i.e., brass, copper, German silver, &c., it should next be well brushed with a moderately stiff brush and powdered pumice and water, using only enough of the latter to keep the pumice moist. All interstices in fancy work, such as cruet feet, mounts, &c., must be made quite clean; if there should be any spots of verdigris or corrosion, it may be necessary to use acid for their removal, a few drops of nitric or dipping acid applied to the spot will quickly accomplish this. The fingers must be kept wet, and should be dipped from time to time in the pumice powder so as to keep them as much as possible from actually touching the article.

As success to a great extent depends on this cleansing, it must be very carefully done, every part must be quite clean and present a uniform dull appearance. The slinging wires should now be attached (before rinsing), and the article brushed all over in one direction if possible so as to give it a quite uniform surface after the necessary handling. It should then be well rinsed (holding by the slinging wires only) in several lots of clean water, and quickly transferred to the vat. If both the vat and battery are in good order, it should turn white after a few seconds immersion; but should it turn brown or streaky, deposition is taking place too quickly, and the battery power should be diminished or the anodes slightly raised so that there is a smaller surface exposed (in the solution).

As soon as the article has received the deposit all over, it is advisable to remove it from the vat; well rinse, and carefully go over it with a wire scratch-brush, plentifully supplied with size and water or beer and water—I prefer the latter. Scratch-brushing soon after the initial immersion greatly helps to keep the deposit uniform and smooth; it will also find out any places that may not have been properly cleaned, and which otherwise might not be discovered until the plating was completed. If, after being scratch-brushed, there are no signs of blistering or stripping, the article may be returned to the vat, remaining there until a sufficiently stout deposit is obtained. On the other hand, should the silver "strip" or "blister" under the scratch-brush, it is advisable to place the article for a few moments in the stripping acid, so as to remove all the silver; then clean, and plate again. At this early stage it is, in my opinion, nearly as quick, and certainly more satisfactory in the end, to do the work over again; but should the stripping occur when the work is near completion, it is sometimes possible to "doctor" it as follows:—Carefully clean the stripped spot and surrounding portions of the article; then wrap a small piece of sheet silver (connected to the negative pole of battery) in thick flannel or cotton wadding wet with silver solution, and apply to the desired spot. The article itself being connected with the positive pole of battery. Of course, only a very slight deposit is obtained by aid of the "doctor"; but if the work is carefully finished, the defect will not be noticeable unless it is in a very prominent position.

There is a quantity of old plated work about, the ornamental mounts, edgings, &c., of which are made of lead or its alloys (by the way, these edges are generally termed "silver (!) edges"), and as the plater is sure, sooner or later, to get some of it to replate, a few words about this particular class of work will not be out of place.

It is very important that this class of work should not be left in the stripping acid longer than is necessary to remove the silver. When "stripped," well wash and dry the article, not merely on the surface, but make it hot, so as to expel any acid that may have found its way between the article and mounts. If this is not thoroughly done, the acid will either get into the vat—which, of course, would be very detrimental—or else will show itself by characteristic green or black marks after the job is finished. After the edges have been thoroughly cleaned with a stiff brush and pumice-and-water, they must either be "quicked" or coppered; the latter is preferable, and as a very slight deposit, on mounts only, is all that is required, it need not take much longer than the "quicking" process. When all the mounts, edges, &c., are coppered, the remaining parts of the article can be cleaned in the usual manner, and the whole plated as before, being carefully washed and dried when finished.

Articles made of Britannia metal are more difficult to deal with than those made of the harder metals. They should be cleaned with extra care as before, well rinsed, and quickly transferred to the vat, where they should remain undisturbed until the desired deposit is obtained. As Britannia metal is but a comparatively poor conductor of electricity, it is necessary to use rather more battery power, and considerably more anode surface—probably twice that used for the same sized article made of brass or copper.

All articles made of lead or its alloys, zinc, iron, steel, &c., should be coppered before they are silvered. The two latter must be pickled in the following before coppering: Sulphuric acid, about 1lb.; hydrochloric acid, about 3oz.; water, about 1 gallon. When freshly made, a few minutes' immersion in the above "pickle" will be sufficient; but after the acid has become somewhat exhausted, or if the article is very much oxidised (rusty), it must remain in "pickle" for some considerable time. After pickling, the article must be well rinsed and cleaned with a stiff brush and pumice—or, what is preferable for this purpose, fine sand and water—until quite clean. It should then be rinsed, given a momentary dip in the pickle, then well rinsed again, and transferred to copper solution.

Articles made of zinc should be cleaned in the following: Sulphuric acid, ¼lb.; water, 1 gallon. Unless very dirty, these articles will come out of the pickle quite clean, and will only need to be rinsed and coppered; but if dirty, they may require cleaning, as above.

As the time necessary to silver-plate an article depends on the thickness of the deposit required, and the state of the vat, battery, &c., it is impossible to give any exact limits; but the battery and solutions I have described will, if in good order, deposit sufficient silver to cover half a dozen dessert forks with a serviceable coat in from three to four hours; the exact amount of metal deposited can easily be ascertained by weighing either the anodes or the article both before and after plating.

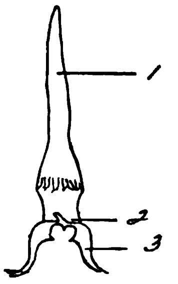
When plated, the articles should be well rinsed in hot water, and carefully dried, which latter is best done by placing them in hot box-sawdust; when quite dry, the dust can be easily removed with a soft brush.

(*To be continued.*)

PRACTICAL MICROSCOPY FOR STUDENTS.—XX.

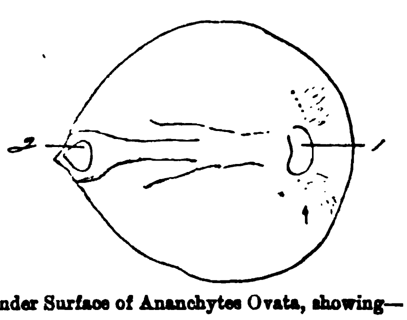
By FREDERICK DAVIS, B.Sc., Associate of the Pharmaceutical Society, &c.

IN studying the division termed "Annuloida," we have two especial types to review; the Sea-urchin, representing the "Echinodermata" and the Tape-worm as the representative of the "Helminthozoa." Upon referring to the table of the Animal Kingdom given in a previous chapter, we find that Echinodermata means "hedge-hog skinned"—that is, the animals of this division are provided with spines, apparently out-growths of their outer skin or shell; some authorities are of opinion these spines exist for the protection of the animal, whilst others hold the opinion that not only are they a protection to the animal, but also assist to no slight degree in its powers of locomotion. Occasionally, when at the sea-side, we find upon the sands, or by examining the cliffs, a hard, somewhat conical shell, perforated over its entire surface with little holes, arranged in a regular manner from the apex downwards: it was from these that the spines formerly extended. It will be observed also the shell is entirely closed, with the exception of two spaces upon the under surface, representing the mouth, and the point of ingress and egress of the water vascular system, and another at the apex, namely, the anus. The shell itself is composed of chalk, beautifully arranged in plates. In its fossilised state this shell is quite full of soft chalk; in fact, we find it in places corresponding to the epoch to which geologists have given the name of the Cretaceous period. A very common variety, and one frequently found embedded in chalk cliffs, carries the name of Ananchytes ovata. Generally speaking, by cracking this shell and removing the chalk which it contains, and carefully washing this latter, we find it to be full of beautiful sponge spicules. The student should retain and mount these as permanent objects for his microscopical collection. But enough has now been said concerning the shell; we must now proceed to the examination of the animal itself. The Echinodermata have a distinct digestive cavity—not directly going from mouth to anus, but proceeding in a circuitous manner. Hitherto, in the various organisms studied, we have not succeeded in absolutely proving the presence of a nervous system, although we have in more cases than one assumed such to exist; but in the echinus we are in a position to state that a nervous system is actually apparent. The mouth of the echinus is covered with a tough membranous substance, through which the teeth of the animal project.



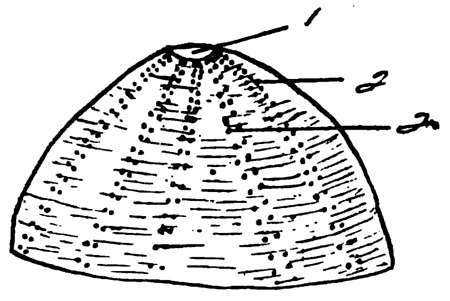
Spine of Echinus.

1, Spine; 2, Basal ligament; 3, Muscle.



Under Surface of Ananchytes Ovata, showing—

1, Mouth; 2, Entrance to water vascular system.



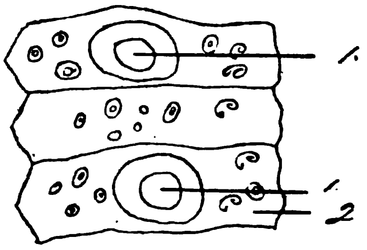
Ananchytes Ovata.

1, Anus; 2, Ambulacral holes.

The teeth are five in number, and form a kind of beak, which is capable of scraping away portions of rocks or other substance to enable the animal to obtain its food, which, for the most part, consists of worms and other sea inhabitors, which bury themselves in the rocks and chalk covered by the sea-weeds. The teeth are of a very complex character, the arrangement most peculiar: they appear to be regulated by a set of distinct muscles from within the body cavity; these are capable of moving the teeth in any direction, so that we may liken the motion at one time to that of a saw, and at another to a vertical or longitudinal movement. Viewed by the microscope, they form an object of especial interest. Each tooth at its apex is pointed or beaked, and is very hard; but as it enters the socket we find it gradually becomes softer, until at the point of insertion it is apparently without any deposit of calcareous matter whatever, and is therefore soft. As the tooth becomes worn away at the apex by constantly scraping the rocks, it is pushed forward or grows from the sockets, and assumes a harder state, until at the apex it is rendered just as hard as the portion which has worn away. The jaw of the animal takes part in the crushing of the food, for we observe it to be furrowed into a series of fine files, which, acting by rubbing together with the food between them, reduce the substance to a very fine state of subdivision, altogether unattainable by the operation of the teeth only. The animal appears to devour every portion of the creatures which become its prey, eventually assimilating certain portions and rejecting the parts which are valueless for its support. The mouth gradually contracts into a kind of gullet or throat, somewhat resembling a funnel in shape, and this goes directly into the intestinal canal, which, after proceeding in a spiral manner, folds upon itself, and finds an exit at the apex of the shell.

The whole canal is held in position by the mesenteries and the body-substance itself, and is well supplied with blood-vessels. Outside the shell we find a mass of sarcode muscular substance, as it were, penetrating the holes previously described as existing in the shell, and in connection with the body cavity within the shell. The spines, we found, were in connection with these holes in the shell; now, each spine is movable, and regulated by a ligament in connection with the body cavity, passing through the holes, and entering the spines. The spine being movable, might be supposed to be affixed by a hinge; this, however, is not the case, as the lower part of the spine merely fits into the hole above which it is placed. It will be seen, therefore, that the movements of the spines are wholly regulated by the ligaments within. In addition to the power of locomotion effected by the spines, we observe a second: it will be found in the shell there are holes larger than the others, arranged in a vertical manner from the apex to the base. Through these little suckers or feet are extended, by means of which the animal is capable of attaching itself to any rock it may come in contact with.

The holes through which these suckers or feet extend are termed ambulacral holes, and the extended feet ambulacral organs. Upon the under surface of the shell we observed at one end the opening termed the mouth, whilst at the other end is another opening; this is in connection with an arrangement known as the "water vascular system," regulated by little bags, which by expansion and retraction serve to extend and contract the feet of the animal. It is also considered the water vascular system regulates the so-called respiratory functions of the animal.



Ambulacral Plates of Echinus Highly Magnified.

1, Ambulacral holes; 2, Plate.

If the student will carefully compare the above description with the diagrams given, he will have little difficulty in understanding this curious animal.

If upon his next visit to the sea coast his attempts to secure a specimen of the sea-urchin should prove futile, let him examine the star-fish: this can always be found, and being one of a class termed Asteroidæ, resembles the urchin in many particulars.

The second portion of this article will be occupied by the consideration of the tape-worm. This creature may be termed in its developed state, an internal parasite. We will, for purposes of convenience, trace the animal through its various phases, from its position of internal parasite to that of egg, and the curious developments which the egg afterwards undergoes. The scientific appellation of this creature is "Tænia solium," *tænia* meaning "band," and *solium* "alone."

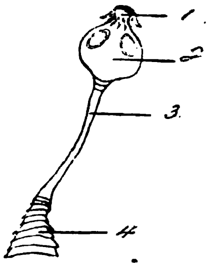
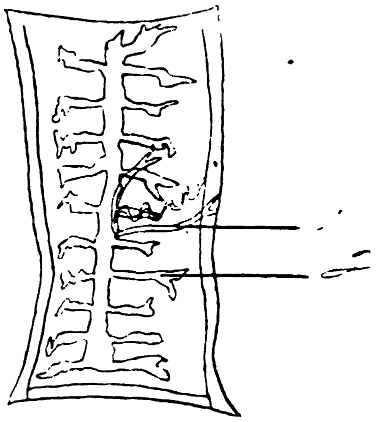


Diagram of Tænia Solium, showing—

1, Hooks; 2, Head; 3, Neck; 4, Segments.

There are several varieties; for instance, that infesting the rabbit, another the dog, and another man himself. We find the animal in many cases 28ft., and even 30ft. long; the head of the creature is circular, provided with a sucker and two rows of prolongations or hooks: it is by means of these it attaches itself and hangs on to the intestines. Proceeding from this head is an elongated neck, which extends itself into a broad bandlike segment, which in its turn is attached to another segment, and so on probably to the length of several yards.

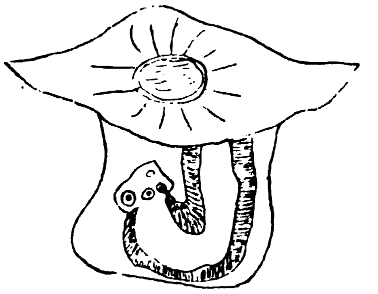
As the segments become mature they fall off one by one, and are excreted with the fæces, their place being taken by others, which are extensions or growths from the neck of the worm downwards. Each segment whilst in the human intestine is capable of developing within itself a number of ova, and also male organs or sperm-cells. The ova become fecundated by the sperm-cells, and as the ova extending and enlarging fill the segment, it drops off and is expelled from the system as previously explained. The number of eggs expelled in this manner is immense, in fact innumerable; but only a few of these ever mature, although all undoubtedly would if the opportunity were given them.



Segment of Tænia Solium.

1, Reproductive Organ leading to side; 2, Water vascular system.

The egg being taken with the food (say of the pig), and being acted upon by the secretions in the alimentary canal, dissolves the chitinous covering and frees the embryo, which develops, and by means of its six hooks, penetrates the coats of the alimentary canal, and finds for itself a suitable position in any of the organs of the body. Here it becomes encysted—that is, forms a case or covering for itself, which is permeable to the fluids of the organ in which it is imbedded. This nourishes the larva, which develops hooks and sucker, and its second stage is complete. No further change can now take place until the larva finds another position. This is secured by an animal eating the flesh in which the lava form exists, which, immediately finding itself in a suitable position—that is, the intestine of a man for instance—the hooks become fixed to the coats, and growth takes place in the form of segments; the segments in turn become matured and fall off. The "tape-worm" requires, therefore, two hosts at least for its completion: generally an herbivorous animal for the immature or cystoid stage, and a carnivorous animal for its cestoid or perfect state. We found that the perfect "tape-worm" is possessed of neither mouth nor anus, strictly so speaking, but absorbs its nourishment from the digested juices in the canal of its host by the process of intussusception.

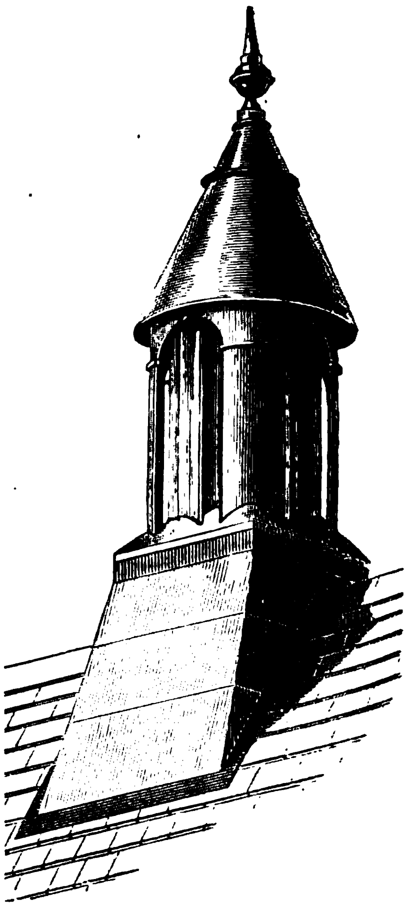


Larva of Tænia Solium encysted.

Some old naturalists gave the name of "Entozoa" to this class of animals, but a better is that now applied. There are other divisions of this class, but resembling to a marked degree the type which we have studied. It will not be necessary to occupy space with these divisions. The flukes and other parasitic worms are all related to this class.

BOYLE'S PATENT IMPROVED AIR-PUMP VENTILATOR.

MR. ROBERT BOYLE, managing director of Messrs. Robert Boyle and Son, Limited, has recently patented an improvement in his air-pump ventilator, which adds considerably to its value as a foul-air exhaust. The ventilator is free from downdraught, and impervious to rain or snow, whilst the vibratory noise caused by the impact of the wind on the edge of the plates is, by the new arrangement, done away with. Auxiliary exhaust chambers may also be fitted to the ventilator, increasing the extracting power 100 per cent., without enlarging the size of the ventilator. The improved ventilator is made of an ornamental character, of the best rolled steel plates, galvanised and painted with enamel paint, and is sold at 50 per cent. less in price than the earlier and inferior forms of the air-pump ventilator.



FITTING.—XV.

AFTER work has been marked out, the question of how best to remove material and to finish surfaces may or may not be a matter of concern to the fitter. In large workshops it is a matter that does not concern him, because the lined-off work is mostly taken at once to the machine-shop and turnery, and is not brought to the fitter until the machining is all done. Exceptions there are, of course, as when cast work has to be fitted by chipping and filing to plated and wrought iron work, and boiler work; but as far as mere automatic mechanism is concerned, the fitter has nothing to do with the formative, or shaping part of the work.

In very small shops, however, where there is a paucity of machines, and in all amateur's workshops, the workman or the amateur have to do some—often a considerable proportion—of the shaping to outline with hand operated tools. This is an inevitable consequence either of lack of machines of types suitable for the purpose required, or very often because the machines available are limited in capacity or power. For this reason I shall best serve the interests of the general body of the readers of a magazine like this, if I assume that they belong mostly to the latter class, who have to resort to many make-shifts and imperfect methods of getting through their work.

With the amateur mostly, and with the country fitter, poorly equipped with machines and tools, the question is not usually how a given job would be done in a large workshop, but rather how may it be best done with such makeshift appliances as are available.

I must, therefore, I think, in the interests of the apprentice and the amateur, describe how work is shaped to outline without the aid derived from the automatic machines of our large establishments. The writer remembers to have seen in his youth much work done with chisel and file, upon which chisel and file are never now used in the large shops. Thus, valve-faces were chipped and filed, which are now done in the planing-machine; surfaces were labouriously got up by draw-filing and emery cloth, now done with a rapidly-revolving emery wheel; bosses and rods were chipped and filed, that are now either shaped or ground; angular brasses were fitted by filing into their plummer-blocks, where turned brasses are now fitted into bored seatings; wheel-teeth were chipped and filed, that are now more commonly moulded smoothly and accurately by machine. In large establishments lads learn less handicraft than formerly; hence a moderate amount of home-work should be as valuable to them as to the amateur. A bit of model work carried through from beginning to end is an excellent object-lesson for them, in doing which they will be brought face to face with problems that would not occur to them in the routine of their sectional tasks at shop. For lads and amateurs especially, therefore, I am going to say a little about the various ways of shaping outlines by handwork. I shall devote an article or two to the purely formative processes of fitting, as carried on with the least possible assistance from machines.

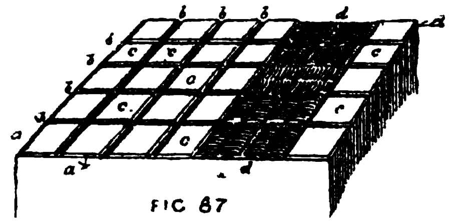


FIG 87

Work is hand-shaped to various outlines by chipping, filing, scraping, grinding, and drifting. It is not convenient to consider these as altogether distinct from one another, but rather as having a natural dependence and sequence.

Not so many years since, the file was the prince among hand tools in our workshops. It was employed for truing large and small surfaces, both flat and curved—work that is now done so much more rapidly with planer and shaper. Intricate forms, combinations of convex and concave curves once filed laboriously to templet, are now done more expeditiously with milling cutters. Yet the file still holds a place in shops, as well as in amateur practice, as a corrective tool. Much work that comes into the fitters' hands from the machines has to be still further trued up and adjusted, first with file and then with scrape. For machined surfaces fitted to machined surfaces without further correction are usually but a rough slop-job, much too rough for the best classes of work. Apart from the more or less ridged surface of machined work, due to the feed of the tool, there is the distortion that frequently follows from clamping it upon the machines and lathe-chucks—distortion which it is the function of the file and scrape to correct. And a very large part of the difference in the cost of second-rate machine tools and those of first-class quality is due to the additional time occupied in hand work done on the latter. The finest fitting of sliding surfaces done by hand with file and scrape on the best machines really begins at the stage at which those of inferior quality are sent out of the shops for delivery.

Because the file lacks the perfect guidance possessed by some classes of tools, skill in its manipulation is essential to the accuracy of work done with it. For this, considerable practice is requisite; but at last the practised hand feels intuitively how to operate the tool in various directions—now heavier, now lighter, now taking a broad surface, now localising the efforts.

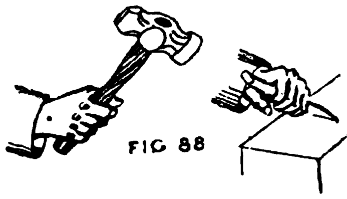


FIG 88

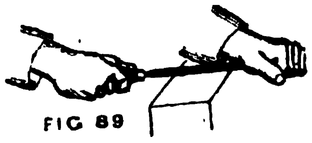
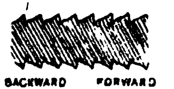


FIG 89

FIG 90



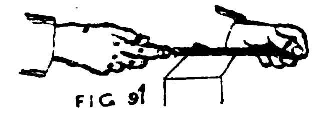


FIG 91

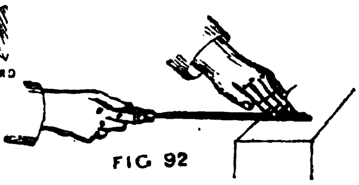


FIG 92

The first difficulty experienced by beginners is that of filing a flat surface: it will become convex. Yet files are for the most part—that is, all except those which are called "dead parallel" —convex in the longitudinal direction, and therefore ought, it might be supposed, to make the work slightly concave. The reason why the surface filed becomes rounding is that most pressure is given first by the right hand on commencing the stroke, and then by the left hand towards its termination, whereas the pressures should be as nearly as possible in equilibrium —that is, the effort should rather be to press harder with the left hand upon the point of the file at the commencement of the stroke, and harder upon the handle near its termination. In this way the file is made to "hang" well to the central portions of the work, instead of slipping over those and pressing harder upon the margins.

There is also a difference in metals. It is easier to file wrought iron than cast, and easier to file any iron true than hard gunmetal. The file clings to wrought iron and steel; but it slips over hard cast iron and over hard gunmetal—to use an expressive term, the latter are "greasy" by comparison with the former.

This filing of surfaces level is the first, and the chief, difficulty, which has to be encountered, and which, when mastered, like the equally simple, yet equally difficult, task of planing a piece of wood true, is never forgotten.

Filing is like most other work—it cannot be done at random, or recklessly. Random work will spoil the files, make wasters of the work, and will yield inaccurate results.

But the precise details of working vary, of course, with area, and with contour, with broad and narrow faces, with convex and concave surfaces. In a series, therefore, of object lessons, I propose to discuss the details of shaping various kinds of work with files. And I think the best plan will be to consider the subject under two types: plain work of large area, and small and delicate work in which the area is inconsiderable. I will consider the first in the present article, the second in the article to follow.

Take, then, in the first place a broad, plain surface, Fig. 87, such as would be planed in a machine in half a day, but which, done by hand, would take at least three or four days.

Such a broad surface has to be operated in detail thus: First, the edges *a* are chamfered off with chisel and file down to the scribed line. Always, before commencing to remove a quantity of material by filing, it is well to chamfer the edges down to the line which has to be worked to. If much in amount, it will be chipped and filed; if little, filed only. The advantages are, that the amount of material that has to be removed in order to get down to the termination of the chamfer can be seen at a glance without bending down to look at the line itself, and that there is little or no risk of unwittingly going below the line.

Next, a number of cross-grooves, *b*, are run across with a cross-cut chisel, about $\frac{1}{4}$in. or $\frac{3}{8}$in. wide, at convenient intervals—say from 1in. to 2in. apart—less or more, according to the extent of the area that has to be operated. The truth of these grooves is tested with a straight-edge. By this device the bulk of the surface chipping is localised at the portions *c*, much diminishing the risk of the broad chisel, Fig. 88, cutting below the required level when operating about the central portions of the area.

A word about chipping: A keen edge is requisite to chip a surface freely. Chip in a direction away from the edge, rather than towards it. If the chipping is being done in lines parallel with the edges of the work, hold the chisel slightly diagonally, so that the force of the blows shall be inwards rather than outwards. Neglect of this will perhaps result in some portions of the edge becoming broken out. In the central part of a piece of work, the chisel-cuts may cross and recross in all directions, as in Fig. 87, *d*, which is a somewhat crude attempt to represent a chipped surface brought down to the level of the grooves *b*.

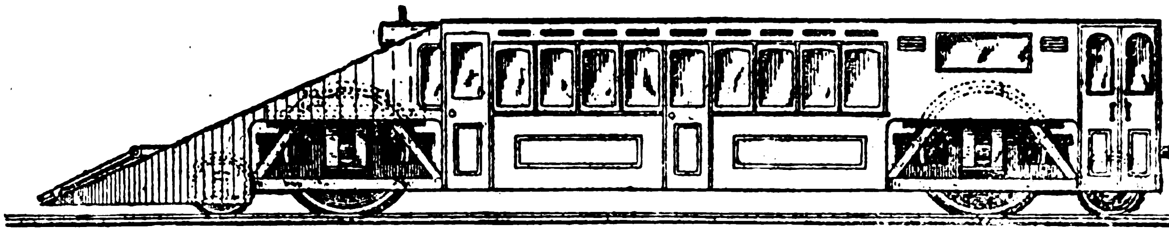
For very heavy work, requiring the removal of a large quantity of material, a coarse, rough-cut file is used. But for by far the general run of work a bastard file is used at the commencement, and when the bulk of the material has been removed, this is followed by the second-cut, or the smooth file.

To test the accuracy of a surface that is being filed, both straight-edge and surface-plate are employed; the first in the earlier stages, the second in the later ones. At the beginning it is quite sufficient to hold the straight-edge across the work, lengthwise, crosswise, and diagonally in succession, when the higher portions of the roughed-out surface will be indicated by the contact of the straight-edge therewith, without any artificial assistance derived from the transference of red lead from the straight-edge to the surface of the work. During this preliminary roughing down, the bastard files are used with the maximum of pressure, the hands holding and operating the file as shown in Fig. 89, and nearly the entire weight of the upper portion of the body being thrown into the work. The right elbow is kept almost close to the body, and the body and left knee are moved in unison with the file. The feet are spread at about 2ft. or 2ft. 6in. apart, to enable the workman to stand firmly, and put the utmost force into his work. The average height at which to set the work for filing is at the same level as the elbow. Heavy filing is done better with the work at a slightly lower level; for delicate filing it should stand rather higher than the elbow.

The weight of the upper portion of the body is thrown into the forward strokes of the file. But during return strokes the file is relieved altogether of that weight. It is not actually lifted from the work, but simply continues in contact with it, without pressure. If the pressure is continued the file will soon become dulled, in consequence of the fracture of the minute teeth. The magnified illustration of the teeth of a file (Fig. 90) will show how weak the teeth are relatively to force applied during the backward stroke by comparison with the forward or cutting stroke. There is plenty of metal backing the cutting edge in the thrust, there is practically none afforded during the return by the nearly perpendicular faces of the teeth.

The file is not moved in a straight invariable direction, but both forward and diagonally, now to right, now to left—a few strokes in one line, then a few in another—obliterating the marks left by the first—a variation which partly relieves the hands, and is more expeditious than constantly working in one set of lines.

To use a roughing file continually on its broad flat surface is not the most expeditious way of removing material in quantity or to economise the life of the file. If a lot of roughing out has to be done, the best way is to use edges and angles, and the unworn portions of half-round files, and to use these in various diagonal directions, crossing and recrossing at almost all angles. Generally the flat files wear out quicker than the backs of the half-round ones. When a considerable amount of roughing down has to be done, therefore, it is economical to use the backs of the half-round files for the purpose. This not only



saves the flat files, but the half-rounds cut more rapidly than the flat ones, so that time is economised as well as tools. When the roughing out has been carried so far that it becomes difficult to detect any inequality in the surface of the work by mere observation of the light between the straight-edge and the work in whatever direction the straight-edge is held, then recourse must be had to the red-lead test. Red lead is made into a thick paste with oil, and is smeared equally along the edge of the straight-edge. The transference of this colouring matter from the straight-edge to the surface of the work affords a delicate test of the reduction of the surface to the accurate level required. During this process the file is used with less pressure, and its action is rather more localised, as in Fig. 91, the point of the file being held between the fingers and thumb of the left hand, instead of the ball of the hand being pressed upon it as in Fig. 89. Much of the weight of the body is still thrown upon it, but not uniformly, being graduated more, according to the quantity of material that has to be removed from a given spot. Also, a fine or smooth grade of file is generally made use of, until at length the surface is wrought into a state of accuracy in which the straight-edge fails to indicate any very appreciable difference in level.

The proper method now is to have recourse to a surface-plate. If the work is small, and of no great weight, its surface is turned over on that of the plate; if massive, the plate is turned upon the work. A thin film of red lead is rubbed over the surface of the plate, using the finger or a bit of waste for the purpose, and now the surface that appeared so true when tested with the straight-edge merely, is seen to present very few points of contact with the plate. But a very slight amount of reduction with the file will serve to reduce these points of contact down to, or even below, the general level, so that at this later stage the work must needs be proceeded with cautiously, and frequent recourse must be had to the test of the surface plate. The red lead must be applied more and more thinly, for if applied thickly it will cover nearly the whole surface of the filed work, instead of indicating the highest points merely. Also, the finest files will be brought into requisition; and frequently, instead of being operated along their whole length, an inch or two only nearest the point will be used,—the fore-fingers of the left hand affording all the pressure necessary, as in Fig. 92. Thus in each successive stage of filing, greater and greater localisation of effort is essential, less and less material is removed, and finer files are used, until the utmost accuracy that is attainable by filing is reached. If a still greater degree of accuracy is wanted, then the scrape is employed, as in the sliding surfaces of the best work, and in the best steam-joints. But for a large class of work nothing is done after the filing is completed.

J. H.

THE HUNDRED-MILES-AN-HOUR ELECTRIC RAILWAY.

WE mentioned last week that an electric railway is to be constructed from St. Louis to Chicago on which trains will run at the rate of one hundred miles an hour. The annexed illustration gives an idea of the high-speed passenger coach. The road is to be worked on the patents of Dr. W. Adams, of St. Louis, and the standard schedule time will be 100 miles an hour for all through cars. The trip from Chicago to St. Louis can, therefore, be made in from two and one-half to three hours. It will not be necessary to travel at night, therefore no through passenger cars will be run after nine o'clock p.m., the tracks being reserved at night for high-class freight, mail and express matter. This does away with the necessity of running Pullman cars, and the expense to the company as well as the travelling public.

The character of the electric carriage or car is shown by the engraving. It is long, low, compact, light, but strong, having two pairs of driving wheels, each driven by a separate distinct electric-motor. The whole weight of the car, with its passengers and of the two electric-motors, comes upon these two pairs of driving-wheels, and is, therefore, all available for traction or adhesion between the rails and the wheels, through the agency of which the car is propelled. The top of the car stands only 9ft. from the rail, which is 3ft. lower than the ordinary street car. This brings the centre of gravity very low and near to the track. It has a wedge-shaped nose or front for cutting the air, which has the effect of decreasing the air resistance (a most important factor in high-speed locomotion) and of helping to keep the car down upon the track. The motor-man stands immediately back of this wedge-shaped point, and between his department and the rear wheels is the compartment for the accommodation of passengers. In the rear of this is a separate compartment for mail and high-class express. The driving wheels are 6ft. in diameter, and are capable of making 500 revolutions per minute. The weight of the entire car, with its motors, is but ten tons, while a steam-engine to make the same speed, if it were practicable, would have to weigh ten times ten tons.

These electric cars will be both illuminated and heated by electricity, and will contain all modern conveniences for comfort. There will be no conductors or brakemen. It will be possible to stop the cars within half a mile by means of the motors themselves and auxiliary brakes. "Through" cars will be run at intervals of an hour, or oftener, as the requirements of traffic demand. Accommodation cars will run every half-hour, stopping at all points along the line. The "accommodation" cars will be differently constructed from the "through" cars, the same requirements not being necessary.

One central power station, six or eight miles from Clinton, DeWitt county, Ill., will operate the whole road. It will be at the mouth of a coal mine owned and operated by the company by means of electric mining locomotives, electric drills, electric cutters, and electric lights. This plan greatly cheapens the present cost of mine operating. Furthermore, the company will obtain the power used for both operating the mine and the entire road from dust or slack, which is not only valueless, but has to be hauled away at an expense to most mining companies. The company will sell the good coal that it mines at a handsome profit, and will, therefore, have another source of revenue.

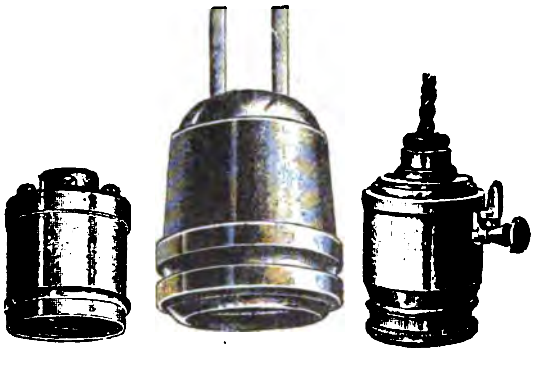
The proposed road will be divided up into twenty-five sections of ten miles each, which will constitute a complete block system, making it impossible for two cars to run at a high speed upon any single section at the same time, thus making collisions impossible. There will be a complete block-signalling system by means of incandescent electric lights, with telephone communication between cars upon the same section whether running or standing still. At night the road will be illuminated by incandescent electric lamps for one mile ahead and one mile behind every car while running. It will be built in a straight line, and, as far as possible, avoiding grade crossings of other roads. At all grade crossings, whether waggon or railroad, a red electric light will be displayed and an electric bell rung for two minutes before it is time for the train to pass.

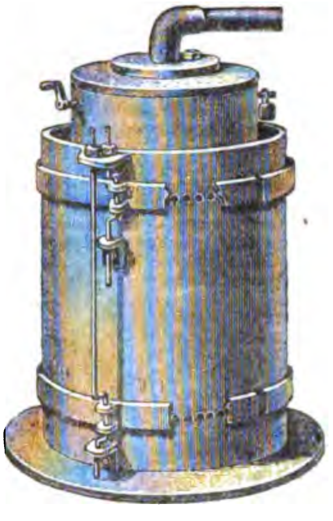
At first only a double track will be built, but it is the intention to ultimately construct four—the two outside tracks for local traffic and high-class freight, while the two inner tracks will be used exclusively for through passenger traffic, mail and high-class express. The through cars will not stop between the two terminal cities. Spurs will be run to Springfield, Decatur, Taylorville, Joliet, and Bloomington, and each of these places will have a through-car service between both St. Louis and Chicago without stop.

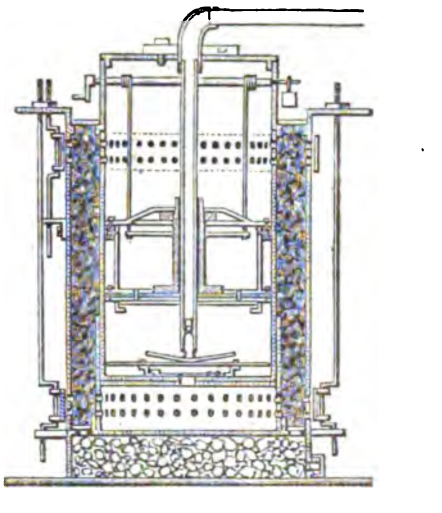
We take the above from a copy of the *St. Louis Republic*, sent us by a well-known correspondent, who says he can personally vouch for the truth of the statements made.

EDISON LAMP-SOCKETS.

THE Edison General Electric Company has devoted considerable time and attention to the perfecting of sockets. The standard Edison sockets are still distinctively characteristic, and the accompanying illustrations show the several types as at present manufactured. The tongue socket is one of the familiar types. Another key socket has been designed, however, but is not intended to displace the former. The pressure or push-button socket was devised for use on flexible and other one-light pendants, and has the advantage of operation by one hand. It is of the same size as the key socket, but instead of the key it has a small push-button, and a retaining catch. The other end of the rod holding the button consists of a small conical plug of insulating material with a metallic collar. Pressure on the button pushes the collar between a set of small brushes, and the contact then made is retained by the small catch. To extinguish the light requires a very slight pressure on the catch, releasing the button, and a spring throws it out, thus breaking the contact instantaneously. The use of the Edison standard keyless socket on artistic fixtures has, on account of the demand for more artistic fixtures, been a matter of considerable importance, and a small keyless socket has been brought out, the use of which will do away with the heavy appearance given to fixtures by the larger keyless socket. This socket, it is claimed, possesses several excellent features, being simple in construction, and in efficiency all that could be desired. Its dimensions are about 1¼in. by 1in., and it is said to be the smallest keyless socket for lamps of 16c.p. and upwards now before practical electricians. A socket for use in breweries, laundries, dye-houses, and other locations where steam and acid fumes exert a disastrous influence on ordinary insulation, having become a necessity, the Edison Company has brought one out, the shell of which is of hard rubber. The interior parts are imbedded in insulating material, impervious to moisture, and offering excellent resistance to acids, and the rubber-covered connecting wires are led out through small holes at the top of the shell. All Edison sockets, with the exception of the last mentioned, will shortly have all their insulation of porcelain. To meet the demand for porcelain electrical devices, the Schenectady works have been increased by a large porcelain factory, where are employed experienced men, whose ability in that line of work is undoubted. In the illustrations, the left-hand figure represents a keyless socket, the centre figure a hard rubber keyless socket, and the other a push-button socket.







A DEVICE FOR RAISING LIQUIDS.

THE accompanying illustration shows a perspective and a sectional view of a device for raising water from wells, rivers, &c., or for raising other liquids, as may be desired. It has been patented by Mr. Carl Storla, of Belford, South Dakota. The central cylindrical casing has a bottom aperture covered by an upwardly-opening valve held in an open frame, the lower end of an upwardly-extending discharge-pipe being secured on a bar of this frame. The pipe has side openings at its lower end, through which water passes from the casing into the pipe, there being also in the pipe a valve to prevent water and air from rushing down when the piston is raised, the pipe extending centrally through a vertically movable piston. This piston is adapted to press on the water in the lower part of the casing, and is raised by ropes winding on a windlass in the upper part of the casing. The piston is adapted to be weighted by suitable material, as stones, &c., or with water, which may be allowed to enter at higher openings, there being a valve in a false bottom of the piston to allow of the escape of the water as the piston is raised. The lower part of the main casing fits into and is supported in a second casing, the lower end of which rests on a plate formed with an outer shell, and forming a space adapted to be filled with filtering material, there being below the plate a base loaded with stone to hold the device in position where it is used in a lake or river, although this is not necessary when it is used in wells. When the piston is held in an uppermost position by the ropes wound upon the windlass, water passes through the lower openings, and through the valve in the bottom of the central casing; the operator then lowers the piston by turning the crank arm of the windlass, and, when the piston reaches the level of the water, the crank arm is released, so that the piston presses by its own weight upon the water, forcing it into and through the discharge-pipe. When the piston has reached a lowermost position, the water in the central casing has been nearly all expelled through the discharge-pipe, and the piston is again raised by winding up the ropes on the windlass.—*Scientific American.*

A NEW MILLING-MACHINE DOG.

OFTEN taper work is done on a milling machine between centres, and an ordinary dog with a bent taper tail is used for carrying the article to be milled. Referring to Fig. 1, it will be noticed that the action which takes place by revolving the work is a continuous gaining and losing one. This is due to the fact that the bent tail continuously changes its position at the point of driving. It readily can be seen that it twists right and left, and at the same time slides forward and back as the dog changes from vertical to horizontal position in turning over. Now if the set screw which holds the tail to the dog carrier is not released for every partial revolution, the tendency is to either spring or bend light work, or it will throw an enormous strain between the centres on heavy work, so that it is almost impossible to revolve it, and causing uneven divisions. Figs. 2 and 3 represent what is called a milling machine dog, in which the above defects are overcome, says the *American Machinist.* The tail of the same is turned cylindrical, and is offset, so that the centre line through the cylindrical part is in line with the end of the work when the dog is set flush. In addition to the dog there is an adjustable clamp attached to the regular dog driver, which firmly holds any size dog, and at the same time admits the tail to swivel either way or slide backward or forward. With a dog and clamp of this design, taper or straight work may be revolved between centres and held firmly in any position without any strain whatever. The same arrangement can be used on lathe work, and it is especially advantageous for thread, cutting, for two reasons:—First, where taper threads are cut between centres with the old style dog, the action of losing and gaining on the thread takes place the same as in the milling machine work, and produces what is called a drunken thread; by using the improved dog this trouble is entirely avoided. Second, there is no back lash in reversing the lathe, and a dog of this pattern is always on time. The Cincinnati Milling Machine Co., Cincinnati, Ohio, make the clamps and dogs.

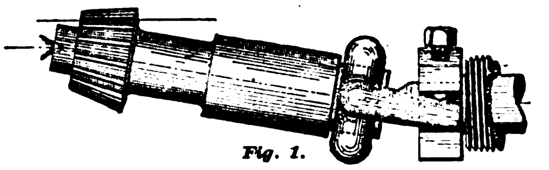


Fig. 1.

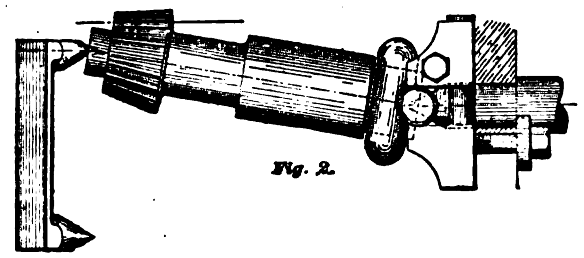


Fig. 2.

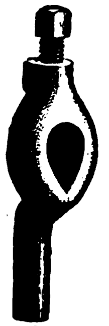


Fig. 3.

THE EVOLUTION OF THE COMPOUND MICROSCOPE.*

TO some of my audience it may not be unknown that the present year is the 300th anniversary of the invention of the compound microscope—the tercentenary of this now, it would seem, well-nigh perfected instrument. It was intended to have celebrated this event by an International Exhibition of Microscopes at Antwerp in August and September, this year, but the exhibition has had to be postponed for want of sufficient space. A circular-letter has been issued regarding the "Exposition de Microscopie Général et Rétrospective," with programme of the undertaking, which gives one some idea of the magnitude of the proposed exhibition. It is intended to make this an event in the history of the microscope, the thorough success of which is assured by the names of the scientific men interested, foremost appearing Abbe, Crisp, Nachet, Hartnack, Zeiss, Dallinger, Cox, Smith, Pelletan, and Van Heurck. It is proposed to subdivide this exposition into ten large sections, treating individually (1) Of microscopes employed in every branch of scientific work, as well as microscopes for special research; (2) all forms, ancient and modern, of apparatus employed for illumination; (3) apparatus used in conjunction with photomicrography; (4) every variety of accessory apparatus, which, for the various means employed, would prove too lengthy for my mention. (5) Apparatus for mensuration. (6) A complete collection of ancient and modern section-cutting machines (or, technically speaking, microtomes). (7) All kinds of apparatus employed in the technique of microscopical research. (8) Every variety of microscopical work to have representation by permanent preparations. (9) Apparatus for bacteriological investigations, modes of culture, &c., and demonstration of the details of this subject; and, lastly, but by no means least, in interest, (10) a section of microscopic bibliography, which will, in a measure, prove the record of all that has been achieved in the past three centuries, and which may be observed in the sections previously mentioned. (See J. Roy. Micr. Soc. Lond. 1891, LXXXI. 271.) At this exhibition the history and development and present perfection in both design and workmanship will be illustrated, covering a period of 300 years. Therefore, it is perhaps not inappropriate that I ask your attention for a short time to the history of an instrument which has been of such profound benefit to mankind. In this hasty review I cannot enter into details concerning the history of this instrument, which served our ancesters as toys and ornaments, and which has developed into the magnificent instrument of to-day, revealing marvels of the unseen world. Should you be so far interested, I would advise you to consult the writings of the various authors upon this subject, when you will observe that almost every step in the improvement of the microscope has been made in the face of the most discouraging predictions of high scientific authority that it was physically impossible. My time this evening and your patience would not allow of more than a hasty glance through its history. For the details, consult the many well-filled books—I might say, libraries. As many as 500 works treating of the microscope and its employment can be found in a single collection in this city. The history of the microscope prior to the year 1590 is fragmentary. The question of antiquity of magnifying lenses has been thoroughly discussed. A large number of writers have, at various periods, been engaged in the collection and examination of the works of ancient writers. These, in turn, were compared, and further elaborate research was conducted as late as 1871 by M. T. H. Martin, who, in his conclusion, remarks that magnifying lenses were not known to the ancients—or, at least, were not used by them for any practical purpose. Mr. John Mayall, of London, deceased but a few weeks since, who had devoted many years of his life to the study of the history of the microscope, also to a collection of ancient and modern instruments, remarks in his excellent series of lectures delivered before the Society of Arts, London, in 1885, that his views agree, in the main, with those of Mr. Martin. He came to the conclusion that the microscope, as we know it and employ it, is essentially an invention of modern times, and, to use his expression, "hit upon at a period corresponding almost marvellously with the advent of the spirit of modern research, when the need of such an instrument was, so to speak, most intensely felt by those precursors of modern science who first struggled out of the meshes of the ancient empirical methods into the free air of experimental methods." There are numerous instances cited of remote date, that many authors are disposed to accept with historical significance, of the microscope. Mention is made in Aristophanes's comedy, "The Clouds," 431 B.C., of the employment of burning glasses. Pliny mentions that physicians cauterised by means of a globe of crystal. Anaxander states that objects may be ignited by heat of the sun passing through "a vase filled with cold water." Similar statements are to be found in the works of Philopon. Seneca makes mention that "letters, though small and indistinct, are seen enlarged and more distinct through a globe of glass filled with water." Many passages could readily be quoted to show that the ancients were awake to the effects of burning glasses, though the underlying principles were not observed. Many remarkable and ridiculous anecdotes are recorded by the ancient writers concerning these early burning glasses. The burning of the Roman fleet before Syracuse, 250 B.C., by means of polished metal specula, shows that the attention of the ancients was directed to the laws of light; but this and other grave and doubtful questions are compared by the able historian before mentioned, Mr. Mayall, "to that of our own Swift when he introduces us to the professor in the Grand Academy of Lagodo engaged upon a project for extracting sunbeams out of cucumbers, which were to be put in vials hermetically sealed, and let out to warm the air in inclement summers." Before passing over the early records, which contain so many allusions to glasses of this form, I should direct your attention to a piece of rock crystal, "plano-convex," found by Mr. Layard at the excavations of Sargon's palace, Nimroud. This lens is oval, about 1¼in. long, 1in. broad, and $\frac{3}{16}$in. thick. This Assyrian "lens" is now in the collection of the British Museum, and bears date of 721-705 B.C. Authorities differ in opinion as to the possibility of this being a lens, or more particularly as to its employment as such. Brewster, after critical examination, states that it condenses light, and that it has a focus of about 4½in. The probable date of this lens is fixed by the authorities of the British Museum by the objects found with it. This Museum contains, also, two antique bosses, to which are assigned the period of "not later than 270-260 B.C." But we will pass beyond this early history of optics involved in considerable obscurity, and call your attention to a more authentic period. The first instrument to which I wish to draw your attention is the first compound microscope, made in Middleburg, Netherlands. It consists only of two convex lenses, and was made by Hans or Zacharias Janssen in 1590. There is a letter written by William Boreel, Dutch Ambassador in France, stating that Hans and Zacharias Janssen, whom he knew perfectly well, having been their neighbour at Middleburg, and having often played with them when they were young, he says in that letter that compound microscopes were made by the Janssens long before the year 1610. About 1806, an old microscope was found at Middleburg. It was exhibited at the South Kensington Loan Collection in 1876. Harting (an author and historian of the microscope), after examining the original, came to the conclusion that it was really made by Janssen. In 1776, when the original was exhibited at the Loan Exhibiton, Mr. Crisp had a copy of it made, and in 1884 Mr. Mayall had a copy made after Mr. Crisp's copy for the collection in the Army Medical Museum in this city. In 1891, shortly before his death, Mr. Mayall went to Middleburg in person and examined the original, became dissatisfied with the accuracy of the reproduction, and had four reproductions made under his eye; one to replace the copy in the Army Medical Museum. The original was presented to the "Zeeuwsch Genootschap der Wetenschappen," and from that time was so unknown even in Holland, that it is not mentioned in such a complete history of the microscope as that of Harting. (Geschichte und gegenwärtiger Zustand des Mikroscopes, Braunschweig, 1866.) The magnifying power obtainable with the instrument is not great. The Italians have made great efforts to give to their nation the credit of inventing the microscope, but it is now clearly shown and accepted that the Janssens made the first microscope at Middleburg, Holland, about 1590 or 1591. Galileo, from the testimony of himself. states that the instrument was of Dutch origin, and of date anterior to his own production of the telescope, 1609. Much interest was shown about the 16th century in the effects produced by varying the position of lenses, and after the first invention there followed a goodly train of makers. Galileo, 1637; Divini, 1657, and Campani, ante 1665; Hooke, 1665; Chérubin d'Orleans, 1671; Leeuwenhoek, 1673; Bonanni, 1691: Hartsoeker, 1694; Musschenbroek, 1702; Marshall, 1704; Adams, Culpeper, ante 1738; Cuff, 1740, and Dolland, 1790. To those of you who are not familiar with drawings of the very early forms of microscopes, it will be interesting to observe the various models of instruments, and you will be readily convinced that the opticians of those days had a very imperfect idea of the requirements of the microscope. Descartes "Galilean" microscope, 1637, and one of 1657, figured in Schotts' *Magia Universalis*, and Divini's, same date, are very curious forms, and apparently measure from 3ft. to 4ft. long, while the eye-glasses are said to have been as broad as the palms of a man's hand. These measurements are vague, but sufficiently suggestive to convince one that it must have been a formidable instrument. During this period the progress was very slow, and the different forms appear to be, more or less, a reproduction of the others. Very little original work can be shown, and as Mr. Wilson, in his history of the microscope, observes, this tends to show "that the instrument was seldom sufficiently used to show its weak points, while little improvement seems to have been made in the definition of the instruments." Fontana, of Naples, claims to have made microscopes in 1618, and even as early as 1592. Hufnagel (George) has published a work on the insects, with copper illustrations, which must have necessitated the use of some high-power lenses. The next microscope I would mention is a very pretty compound microscope by Giuseppi Campani, and antedates 1665. Campani was an optician of considerable note, and this instrument is dated as preceding Robert Hooke's, 1665, because it has no field lens to the ocular. As Campani would not have neglected so important a feature after its publication, it is safely assumed that his instruments were constructed before 1665. The body-tube of this instrument is of ivory, screwing into a ring of bone. This is mounted within a silver ring connected with three silver scroll legs coming off from a base of ebony. It is about 12in. high when extended. The instrument bears the name of Campani, and I would add, in passing, that it is a tradition in the museums of Italy that Campani put his name on all of his microscopes. This form of microscope is considered a beautiful example of an early Italian microscope. The year 1665 brings us to a specially interesting period in the history of this great instrument. The publication of Hooke's "Micrographia" and the suggestions contained therein all point to his practical ability in the use of the microscope. He has described and illustrated a very great number of objects as seen through the instrument of his day, and describes, also, his method of constructing high-power lenses. Some authorities are of the opinion that he was the first to apply the field lens to the eyepiece, but in the notice of Huyghens, in the *Bibliographie Universelle*, it appears that Huyghens had applied this to his telescopes previous to 1659, and this is prior to Hooke's work about six years. Hooke was, it is thought, the first to describe a method of estimating the magnifying power of the compound microscope, and must be credited with the first suggestion of immersion lenses. He was the first to give new life to microscopy in England, and made great progress in the improvement of the instrument, both optically and mechanically, and a glance through his "Micrographia" would readily convince one of his knowledge of the use of the instrument and its application to research. Herschel has referred to him (Hooke) as "the great contemporary, and almost the worthy rival of Newton." On February 2, 1672, Sir Isaac Newton communicated to the Royal Society his "design of a microscope by reflection," consisting of a spherical concave speculum of metal, and an eye-glass which magnified the reflected image of any object placed between them in the focus of the speculum. Leeuwenhoek, the founder of histology, is prominent in the history of the microscope during the latter part of the 17th century—about 1673. His microscopes were of the rudest construction mechanically, while optically they consisted only of a bi-convex lens let into a socket and a hole drilled into the plate for the eye to look through. To quote Mr. Mayall, "his reputation as a discoverer in microscopy was really based on his patience and dexterity in the preparation of his objects, and on the skill he brought to bear on the interpretation of his observations." His investigations in histology were very great, as are shown in his "Anatomia Interiora Rerum." Particularly noteworthy are his researches on minute nerve structure and on the capillaries. With such imperfect instruments and no methods of preserving histological objects, we can well marvel at the amount of his work and the accuracy of his observations. While it is difficult to assign the microscopes of the latter part of the 17th century to chronological order, the period is remarkable for a large number of instruments of various designs, prominent among them being some excellent models of early English microscopes. Two quaint models, binocular, by Chérubin d'Orleans, respectively 1677 and 1685, Grindl's compound microscope, 1687, Bonnani, 1691, and Hartsoeker's simple, 1694, and Gray's "Water Microscope," 1696, consisting of a plate of brass with minute holes in which drops of water were to be placed, but without any arrangement for holding the object. Drops of water were put in the minute apertures, forming a bi-convex lens of unequal curvatures by which, with care, observations could doubtless be made. The first half of the 18th century records the names of many makers of microscopes, and the period is remarkable for originality. John Marshall's double microscope, 1702. A number of important innovations in microscopical research are embodied in this—a fine adjustment screw; a ball-and-socket joint is employed with the advantage of inclining the entire microscope, and the first appearance of a condensing lens. This instrument is employed with a candle beneath the condenser, from which it is inferred that the mirror used for reflection of rays was at this date still unknown. Musschenbroek had two curious forms dating 1702. Culpeper made a number of models between the date of 1720—1740, each model being a decided improvement over the previous ones. His microscopes are all figured with the mirror. Scarlet's, Lieberkühn's solar microscope, Martin's universal, and George Adams's universal microscopes all appeared in rapid order prior to 1750, and the improvements, as shown by each one of them at their respective dates, were remarkable. About 1750 appeared Adams's solar microscope for transparent and opaque objects, and these are now considered beautiful specimens of rare solar microscopes. Adams made a number of forms which are figured in his "Essays on the Microscope," London, 1787. During the years 1750 to 1800 makers of microscopes were numerous, the most distinguished makers being Cuff, Ellis, Dolland, Martin, Adams, and Dellebarre; the works of these men speaking of difficult investigation, originality, and marked progress. Cuff's models were much sought in their day, and were considered very serviceable working instruments. The fine adjustment was of great delicacy, and showed that Cuff spent much labour in the improvement of the mechanical construction. The period of achromatism as applied to the microscope, about 1820, marks a period in the history of the instrument from which one can readily observe the great advance made in the perfecting of the instrument, both optically and mechanically. Great changes took place in the construction, with particular reference to the means of focussing. This period may be reckoned as the dividing time between the two classes of instruments — namely, the ancient—those made prior to the date of achromatism—and the modern—those constructed subsequently. In 1824 Tully constructed an achromatic microscope, and he applied mechanical motion to the stage of the instrument. Amici, Selligue, Chevalier, and Merz seem contemporaneous, and represent microscopes of the achromatic type between 1820 and 1835. In the history of this instrument from this date on to the present year the names of Oherhaeuser, Hartnack, Zeiss, Reichert, Nachet, Powell, and Leland, Grubb, Zentmayer, Tolles, Bulloch, Beck, Ross, and Swift will ever stand out as memorials, and mark distinctive epochs of advancement. During this period inventions of every description, different forms of stands, innumerable accessories, achromatic condensers, mechanical stages, a variety of new lenses, both dry and immersion, adjustable and non-adjustable, and new forms of oculars, have been introduced in a whirl. Many of these proved of little value, some were but the stepping-stones to valuable future improvement, while many will prove of everlasting benefit and service. To repeat Mr. Wilson: "It would be quite impossible to pass in review the many excellent types of microscopes designed since the introduction of achromatism, and the progressive stages by which our grand instruments have been undergoing a gradual process of evolution from the primitive ones. Suffice it to say, that the advance in the construction of the instrument has been steady and continuous from the earliest known simple model by Tulley, with its struts connecting the base with the body-tube as a support, to the handsome and perfect instruments of the present day, embracing every possible adjustment that is known to make it suitable for all purposes of investigation." It may be of interest to you to know that, contained in the Army Medical Museum in this city, there is a collection of ancient and modern microscopes, numbering at present about 175 instruments of all forms, where you may observe the progressive stages by which the instrument has grown to its present state of perfection. Mr. Frank Crisp, of London, has one of the largest and most complete collections of this character. During the last fifteen years great progress has been made in the improvement of the objectives or object-glasses. The English, Germans, and Americans have been in active competition, and each year has witnessed some great advance by one or the other in the perfecting of objectives. Ten years ago the President of the American Society of Microscopists in his annual address remarked, "that lenses which were believed to have so nearly reached the limit of perfection fifteen years ago are antiquated now, and the theoretical limit of perfection has moved forward like the horizon, and is as far off as ever." Compare the state of the microscope of 1882 with 1891, and note the change that has been realised. In 1869, in a letter addressed to Col. Woodward, U.S.A., Nobert expressed his belief that it was physically impossible to resolve with a $\frac{1}{18}$ lens more than 91,000 lines to the inch. But a short time after Col. Woodward had succeeded with a Powell and Leland lens, $\frac{1}{18}$, in resolving 112,000 lines to the inch—21,000 lines more. The highest record of resolution that has been attained is that of Mr. Fassoldt, who has ruled and demonstrated 120,000 to the inch. This may be considered the present limit of visibility. The theoretical limit of 1869 was passed. Water immersion lenses proved a gain over the former dry lenses. Later, the latter gave way to the homogeneous immersion lenses. But a few years since, 1886, the labours of Prof. Abbe brought forth a new kind of optical glass, the invention of which gave new life to microscopy. These special lenses, called apochromatic, are remarkable for their freedom from spherical aberration, practically colourless, giving an image clearer and of better definition than could be gained by the achromatic lens. Of special advantage are the new glasses in photo-micrography—the faithful recorder of all microscopic observations. In this brief description of the history of this wonderful instrument, mention has been made of but a few facts concerned in its development. If you will look into some of the old works of the 16th and 17th centuries, where much of the interesting history of the microscope is written, you will be curious to observe how, from the exciting curiosity it was in its infancy, it grew to the valuable, remarkable, and perfect instrument of research it is to-day. Look deeper, and see the investigations and discoveries that have followed its birth. Fields of investigation unheard of were opened up. What of the branches of science, histology, biology, embryology, bacteriology? What have we learned from this instrument, which a few hundred years ago was a toy, delighting and bewildering alike the makers and the curious employers? Mr. Wilson remarks: "What the future development of the microscope may be it is impossible to say. Fifty years ago no one would have dreamt of the great advances which have been made up to the present time, and only a few years ago the limit to the further improvement seemed to have been reached when the introduction of the new kind of glass gave a fresh impetus to microscopy." "There remains, of course," says Prof. Abbe, "the consolation that there is much between heaven and earth that is not dreamt of in our philosophy." "Perhaps in the future, however, genius may succeed in making forces and processes serviceable, which may enable the boundaries to be overstepped which now seem impassable. I believe, however, that those instruments which may, perhaps, in the future more effectually aid our senses in the investigation of the material world than the microscope of the present will have little else than the name in common with it." To look at the microscope in its early days, three hundred, two hundred, yes, but twenty-five years ago, and review the progress made in the optical and mechanical construction, of the investigations that have been instituted, and the results achieved by the aid of this wonderful instrument, you can but predict that the microscope has before it the prospect, if not the assurance, of a most glorious future.

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* An address delivered by J. Melvin Lamb, M.D., Washington, D.C., at the opening of the Medical Department of Howard University.

SCIENTIFIC SOCIETIES.

ROYAL ASTRONOMICAL SOCIETY.

THE annual general meeting was held on Friday, February the 12th, General Tennant, president, in the chair. The annual report stated that the society now consists of 617 Fellows and 47 Foreign Associates. In the list of Fellows who have died during the past year, the names of several distinguished astronomers are to be found. Amongst others will be noticed the names of Sir G. B. Airy, Prof. J. C. Adams, Dr. F. E. Brünnow, Mr. Norman Pogson, Prof. Schönfeld, and Mr. Henry Pratt.

During the past year 21 minor planets have been discovered, bringing the total number up to 323. M. Charlois, of the Nice Obervatory, heads the list as the discoverer of ten of them. This is the largest number of minor planets which have hitherto been discovered in any one year. Five comets have been observed during the year. The first was discovered by Mr. Barnard, of the Lick Observatory, and also independently by Mr. Denning, of Bristol. The return to perihelion of Wolf's comet; Encke's comet has been observed, as well as the return of a comet which was first observed in 1869, and which is now known as the Tempel-Swift comet. Mr. Mr. Barnard also discovered, on Oct. 3, a telescopic comet in the constellation Argo; but its southern declination and small brilliancy have prevented it being satisfactorily observed.

The gold medal of the Society has been awarded this year to Prof. G. H. Darwin, for his work on "The Tides, and their Influence on the Figures and Motions of the Heavenly Bodies."

The following gentlemen were elected as officers and council of the Society for the ensuing year:— As president: Mr. E. B. Knobel. As vice-presidents: Mr. W. H. M. Christie, M.A., F.R.S., Astronomer Royal; Mr. J. W. L. Glaisher, M.A., Sc.D., F.R.S.; Mr. E. J. Stone, M.A., F.R.S., Radcliffe Observer; Lieut.-Gen. J. F. Tennant, C.I.E., R.E., F.R.S. As treasurer: Mr. A. A. Common, LL.D., F.R.S. As secretaries: Mr. E. W. Maunder, Mr. H. H. Turner, M.A., B.Sc. As foreign secretary: Mr. William Huggins, LL.D., D.C.L., F.R.S. As council: Capt. W. de W. Abney, C.B., R.E., D.C.L., F.R.S.; Mr. Arthur Cayley, M.A., Sc.D., LL.D., D.C.L., F.R.S., Sadlerian Professor of Pure Mathematics, Cambridge; Hon. Sir James Cockle, M.A., F.R.S.; Mr. A. M. W. Downing, M.A., Superintendent of the *Nautical Almanac*; Mr. George Knott, B.A., LL.B.; Mr. Frank McLean, M.A.; Mr. W. H. Maw; Mr. W. E. Plummer, M.A.; Mr. A. Cowper Ranyard, M.A.; Mr. Isaac Roberts, F.R.S.; Rev. Walter Sidgreaves, S.J.; Mr. E. J. Spitta.

THE difference in the length of the cables in the East River Bridge, Brooklyn, when the thermometer registers zero, and when it registers 100° above, is 2ft. 4in. The difference in the rope which hauls the car is 7ft. 6in.

SCIENTIFIC NEWS.

THERE seems to be a large increase in the number of sunspots lately, some of them so large that they have been observed with the naked eye by those possessed of the ability to withstand the strong glare.

Small planet No. 324 has been found on photographic plates taken by Dr. Max Wolf in November and December last, and was afterwards observed by Dr. Palisa on Jan. 20. It will therefore belong to 1891, which, it seems, has a longer list of discoveries of minor planets than any previous year.

From Prof. Tacchini's records at the observatory of the Roman College, we find that during the last quarter of 1891 there was not a day without sunspots.

At Gresham College, on Feb. 23, 24, 25, and 26, the Rev. Edmund Ledger, M.A., F.R.A.S., will deliver four lectures on "The Sun and other Suns." The lectures commence at 6 p.m., and will be illustrated by the aid of the limelight. Admission free.

The *Annuaire* de l'Observatoire Royal de Belgique for 1892 has been received. Besides the usual matter, it contains, amongst the short papers, one on the Leonids of 1891, by M. Niesten, and one on the first determination of the difference of longitude between Brussels and Uccle.

M. Gautier, of Geneva, publishes, in the *Ast. Nach.*, No. 3075, an ephemeris of Tempel's first periodical comet, which, he calculates, will return to perihelion in April next. The comet is of interest, as it is supposed that its motions are perturbed by Jupiter, and it is hoped that weather and other conditions will be favourable for observing on its approaching return, which should be early in April.

During the past week the death has been announced of Colonel Grant, the companion of Speke, and also of another distinguished African explorer, in the person of Johann Wilhelm Junker. Dr. Junker was born in Moscow in 1840, of German parents, and received his education in Germany. His first journeyings were in Tunis and Lower Egypt. In 1876 he explored the Soudan, visiting Kassala, Khartoum, and the Western Nile valley. Soon after his return from this expedition he again went to Africa, and in 1879 continued his travels. In 1883 his return journey was stopped by the Mahdist insurrection, and he then betook himself to the Equatorial Province, where he joined Emin Pasha and Casati. Expeditions under Fischer and Lenz went to his rescue, but failed to reach him. In 1886 he finally managed to make his way to Zanzibar by an easterly route. Dr. Junker belonged to a rich banking family, but financial pursuits were not to his taste, and he spent a useful, though rather short, life in travelling through comparatively unknown regions. He received the gold medal of the Royal Geographical Society.

One of the most distinguished of those useful workers known as plant collectors died recently in the military hospital of Hanoi, Tongking. M. B. Balansa was, we believe, a Frenchman; but, besides being a plant collector, he was also an accomplished botanist, and did much to enrich nearly all the principal herbaria of Europe, our own collection at Kew being indebted to him for about 2,000 species, mostly from New Caledonia.

Mr. W. G. Smith has now completed, for the public gallery in the Botanical Department of the British Museum, water-colour drawings of nearly 500 species of British Bacidiomycetes, which include the whole of the white-spored species of Agarics. The total number of species is said to be over 2,000, and the drawings will occupy nearly 100 sheets.

The successful cultivation of the camphor tree in Florida, where it is said to flourish so vigorously and grow so rapidly, suggests the probability that in a few years' time there will be more camphor than orange trees in the country.

Dr. J. N. Brainerd, of Alma, Michigan, places a high therapeutic value on eucalyptol in bronchial and pulmonary affections. His experience, derived from its use for a period of ten years, has led him to believe it to be of utility, though to a smaller degree, even in cases of tuberculosis.

MM. Cornil and Chantemesse have informed the Paris Academy of Medicine that they have caught some of the influenza bacilli, and are cultivating them in bouillon, after the Pasteur method. The organisms are formed like the figure 8, and the largest of them are barely the size of the twentieth part of the diameter of a drop of blood. Experiments were made on rabbits and monkeys: the animals inoculated showing every symptom of influenza soon after they had been injected with the preparation obtained by the professors from the cultivation of the microbe. The experiments of MM. Cornil and Chantemesse confirm the results of the researches of Babès, Pfeiffer, and Canon, and help to prove that infectious influenza is due to a bacillus.

Dr. James Leicester, of Bristol, has been investigating the germination and growth of seeds in electrified earth—that is, the seeds were raised in a sort of earth battery, a box containing mould, and having a copper plate at one end and a zinc plate at the other, connected together by a wire. The action of the mould on the zinc sets up a current, and it was found that in the case of many seeds the plants grew more quickly than those from similar seeds in boxes which were not converted into voltaic cells. In the case of hemp-seed, "it was fully an inch above the surface before there was any sign of it in the ordinary vessels." The experiments were made in several ways—in glasses, pots, and boxes, with soil from the same heap—but in each case germination and growth were hastened when the metal plates were added.

It is stated that at the Jena Glass Works a "metal" which will pass none but the red rays is being made.

The highest points in Europe which have the benefit of the electric light are said to be Pontresina, the Kulm Hotel at St. Moritz, and the Riffel Alp Hotel, Zermatt, and the Maloja Hotel in the Engadine. Pontresina has the lowest altitude of the places named; but the inhabitants have utilised a waterfall of some 430ft., and supply themselves with light and power at a comparatively cheap rate.

Messrs. Shaw and Sons, of Coventry, have, it is stated, completed for Major Moore, R.E., a flying machine, which is based on the experiments made by that officer in India. The wings measure 17ft. 6in. by 8ft. 6in. in the widest part. For the present they are covered with calico, but, when attached to the box and electric motors, will have double woven silk, specially prepared, stitched on; the silk will cover the box as well as the wings. A closer inspection shows how carefully the anatomy of the flying-fox has been followed. There are seven bones, leading off with two of 8ft. and 10ft. long, and finishing with one of 12ft., and are manufactured of the best weldless steel tubes, with brass-bushed joints; each joint and bearing has been forged, and this is the work that has delayed the completion of the machine. The tips of the wings are flexible. The head is formed of a loop of steel tubing, covered with silk, continuous without break from the body and wings. The tail is of tapering tubes, in prolongation of the side tubes or upper edges of the box which forms the body. Returning to the wings, which are of concave shape, each will have a sweep of 24ft., 12 up and 12 down, and are expected to make 50 strokes per minute. They are to be thoroughly tested, and when supported from the hinge only will have to bear a distributed dead load of 4lb. per superficial foot when the machine is turned on its back. Each wing is 120lb. in weight, and the machine, with the box and motors, is expected to turn the scale at 700lb. The total cost of the machine will be about £1,000.

It is stated that Mount Washington, U.S.A., is to be capped with the largest electric searchlight ever made, and the highest beam of artificial light in the world. It can be easily seen from Portland, Maine, and under proper conditions it can probably be seen even from Boston. The company which is to be organised to carry out the scheme will be made up of prominent railway and hotel men interested in the future development of New Hampshire.

Dr. Peters has discovered enormous [illegible] beds between Mount Kilima-Njaro and the volcano Donjo Ngai, and at the same time springs containing bromine, chlorine, and sulphuretted hydrogen gas. The whole great territory between Kilima-Njaro and Donjo Ngai is said to be one great saltpetre bed. In colonial quarters in Berlin it is expected that this discovery will rob the saltpetre beds in Chili of their monopoly.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

All Cheques and Post-office Orders to be made payable to J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks, a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

DIMENSIONS OF THE SATURNIAN SYSTEM — THE "NAUTICAL ALMANAC" — ASCENDING METEORITE — EARTH'S ORBITAL VELOCITY — RAIN-GAUGE — NEPTUNE — MARKINGS ON JUPITER'S THIRD SATELLITE — DARK CHANNELS IN 13 M HERCULIS—DRAWINGS FROM THE LICK LUNAR PHOTOGRAPHS—THE "ANNUAIRE" OF THE BELGIAN ROYAL OBSERVATORY—INFLUENZA —THE ICE AGE — A "WATERY" COMET—RAIN-GAUGE MEASURING GLASSES — OPTICAL ILLUSION — THE SUN AND EARTH—SHOOTING STARS—SATURN.

[33181.]—AMONG little improvements which might be made in the *Nautical Almanac*, without costing a farthing, I would instance the use of improved measures of the component parts of the Saturnian system. The results of the very elaborate measures made by Prof. Asaph Hall with the great 26in. refractor at Washington between 1884 and 1887 might well be adopted in our national ephemeris, as I have no doubt that there is a copy of Appendix II. to the "Washington Observations, 1885," at Verulam Buildings. Prof. Oudemans, of Utrecht, too, in the last number of the *R.A.S. Monthly Notices*, gives certain dimensions of the Saturnian ball and rings, which are very nearly in agreement with those of Prof. Hall, and would form a manifest improvement on those now in use in our national ephemeris. Anyone who doubts this should make two drawings of Saturn for some given epoch—one with Hall's data, and the other with those furnished in the *Nautical Almanac*—and compare them with the image of the planet in the telescope. Le Verrier's erroneous dimensions of Mars, too, ought to be similarly revised.

And, apropos of the *Nautical Almanac*, a rumour reaches me (but in so very roundabout a way that I repeat it with all reserve, and sincerely hope that it is not true) that the Admiralty are averse to any alterations for the better in it, on the specific ground that *they would cost money*. It would be a very curious thing to get at the real truth as to who it is who advises the Government concerning their scientific expenditure, for surely there is no European nation which—to employ a Westmoreland colloquialism—"saves at the spigot and lets out at the bunghole" in this matter as we do. Imagine the Admiralty or the Treasury—or some other department of the Circumlocution Office—boggling over the comparatively little sum needed to put our *Nautical Almanac* on an equality with, say, the American one; while the powers that be cheerfully acquiesced in the perfectly monstrous expenditure entailed on the nation by the *Challenger* expedition!

On the night of the 5th inst. I witnessed a phenomenon which was certainly unfamiliar to me. I was examining the spectrum of the Great Nebula in Orion, and while adjusting the equatoreal, saw ("out of the corner of my eye") a meteorite rise vertically, like a rocket, from the horizon. The whole thing was so sudden that I did not attempt to trace its path (or even to note the time); but I suppose that it must have come from the southern part of Canis Major.

Mr. Boraston's reply (76223) on p. 535, now makes his original query on p. 449 more intelligible. I was puzzled over his "sun's variation in R.A. per hour in arc," &c., because it is the sun's apparent motion in longitude, and not in right ascension, that is, so to speak, the reflection in the heavens of the terrestrial orbit. His principle is perfectly sound and self-evident, but his numerical data would bear improvement. For example, at the earth's mean distance from the sun, his semidiameter = 16′ 1·82″ (preface to *Nautical Almanac*, p. v.) The log. sin. of this is— 7·6686671;
and if to this we add the log. of
the earth's mean distance— 7·9656365

we get 5·6343036, the log. of 430,827·624 miles, the sun's true semidiameter. Or, adopting your correspondent's mode of proceeding, we say:

90,842.919 miles, log. 7·9582911
16′·18·2″ log. sin. 7·6760009

430816·16 miles, log. 5 6342920

Mr. Boraston will, of course, see that his method gives the orbital velocity of the earth at the selected epoch only, not its *mean* velocity.

One would be curious to know how "A. E. B." (Reply 76385, p. 537) measures ·01in. of rain. It is all very well to talk about measuring 2in.; but how often in this country does that amount fall in a day?

An answer to Query 76469 (p. 540) need occupy but little space indeed. Nothing, or next to nothing, is known of the time of rotation of Neptune. Maxwell Hall (R. A. S. *Monthly Notices*, Vol. XLIV. p. 25) observing in Jamaica, fancied from variations in the planet's light that it *might* rotate in 7h. 55m. 12s.; but enormously larger telescopes than his have failed to confirm his suspicion. Its "first" (and only) satellite is so far unnamed. It is simply idle to talk about its "diameter," as it shines as a star of the 14th magnitude, and requires a telescope of at least 9in. aperture even to glimpse it. It is 223,000 miles from its primary, and its period is 5d. 21h. 3m. At its extreme distance it is only 18″ from Neptune.

Everyone who is familiar with the description and drawings of the markings of Jupiter's IIIrd. Satellite, which Webb gives on pp. 168-169 of his "Celestial Objects for Common Telescopes," will read with interest the profusely illustrated paper on this subject by Messrs. Schaeberle and Campbell, which appears in No 19 of the third volume of the *Publications* of the Astronomical Society of the Pacific. During August, September, and October last year, these gentlemen had the Jovian system under constant observation, and a series of drawings made independently of each other suffice to show not only the objective reality of these markings on Satellite III., but to render it very probable that (as in the case of our moon) its periods of revolution and rotation are identical. They further seem to have established beyond reasonable doubt that while Satellites II., III., IV. are round, Satellite I. is decidedly elliptical, the ratio of the axes being 5 : 4, and the major axis lying parallel to Jupiter's equator. Part of this apparent elongation the observers are disposed to attribute to very bright regions at the extremities of the major axis of the satellite, the brightness exaggerating its contour. Here again Messrs. Schaeberle and Campbell arrived at the conclusion that the periods of revolution and rotation of the satellite were coincident. Of course, for work of this description the mammoth refractor is unapproachable.

The same number of the *Publications* also contains a paper by Prof. Holden on "Characteristic Forms within the Cluster in Hercules," in which he shows from the negatives taken with the Great Telescope that that marvellous object is intersected by a curious system of dark channels, the intersections of which he regards as centres of force. This paper should be read in connection with the admirable series which have appeared in this country in *Knowledge*.

Finally, I may add that the number of which I am speaking is adorned with two remarkable lithographic reproductions of enlarged drawings of the lunar crater Archimedes (under the morning and evening sun respectively), made by Dr. Weinek, of Prague, from the superb photographs of the moon taken in the principal focus of the 36in. refractor. The work on which Dr. Weinek is engaged is of the very highest interest to selenographers everywhere.

I referred in my last letter (33128) on p. 530 to the extraordinary delay in the appearance of the *Annuaire* of the Belgian Royal Observatory. Thanks to the kindness of a very eminent astronomer in that country, I am now in the possession of a copy; so that it has been, after all, only some five weeks late in coming out! I am not thoroughly sure that it was quite worth waiting such an inordinate time for. There are the usual ephemerides, and details of the Solar System, &c.; a little geodesy; some details as to physical constants and units; a mass of national statistics; a short account of the preliminary observations for the determination of the difference of longitude between the old Observatory in Brussels and the one at Uccle; papers by the editor on (what he calls) "La Nutation Initiale," and "Les Formules correctes du mouvement de rotation de la Terre," 166 mortal pages on meteorology, and a description, and in some cases the elements, of the planetoids discovered in 1891, and the five comets observed during the year just past. Of course, some of this is of interest, and use for reference; but, as a whole, it seems rather to have failed to satisfy popular taste in the country in which it has appeared, if we may judge from a review in the Brussels paper *La Gazette*, which says:—"Abstraction fait de l'étude annuelle de M. Lancaster sur le *Climat de la Belgique*, l'Annuaire n'est plus qu'une compilation de renseignements administratifs et scientifiques quelconques, qui ne s'adresse à aucune catégorie particulière de lecteurs et qui n'intéresse plus le grand public. Que nous voilà loin de *l'Annuaire* si bien compris que l'Observatoire nous donnait au temps de J.-C. Houzeau, véritable œuvre de vulgarisation scientifique qui répandait dans le public tant de connaissances intéressantes et utiles!" This might be more complimentary!

I can affirm experimentally that the allegation contained in your Scientific News, on p. 549, "that an attack of influenza protects from a second infection" is a mistaken one; having myself suffered from it in February—March, 1891, and again in December.

With reference to what Mr. Monck says in letter 33161 (p. 549), I suspect that what Sir R. S. Ball was commenting on is Sir John Herschel's statement, that "In passing from either equinox to the other, the whole earth receives equal amount of heat, the inequality in the intensities of solar radiation in the two intervals being precisely compensated by the opposite inequality in the duration of the intervals themselves."

I ask Mr. Garbett for bread—and he gives me (letter 33162, p. 550) a stone. Will he, or will he not—in other words, *can* he furnish us with the very faintest shadow of proof that a *watery* comet ever did exist, does exist, or ever will exist? He seems to labour chronically under the hallucination that he has only to talk about such a monstrosity to show that it may have objective existence. Moreover, as every geologist well knows, his "50 century" gravel is equally a figment. We all view his utterances with profound respect, but he is not infallible.

If "Non-Mathematical" (reply 76385, p. 556) had done me the honour to read paragraph eleven in my letter (33128) on p. 530, he would have learned that 2½in. in depth of a cylindrical glass 2½in. in diameter do *not* measure 1in. of rain caught in a gauge whose diameter is 5in. This would fill such a cylinder to the depth of 4in.; 2½in. of it would only measure 0·625in. received in the larger vessel.

"J. H. A." (query 76509, p. 560), has simply been performing an experiment illustrating the faulty achromatism of the human eye. It was this, among other imperfections, which elicited the remark for which the great German physicist Helmholtz has been so roundly abused—viz., that "if the eye were sent to him by an optician as an optical instrument, he should return it on his hands for its defects."

If, as supposed by "L." (in query 76512, on p. 560), the mass of the earth were increased until it equalled that of the sun, their present distance remaining unaltered, then they would obviously revolve round a point midway between them (the centre of gravity of the system), and each body would only describe an orbit *in space* with half the diameter of the earth's existing one. Relatively to the sun, however, our new earth—or sun—would seem to describe an orbit of the same size as it does now, and as the square of the periodic time is proportional to the sum of the masses of the two bodies, the year, instead of being 365·256 days long, would be $\frac{365\cdot256}{\sqrt{2}}$, or, say, 258·275 days in length.

The "star" seen by "Curious" (query 76522, p. 560), was only a large specimen of the ordinary meteorite. Two separate showers of these bodies are supposed to occur on February 15th, though but few of the components may be expected to be seen. With regard to the concluding question put by your correspondent, Saturn is in Virgo, above β and η in that constellation, and may be seen in the east before midnight, as a large, dull, leaden-looking star.

A Fellow of the Royal Astronomical Society.

NEW STAR IN AURIGA.

[33182.]—HAVING regularly observed variable stars at this observatory during the last seven years, I was much struck by the words in the *Times* report of Feb. 3rd, "slightly fuzzy." This is an appearance which, as shown by the following notes, accurately described R Pegasi on Aug. 29th, 1888, "hazy, ill-defined." S Cephei, 1889, April 25th, "looks like a well-defined star seen through a ruddy haze"; 1890, May 22nd, "deep red, surrounded with a ruddy haze." I have in each case a note

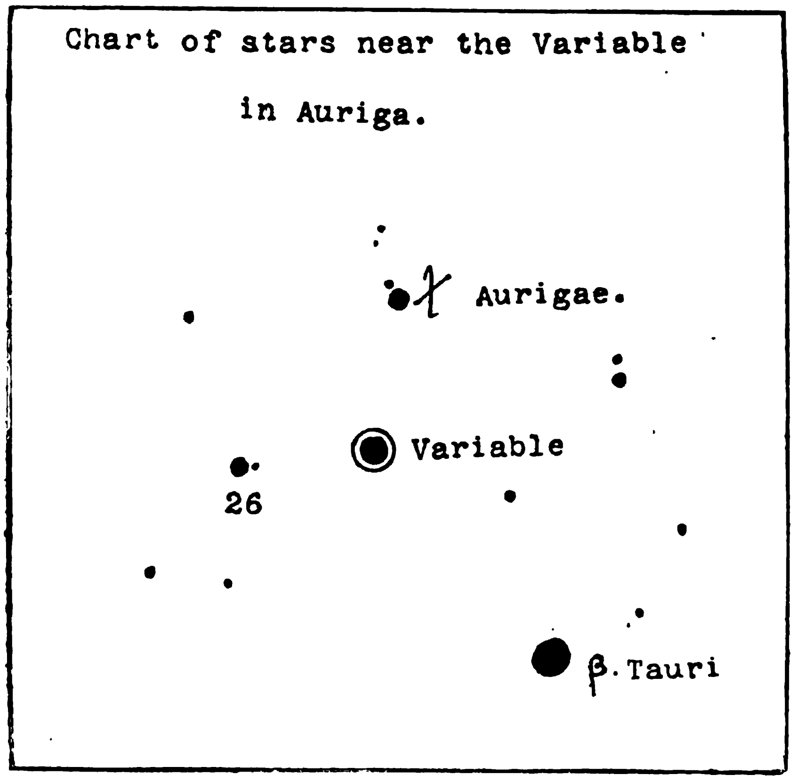


Chart of stars near the Variable in Auriga.

that the definition on the nights in question was excellent.

On the 5th inst. the new variable was carefully compared with β Tauri, χ Aurigæ, 26 Aurigæ, and 14 Aurigæ, the result being a mean magnitude of 4·2. The magnitudes of the comparison stars were taken from the Oxford observations. The variable is of a creamy or light yellow colour, and is well-defined in the telescope (6⅓in. o.g.) The comparisons were made with a binocular glass. I inclose a rough chart of the field. **Cuth. E. Peek.**

Rousdon Observatory, Lyme Regis,
Feb. 8th, 1892.

[33183.]—This star is easily found. It precedes the beautiful triple star 26 Aurigæ by 6m. 42s., and is not more than 3′ south of that star. Nova is about one magnitude brighter than the chief star of 26 Aurigæ, which is of 5·8 mag., according to Struve. The mean place of 26 for 1892·0 appears to be in R.A. 5h. 31m. 41·9s., and N.D. 30° 25′ 41″. Nova Aurigæ is followed by a 10th magnitude star to the north of it at a distance of about 45″. The colour of Nova in a 6⅓in. refractor is orange.

A. Freeman.

Murston Rectory, Sittingbourne.

[33184.]—I got an observation of this star on the evening of the 4th inst., when I estimated it about 5¼ mag. I did not get another observation till the 8th inst., when it struck me that the star had increased in brightness somewhat, but not being much accustomed to close estimation of magnitudes, I may have been mistaken. **T. R. Clapham.**

SATELLITES EXTRAORDINARY—ZODIACAL LIGHT.

[33185.]—A few days ago I received a letter from England, in which the writer asked me if I had ever seen Jupiter's satellites by reflecting the planet in a looking-glass! The rationale of this remarkable experiment struck me at once—as no doubt it will most of the readers of the "E.M." who have ever considered why the mirror of a reflecting telescope is silvered *in front*. I hunted up the thickest piece of looking-glass I could find, and proceeded to turn it on Sirius, then blazing high in the southern sky. It appeared furnished with two satellites, equidistant from the primary. Venus was so brilliant as to form further faint satellites, like Rhea and Dione.

The experiment is really a beautiful one, and, of course, depends upon the double reflections from the silver at the back of the glass, and from the surface of the glass itself. With a good thick piece of mirror glass, arranged with a few deceptive accessories, a London tramp might make a good living by showing "Jupiter's satellites" to the unscientific denizens of the East-end—if any such there be in these Board school days!

The Zodiacal Light is very conspicuous in the moonless evenings at present. So far as I can judge, Venus and Jupiter lie almost in its longer axis just at present. My wife compared the appearance of the western sky on the night of the 24th to two white rockets with the accompanying illumination of the air through which they passed. The rapidity of Venus's apparent motion at present is most pleasing to watch. I point out to friends the position in Taurus where she will arrive in the early days of April, and it gives them a fine sense of the derivation of "planet."

T. Preston Battersby, Capt. R.A., F.R.A.S.

Barbados, Jan. 26, 1892.

RIGEL.

[33186.]—I was glad to read of "Beta's" success with Rigel (letter 33129), and in reply to his question I tried the Trapezium with a 2in. stop and afterwards with 1¾in., and found with the latter the fourth star was just visible; it was moonlight at the time. The companion to Rigel was also glimpsed with the latter aperture, the power on the glass at the time being 180.

Also tried Zeta Orionis, and found it fairly divided, the greenish colour of the smaller star being noticeable, and the third (more distant one) easily seen. As a test, I then examined 52 Orionis with highest power, 270, and found the dividing line could just be seen; but being a small star and so close a double, it is with my glass a trying object, and just about the limit of separating power.

The amount of detail visible on the moon is to me surprising, and more interesting than double stars, which I value only as tests, my sight not being good for colours. One evening lately I found a large crater near the terminator, and could see the radiating ridges around it—a very striking feature. On reference to Webb, it was identified as Theophilus. The same appearance is very noticeable about Copernicus and several others. The latter crater was well seen some days later, there being three peaks to the central mountain visible, while the complex ring and the peaked shadow of the wall within the ring were obvious with power of 180.

These details, I am aware, will be quite uninteresting to possessors of large instruments, and are only intended for beginners with glasses of limited scope, and who, like myself, may wish to compare notes. **Orion.**

THE MOON.

[33187.]—In the twenty years that I have regularly read the "E. M.," but chiefly its astronomical articles and correspondence, I have seen discussions by our experts regarding the lunar atmosphere, and to try to convince such as deny its existence, I would direct their attention to the next and now approaching new moon. They will notice that the outer edge of the illumination along the western limb rises above the level of the rest of the edge of the moon—i.e., of the "blue moon," or "old moon in the new moon's arms."

This excess of illumination seems to indicate an atmospheric envelope of the depth of the excess. There may be solid particles floating in it, though clean air can reflect solar light, for the tails of comets, whose composition is the "vanishing point" of matter, reflect it, as all your readers know who remember seeing the great comet of 1858 and others since.

The small depth given to the lunar atmosphere as revealed by this excess of illumination, compared to that of Venus—an organised world of sea as well as land—revealed during its transits, gives the hypothesis its "likelihood to lead it." There is no optical illusion in this cap of the moon appearing larger than the head. I think your eminent correspondents, if they deem it worthy of their expressed opinions, will agree with my view of this overplus of lunar light. **J. Hugh Evans.**

COMETS.

[33188.]—I well remember the day on which the earth passed through the tail of a comet—or, at least, is said to have done so. It was, I think, a Sunday, and the atmosphere had a peculiar yellow tinge that was apparent, not only when one looked through a long expanse of air, but also on taking a short view. This fact most unquestionably proved that the matter of the comet was not as unsubstantial as theory makes out cometic matter to be. There must have been, comparatively speaking, considerable density to produce such a hue. Comets may be composed of more than one element or combination of elements, and if one or more of them absorbs, instead of reflecting, light, the spectroscope can take no cognisance of those constituents of the cometic masses, and consequently can give but imperfect information regarding their nature.

The now accepted Krakatao theory was so laughed at for a while that we should be careful not to be too confident regarding our acquaintance with the contents of the realms of space. **B.**

NEW EDITION OF "CELESTIAL OBJECTS FOR THE COMMON TELESCOPE."

[33189.]—Will you kindly allow me, through the medium of your columns, to say that a new edition of "Celestial Objects for the Common Telescope" is in course of preparation, and that I shall welcome any suggestions and additions as far as space will allow. I am leaving home for some weeks, and may not be able to immediately acknowledge any communications sent to me.

T. E. Espin.

Tow Law, Darlington, Feb. 10.

THE ICE-AGE.

[33190.]—I have since referred to Sir Robert Ball's book, and find that the passage on which he relies is to be found at 368 *c* of Herschel's *Outlines*. The language employed is certainly incautious; but, taken in connection with the context, I think the author may be fairly assumed to be speaking of the heat received by the earth during the two seasons, and not the heat received by each hemisphere.

Mr. Garbett's own statement that "you know nothing whatever of what a comet of 50 centuries ago contained" is, I think, a sufficient answer to a theorist who tells me that it contained water. But it is rather a violent hypothesis to assume the existence of former comets with properties unlike those with which we are acquainted, and then to add that it was one of these comets that collided with the earth. And while I regard collision with a comet as a thing that probably occurred at some past period, I think the chances would be considerably against its having happened within so short a period as 5,000, or even 10,000 years. Then as to the Deluge, I presume Mr. Garbett does not imagine that the comet-water has disappeared in some mysterious way, but that it is here still; in which case we ought to have geological evidence of a striking deficiency of water (as compared with our present supply) during the earlier geological periods. I am not aware that evidence of such a deficiency exists, and the most unlikely time to fix upon for such a deficiency would, I think, be that when our islands were groaning under the weight of enormous masses of snow and ice. However, I leave it to your geological readers to deal with that branch of the subject, and content myself with saying that so far as astronomy is concerned, Mr. Garbett's foundation appears to be of the sandiest description.

Dublin, Feb. 12. **W. H. S. Monck.**

[33191.]—Mr. W. H. Monck (letter 3361) thinks Sir R. Ball has "blundered" as to the doctrines of Herschel; but it appears to me that he himself has failed to see the inaccuracy of paragraph 368*c* of the "Outlines." Paragraph 368*a* shows that each hemisphere receives more heat during its summer than during its winter (Ball says in the proportion of 63 to 37). 368*b* shows that the nearness of the sun at summer solstice is compensated by the 7¾ days' longer northern spring and summer; but in paragraph 368*c*, whilst supposing the eccentricity of the earth's orbit were very much greater than it is, and the position of the perihelion remaining the same, Herschel goes on to state that whilst the northern hemisphere would have an approach to perpetual spring, the southern hemisphere would be inconvenienced by the concentration of *half* the annual heat into a short summer, and the spreading the other half over a long winter.

The real meaning of this passage is of course that half the annual supply of heat would be concentrated into a southern summer of short duration, and a concurrently short northern winter, whilst the other half would be spread over a long mild northern summer, and a concurrently long and severe southern winter—that is to say, exaggerating the present state of affairs—the earth's orbit being lengthened, and the perihelion remaining the same. Herschel clearly did not suggest that under these conditions that each hemisphere would receive equal quantities of heat during its summer and during its winter; nor is any such idea really propounded in 368.*c*, as Mr. Monck seems erroneously to suppose.

I await with interest the remarks of "F.R.A.S." on this subject.
S.

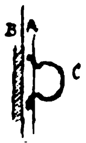
THE ICE AGE: ERRATA.

[33192.]—In line 10 of letter on "Two Real Causes of an Ice Age" (p. 550), 80,000th should be "one-80,000th." Line 2 of third paragraph, omit "as." Line 16 from bottom, I wrote "a still smaller quantity of water," meaning "a *greater* quantity."
E. L. Garbett.

A POCKET CHESS-BOARD.

[33193.]—The following is a cheap and, I believe, novel, way of making a pocket chess-board, suitable for use during long journeys, &c.

Take two pieces of ⅛in. planed wood (deal will do), 3in. by 6in. Glue on each a strip of cork such as entomologists use for lining their cabinets. On the cork paste (or paint) halves of a 6in. chess square. Two small hinges must now be screwed on the longer sides, in such a way as to allow the now joined boards to fold with the wooden sides touching, and to show a chess square when open flat. Fix a wire loop in the centre of the longer and outer edge of each half, the loop being bent thus:—



A, the edge of the wood; B, ditto of cork;
C, the wire loop.

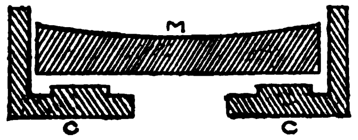
A lead pencil or a strip of wood thrust through these two loops will now produce a rigid and serviceable chess-board. The chessmen are slices of bottle-corks, with their denominations pasted or painted on them, and transfixed with pins, wherewith to fix them on their squares. A little case to hold the closed board and men can, of course, be made if wanted, and at a little greater cost some improvements might be introduced. The above, however, will be found quite efficient as it is, and takes up extremely little room.
John Dormer.

SILVERING MIRRORS.

[33194.]—"Ztrif's" method of silvering is indeed a novel one. Paragraph two of his letter puzzles me. Mr. Booth roasts the mirror, "Ztrif" boils it. These so-called delicate mirrors seem "hard to kill."

"Ztrif's" process must be a very slow-acting one to require a quarter of an hour with nearly boiling solutions to throw down the silver. I remember once trying considerably hot solutions to see how it acted. Before I could suspend the mirror the silver was all on the top—it came up instantly.

"Ztrif" asks: How to tell when the silver is polished enough? When the whitish bloom is off, and the blue silver appears. This takes one to ten minutes, according to size, and if the mirror is removed from the bath before the action is over, it hardly wants touching at all. It may be thus early removed from the bath if it be an overstrong one, and the waste no consideration.



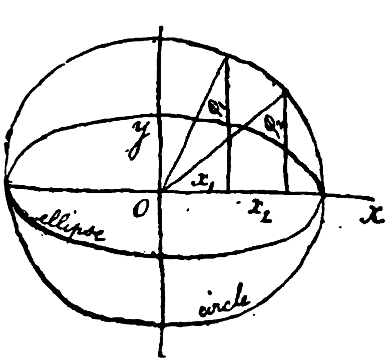
As to the best way "to prevent flexure" of the mirror, to mount a telescope properly requires experience. More depends on a proper tube, its arrangements and adjustments, than those without experience are aware of, rather than the cell—and herein lies the secret—the flexure, distortion, and sundry other troubles or infirmities one used to hear so much about.

For the large mirror, a well-turned metal cell, with just one thickness of cloth to lay mirror on, is safe for anything. I mount mine thus: (*m*) the mirror, (*c*) the cell.
G. Calver.

LENGTH OF ELLIPTIC ARC.

[33195.]—An excuse for venturing on this reply, is that I am alluded to, amongst others, in letter 33151. I do not, however, feel at all sure that my remarks will hit any of the requirements. In the first place I am not certain that the length of radius required is intended (in dialling) to mean the length of radius of *curvature*; but if this be intended, then, as will be seen in Todhunter's "Differential Calculus," fourth edition, p. 355, example 33, the radius of curvature at any point of an ellipse is $\frac{(r\,r^1)^{\frac{3}{2}}}{a\,b}$ or $\frac{b^2}{a\,(1-e^2\,\text{sin.}^2\,\psi)^{\frac{3}{2}}}$, where r and r^1 are the focal distances of the point, and ψ is the angle which the normal at the point makes with the major axis.

In regard to the second and third parts of the letter, I would simply say that, if the co-ordinates of the two points in the same quadrant be known, or can be found, then the length of the elliptic arc between these points is represented by—



$$a\int_{\phi_1}^{\phi_2}\sqrt{1-e^2\,\text{sin.}^2\,\phi}\;.\;d\phi,$$

or

$$\int_{\text{sin.}^{-1}\frac{x_1}{a}}^{\text{sin.}^{-1}\frac{x_2}{a}}\sqrt{1-e^2\,\text{sin.}^2\,\phi}\;.\;d\phi,$$

where x and x_2 are the abscissæ of the two points; $o\,x$, $o\,y$ the axes of co-ordinates; ϕ_1 ϕ_2 the complements of the eccentric angles, as shown.

$$x_1 = a\;.\;\text{sin.}\;\phi_1 \quad . \quad x_2 = a\;.\;\text{sin.}\;\phi_2,$$

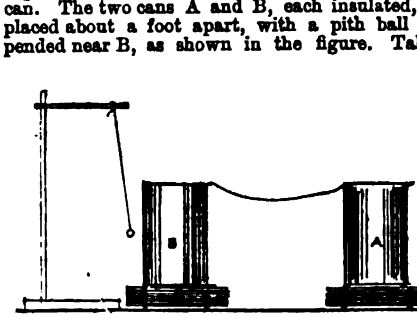
$$\text{or}\quad \phi_1 = \text{sin.}^{-1}\frac{x_1}{a} \quad . \quad \phi_2 = \text{sin.}^{-1}\frac{x_2}{a}$$

In this letter, a and b are the semi-axes of ellipse, and e the eccentricity.

To obtain the approximate numerical value of the integral the method recently shown in these pages can be followed.
J. H. Truscott.

EXPERIMENTS IN ELECTROSTATICS.
—IV.

[33196.] — 8. Conductors. — The apparatus required is similar to that described for the last experiment, with the addition of a second insulated can. The two cans A and B, each insulated, are placed about a foot apart, with a pith ball suspended near B, as shown in the figure. Take a piece of thread about 2ft. long and place it across the rims of the two cans, allowing one end of the thread to dip into each. Run the excited glass rod through the hook attached to A. It will be found that the pith ball is attracted by B. Repeat the experiment, substituting a piece of brass wire, a piece of sewing cotton, a filament of clean dry silk, a rod of ebonite, and a glass rod, successively, for the thread, and note in each case the effect on the pith ball. The results obtained will probably be as follows:—



Thread........Pith ball attracted.
Brass wire ....Pith ball attracted.
Sewing cotton..Pith ball attracted after a short time.
Silk ....No action.
Ebonite rod ..No action.
Glass rod......No action.

It follows from the above that the thread and the brass wire are conductors; and that the silk, the ebonite, and the glass are insulators, while the cotton occupies an intermediate place, and may be described as a bad conductor. For we know from the last experiment that the can A is a conductor, and as B is a precisely similar can, it must also be a conductor. If, therefore, any point on A be joined to any point on B by a third conductor, while A is electrified, B will also become electrified, and will consequently attract the pith ball. If, however, an insulator be used to join the cans, although one end becomes electrified with A, the other end will remain in its natural state, and consequently the can B will also remain unelectrified.

9. *Walls of a Room are Conductors.*—Having arranged the apparatus as in Exp. No. 4, electrify the can, and then touch it with a brass wire, one end of which is in contact with the table or the wall of the room, the wire itself being held in an insulating holder. The pith ball at once ceases to be attracted. The same result ensues when the can is touched with the finger, or with a metal rod held in the hand; but if the can is touched with a stick of sealing-wax, no effect is produced.

It hence appears that when an electrified body is joined to the walls of a room by means of a conductor, its electrification disappears. The disappearance of the electrification on touching the can may be explained by the body of the experimenter acting as a conductor in communication with the floor and walls of the room. We may in fact assume that the walls, floor, body of the experimenter, and other objects inside the room, form part of a single conducting system. It follows from this assumption that if the can be touched with a conductor held in the hand, it will lose its electrification, but if with an insulator, such as a stick of sealing-wax, no effect will be produced. It results from this experiment that we may add the floor and walls of a room constructed of ordinary materials, and the human body to our list of conductors, and sealing-wax to our list of insulators.

It must be noted that the inductions from the last two experiments involve the assumption that a body when brought into contact with an electrified body, becomes wholly or partially electrified. See Exp. No. 7.

Practical Notes.—The "insulating handle" mentioned above consists simply of a stick of sealing wax. If a piece of thin wire is stuck about its middle on the end of the stick, we can connect any two bodies together electrically, while both are insulated from the body of the operator.

Charge and Discharge.—To "charge" a conductor is another expression for electrifying it. To "discharge" it is to bring it back to its natural state by touching it or otherwise bringing it into electrical communication with the ground.

Conductors and Insulators.—The last experiment gives us a very convenient and easy method of ascertaining whether any body is a conductor or an insulator. We electrify the insulated can, and then ascertain whether it can be discharged by touching it with a piece of the body under examination. Sometimes the discharge takes a sensible time: we have then a bad conductor. Sometimes the discharge is very slow—we have then a bad insulator. The following is a list of some of the most important conductors and insulators:—

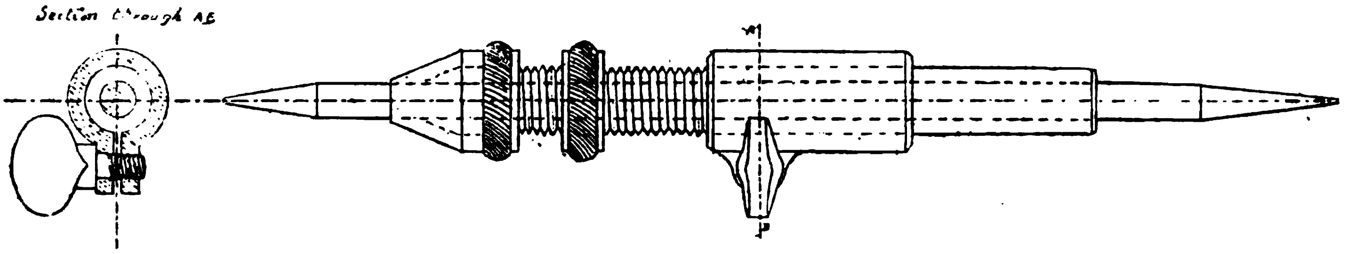
Conductors.—All metals, carbon, sulphuric acid, water, flax.

Insulators.—Glass, porcelain, ebonite, gutta-percha, shellac, sealing-wax, silk.

A large number of substances act as conductors or insulators, just as they happen to be damp or dry. Glass, which, when dry, is the best insulator known, acts as a bad conductor when its surface is damp. Hence the importance of always keeping electrical apparatus perfectly dry.
G. J. B.

A SUGGESTION FOR A SMALL DYNAMO FOR CHARGING ACCUMULATORS.

[33197.]—The form of dynamo with two H-armatures as illustrated would probably work very well in practice. In the first place, it is not very different in principle from the four-poled dynamo illustrated in the "E. M.," Vol. XL., page 136, except that the wires have eight ends instead of four. Besides it is nothing else than a four-pole Lontin dynamo (see the "E. M.," Vol. XXVI. p. 524, which gave excellent results. It is better to have more than four poles, say not less than ten, as greater steadiness of current is thereby obtained. A small eight-poled machine of this type of Lontin's was exhibited on his stand in the Electrical Exhibition in Paris in September, 1879. An illustration and some particulars of it appeared in *L'Electricité* of the 20th October of that year.
Mistral.



TELESCOPE GAUGE.

[33198.]—THIS gauge is made of ¾in. solid drawn tube, on which is screwed a coupling split nearly all the way up one side. A fine threaded sleeve fits inside the coupling, and is fastened to it by drawing togethcr the slot by a small thumb-screw adjusted to side of coupling. This arrangement allows a finer adjustment than the lock nut. The sketch will show clearly the other parts of gauge. The movable point is ¼in. hard steel wire.

Fairfield.

IN MEMORIAM: "J. K. P."

[33199.]—WE have to mourn the loss, this week, of our greatest authority in matters mechanical—our much-valued contributor, "J. K. P." With what sorrow we shall miss those once familiar initials from the pages of our "E. M.," who shall say, and the loss, who shall tell it?

He died on Tuesday, 9th inst., after but a short illness, and at an age when we might have hoped he had still left him many a year in which he would delight us with pithy, practical letters. Someone better skilled than I must speak his praise. He was my personal friend, and the estimate I have formed of his character may seem to others exaggerated—the kindest, most generous of friends, ever ready to help, and untired in helping. I have sat at his feet for over twenty years, during which time he has helped me unsparingly out of his almost inexhaustible store of experience-bought knowledge on subjects often very far apart indeed in the mechanical world. In most things his word was law with me, though the pupil has had more than one tough argument with his master, sometimes proving his point against him—*in theoretical matters;* but whenever in *practical matters* he ventured to differ from him, he has had, time and again, to admit his failure, undo his whole work, and follow implicitly the master's directions; so that when he spoke in mechanical matters, it was an end of the matter. *Roma locutus est, causa finita est.*

The last instance of this was my French design of circular-cutter making machine, which he did not approve of. He let me make it, as I thought it would do good work; but when I came to grief over it, and in great disgust went to report my failure, and to ask a way out of my difficulty, he sat down and showed me the better way, illustrating it with carefully-made drawings, which, as they were the last he made, and the letter the last he wrote, I need not say I prize them as much for their intrinsic value as for their memories.

Though I feel that I was greatly honoured by all the trouble he took to teach me, and the numberless kind turns he did for me, I have no reason to think I was an exception. His acquaintance was a large one; and it seemed to me there were few who had not to thank him, perhaps, as often for that "cunning," which to the last never forsook "his right hand," as for the written or spoken word of sound advice.

Many a time I urged him to commit his experience to writing, and give us a book; but he said it would take such a lot of preparation. It gave him no trouble straight off to answer any mechanical difficulty a querist would put to him, because he knew exactly what was wanted; but he never could bring himself down to the Mrs. Glass style of writing, which alone seemed to be acceptable to editors and publishers. "*First*, 'catch your hare.' *Then*, &c., &c." "*First*, get a piece of wood large enough to, &c., &c. *Then*, take, &c." This twaddle, no matter where appearing, he never read, and did not believe it could do anyone the least good to read.

He used also to say that when he was no longer fit for work, he might then think of sitting down to write a book. Now that our kindly friend and valued contributor is gone, we know what a valuable treasure even a note-book of his would be, had he jotted down in it, without any regard to order or sequence, the vast amount of information he had literally at his fingers' ends.

I doubt not, therefore, there will be many like myself, who for many a day to come, will miss those well known letters, and mourn the cause of their absence from our pages. **Fredk. Carre.**

DETERMINATION OF TERRESTRIAL MOTION IN THE LINE OF SIGHT.

[33200.]—THE following simple method may not be without interest to some of your readers.

Concluding that all motion in an orbit as seen from a star where the diameter of that orbit subtends an appreciable angle will revolve itself into an apparent to and fro movement in the line of sight, I drew a large quadrant, graduating it to 2½° spaces on the arc, and by measuring the distance perpendicularly of each point of division from the horizontal radius by means of a finely divided scale giving 2,870 divisions to the radius, obtained the following values for motion on the arc as compared with that portion of it visible in the line of sight, which I represented by the perpendicular radius marked 0°. I was guided by the obvious fact that motion at right-angles to radius 0° becomes nil in the line of sight, whilst that at 90° on either side, being parallel, is valid in the line of sight to the full amount of its actual velocity in the orbit.

TABLE A.					TABLE B. Motion at 5° : M.in. L. of S.	
Velocity at	5°	:V. at 90° ::	5	: 126	: : 2865	: 2870
,,	7½	,,	12	,,	2853	,,
,,	10	,,	18	,,	2835	,,
,,	12½	,,	22	,,	2813	,,
,,	15	,,	27	,,	2786	,,
,,	17½	,,	34	,,	2752	,,
,,	20	,,	41	,,	2711	,,
,,	22½	,,	47	,,	2664	,,
,,	25	,,	54	,,	2610	,,
,,	27½	,,	57	,,	2553	,,
,,	30	,,	60	,,	2493	,,
,,	32½	,,	63	,,	2430	,,
,,	35	,,	68	,,	2362	,,
,,	37½	,,	73	,,	2289	,,
,,	40	,,	77	,,	2212	,,
,,	42½	,,	82	,,	2130	,,
,,	45	,,	88	,,	2042	,,
,,	47½	,,	92	,,	1950	,,
,,	50	,,	96	,,	1854	,,
,,	52½	,,	99	,,	1755	,,
,,	55	,,	102	,,	1653	,,
,,	57½	,,	106	,,	1547	,,
,,	60	,,	110	,,	1437	,,
,,	62½	,,	112	,,	1325	,,
,,	65	,,	114	,,	1211	,,
,,	67½	,,	116	,,	1095	,,
,,	70	,,	117	,,	978	,,
,,	72½	,,	118	,,	860	,,
,,	75	,,	119	,,	741	,,
,,	77½	,,	121	,,	620	,,
,,	80	,,	122	,,	498	,,
,,	82½	,,	123	,,	375	,,
,,	85	,,	124	,,	251	,,
,,	87½	,,	125	,,	126	,,
,,	90	Totality.			*Nil.*	

The first column of Table A represents the measure of the portion of the perpendicular radius opposite the several divisions on the arc, and as the division 87½–90° is that where actual and apparent motion are equal, motion at any other point will be in the proportion of its measure to the measure of segment 87½–90°, which is 126.

Table B, which is but a modification of A, shows the proportion of residual to total motion, owing to the inclination of line of sight to the plane of the ecliptic. This becomes *nil* at 90° = pole of ecliptic, and is obviously equal to the amount determined by Table A when the line of sight is at 0°, or in the plane of ecliptic.

I apply the tables in the case of Procyon for March 22, when the earth's orbital velocity is 18·452 miles per second.

Earth's R.A.	182°	9'	15"
Star's R.A.	113	21	30
Difference........	68	47	45

Table A gives—

Velocity at 69° : V. at 90° : : 117 : 126

∴ 126 : 18·452 : : 117 : 17·134 miles per second.

Procyon being at an angle of 17½° to the plane of Ecliptic, Table B gives—

Motion at 17½° : M. in line of sight : : 2752 : 2780
∴ 2780 : 17·134 : : 2752 : 16·430 miles per second.

Greenwich results give 16·4.

The ellipticity of earth's orbit has been neglected. I was not so fortunate in some other instances:—

March	6,	Pollux,	14·629	against	Greenwich	15·0
,,	,,	Castor,	14·942	,,	,,	15·4
,,	,,	Rigel,	15·851	,,	,,	16·0
,,	,,	Sirius	13·148	,,	,,	12·8
,,	,,	Procyon	14·242	,;	,,	14·0

Is there any other element not considered beside solar proper motion which has evidently not been taken into account, or is the discrepancy due to insufficiently delicate measurement?

J. M. Boraston.

PROJECTILES AND THE ROTATION OF THE EARTH.

[33201.]—IN replying to Mr. Wake's assertion (letter 33138) that my expressions for the deflection (or deviation) of a shot, due to the earth's rotation, fails in the two cases he mentions, I would observe that the time of flight, t, is the number of seconds a shot S would take to travel from A, the gun, to B, the target, supposing the earth did *not* rotate. If v and $v + w$ be the tangential velocities of A and B respectively, S has a velocity v throughout its whole course, independent of its velocity of projection. Hence, by the second law of motion, we may, in investigating the case, cancel v from A, B, and S, and consider A a fixed point, and B a point moving from west to east with a velocity w. Then, if C be the position in space of B at the instant of discharge (the earth's orbital motion not being taken into account), the shot will drop on C, and the distance $BC = tw$ will evidently be the deflection. In the case of a shot fired due east or west, A and B are on the same parallel of latitude, and, therefore, $w = 0$; and, whatever be the angle of elevation, there can be no deflection. How Mr. Wake can prove that there is no deviation in a shot fired north, with 75° 9' elevation, in latitude 51° 30', quite puzzles me.

Referring to the letter of "M.I.C.E.," I think he is, at least, as well able to investigate the vertical motion of a projectile as I am. It is, however, highly necessary to distinguish between the case of a shot whose trajectory is a fixed straight line, vertical at the instant of discharge, and that of a shot projected from a gun, the *axis* of which is vertical. In the first case, the gun must be laid with its axis leaning towards the west, and in such a position that the direction of the whole initial velocity of the shot shall be that of the resultant of its two velocities v, and the velocity due to the charge. The range A B will be due west, and there will be no deflection, for the reason already given. But it is to the second case that, if I mistake not, "M.I.C.E.'s" remarks chiefly refer. Now, the flight of a projectile in vacuo is the arc of an ellipse of which the further focus is at the earth's centre. But in all *possible* experiments we may take the arc as that of a parabola, the force of gravity being assumed to be constant, and to act in parallel vertical lines. If, then, the axis of the gun be vertical, B coincides with A, and the shot will (theoretically) drop back into the bore, not to the *west* of it. But if I drop a bullet from a high tower, supposing there to be no motion in the air, it will strike the ground a little to the *east* of the point where the vertical line to my hand cuts the surface, simply because the tangential velocity of the top of the tower somewhat exceeds that of the base. The experiment has been tried more than once (see "Motion of the Earth" in that most valuable book "The Cyclopædia of Arts and Sciences"), and it appears that from a height of 235 French feet the deflection was less than an inch.

I ought to have said, in the first part of my letter, that, for the sake of simplicity, I assume the points A, B, C to lie in one horizontal plane. But the rule will still hold good if A and B be on different levels, so long as t and w have their proper values given them. Of course, w may be positive or negative, according as B or A is nearest to the Equator.

Charing, Kent. **J. R. C.**

[33202.]—IF "M.I.C.E." has given the above subject further thought, he will no doubt have discovered the error in his letter 33170. But for the benefit of your unmathematical readers who may take an interest in the subject, I will, with your permission, try to show the reason why a body dropped from a height would fall to the east, and why this fact does not bear on the above subject.

The reason a body falls to the east when dropped from a high tower is because the top of the tower has a greater linear velocity than the earth's surface, on account of its greater distance from the centre of rotation (the earth's centre). As the body retains this velocity till it touches the earth, it is clear that it must advance further than the bottom of the tower. Consequently it falls to the east.

In the case of the shot projected vertically, the initial linear horizontal velocity is the same as the surface of the earth; so from the moment it leaves the gun it is losing in *angular* velocity till it reaches its highest point, when it begins to return to its original angular velocity, and when it reaches the earth it has exactly the same velocity, both angular and linear, as when it started. The linear velocity has never changed, but the angular velocity has fallen off at a gradually decreasing rate till the highest point is reached, when it begins to return at the same rate to its original velocity. But to have kept vertically over the spot it left it would have to have maintained the same average angular velocity as the earth's surface; consequently, all the angular velocity lost represents deviation to the west, and as the loss is exactly the same in the ascent as in the descent, I think "M.I.C.E." will see that his first solution (except for the mistake of taking the whole height instead of two-thirds) is more likely to be correct than the one in his last letter.

The formula I gave $\frac{16 h \pi t}{3 P} = D$ is one I have in my notebook initialled "R. A. P.," for the late R. A. Proctor. I fancy I got it out of either the "E.M." or *Knowledge* of eight or ten years ago. I satisfied myself it was correct at the time of copying, by a rather cumbersome calculation, which I intended to condense and copy into my note-book; but I put it off, and now it is lost.

I scarcely think Mr. Proctor would be mistaken; but I have an idea that the process by which I convinced myself of the correctness of the formula depended on the assumption that for the shot to fall again on to the spot it left, it would need to maintain the same angular velocity at its average height as the rotational movement of the earth. But it is evident, as "M.I.C.E.'s" letter reminds me, and as I have shown above, that if that were so, the shot would overshoot the gun on its descent by the amount a body would fall east if dropped from a tower of the same height.

If R. A. Proctor's formula is wrong, I feel sure it will be found that it gives just double the true result. I got just half when working out the example I gave in reply to the original query (76062) by "Kinetic," as I had forgotten for the moment about the double result, which I had before satisfied myself was true; and if "M.I.C.E." will multiply his result in letter 33088 by $\frac{2}{3}$rds, it will be just half the result given by the formula of "R. A. P.'s" that I gave.

Feb. 15. **H. Wake.**

FLEXURE OF MIRRORS.

[33203.]—I PERFECTLY agree with Mr. Vallance about flexure; but there is no question that many mirrors perform better with one diameter vertical than any other.

I think the cause is to be found in the manner of testing. With both zonal and Foucault tests the eye is necessarily to right or left of the aperture of the testing apparatus. The incident rays are at an angle with a perpendicular from the centre of mirror, and the reflected rays are at a similar angle some degrees away. As long as the mirror is in this position it looks perfect; but turn it one quarter round, and the two points from and to which the rays proceed are at right angles to former position. The light now proceeds to a third point different from either of the first ones, and apparent flexure results.

If the mirror is tested in the telescope in the same position as tested during making, a slight give and take with both flat and mirror compensates for the want of vertical incidence; but when turned one quarter round, this compensation of positions is not possible, and a star appears out of shape. Flexure is simulated.

Dr. Draper found that mirrors that gave a sharp image of the testing pinhole when on one diameter, gave two images and planes when turned quarter-round. He attributed the result to alteration of shape caused by pressure on the edge whereon the mirror rested. He says: "No material difference was observed whether the supporting arc below was large or small, nor when it was replaced by a thin semicircle of tinplate lined with cotton wool."

I wonder that finding that the removal of the points of pressure had no effect on the deformation of the image, did not convince him that pressure on the edge had nothing to do with the phenomena at all.

If my supposition is correct, then in the faulty position the cone of rays would present an elliptical section, which is just what Dr. Draper found, and it would be as he found it, with the major axis horizontal inside and vertical outside the focus.

The moral seems to be that the final testing ought to be upon a star with a perfect plane in position.

Edwin Holmes.

[33204.]—THE letter on page 552 from our old respected friend and contributor, Mr. P. Vallance, would almost lead one to suppose that flexure in specula did not exist; but I can assure him positively that while I did not observe any in the specula which I tested while on my visit to him, I have often observed it at home in some specula which have been sent to me to rework or to figure.

A curious point is that it is not observable in the earlier stages of shadow-testing; but in the later stages I have frequently had either to select some other diameter of the speculum to be placed perpendicularly, or have had to let the speculum rest in its testing position (nearly upright) for an hour or more before I could do anything with it. It seems to me to be a question of tempering the glass, for some thin discs (notably among Mr. With's specula) do not show it, while I have seen some thick ones do so.

Ramsgate. **J. Linscott.**

VIOLIN-MAKING.

[33205.]—IN answer to letter 33143, the correct distance from the nut to the bridge of a violin is 13in. Owing to the shape of some instruments, this distance may vary a trifle from this measurement, but the variation should never be more than a $\frac{1}{4}$in., because the stopping would then be materially affected. The notches in the sound-holes indicate the position of the bridge, and as different measurements have been given for these measuring from different points, I now give you the precise location of these notches, as usually accepted by the best makers.

In a 14in. violin, measure along the centre line of the belly from the top or neck end 7$\frac{3}{4}$in. or from the bottom 6$\frac{1}{4}$in., and draw a line across the centre line, and at right angles with it at this point. The inner notches of the sound-holes are on this line, and removed from the centre line 1$\frac{7}{16}$in.

The centre of the sound-holes at the ends nearest the finger-boards should be 1$\frac{5}{8}$in. apart, or $\frac{13}{16}$in. from the centre line. These two points being fixed will enable any one to place a model sound-hole in position for marking off and cutting out. The bridge is placed with its feet just up to the line of the sound-hole notches, so that it stands the width of itself nearer the tail rest than the line.

Glasgow. **S. Fingland.**

[33206.]—WHEN it is suggested to increase the number of strings on a violin, it does not necessarily mean that higher-pitched strings are to be added, as "Ned" (letter 33164) seems to suppose. If strings of sufficient tension were got, and used as extra strings above the E string, they would certainly be dreadfully shrill in the upper positions. A bass C silver string below the usual 4th string would be better. But I think it would quite spoil a violin to have more than four strings; in fact, you would have to have a much wider back and belly; besides which, the bow would be very awkward to manage, and this would be a great inconvenience in playing.

Can any reader explain the following for me? When an A tuning-fork is held on the bridge of a violin, and a string twanged, it ought to vibrate. So it does if it is the A string that has been sounded, but not if it is one of the others. Why is this so? The other strings must cause the bridge to vibrate as much as the A, and the tuning-fork ought to vibrate, sounding its A.

Also, will Mr. Pickering kindly tell me whether revarnishing a violin which I have would be likely to make it worse than it is or improve it? It is a bad-toned new instrument, comparatively, very dirty inside, and got up outside with varnish, scratches, and blackenings to look old. I wish to know if it would make it worse to sandpaper it all over, and then revarnish with a bottle of bought oil varnish? I am not able to experiment with varnishes just now, but should be glad to improve the appearance of my violin.

G. E. Newland-Smith.

THE HUMBERSTONE ROAD ACCIDENT.

[33207.]—THANKS to Mr. Stretton. It seems the waggon was pitched on to the down main just in front of the express, so that no brake would have been of any use. Then comes the question, Will not directors of railway companies, or, failing them, the Board of Trade, prohibit shunting on lines adjoining the main when the signals are off for the main? The "loss of time" cannot amount to much, but the loss of life has often been great in accidents similar to that at Humberstone-road, caused by goods waggons fouling the main. Fly shunting should in such conditions be strictly forbidden.

Nun. Dor.

REPLIES TO QUERIES.

◆

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[75180.]—**Cement for Lamps.**—Melt a little common glue, and stir into it a little common whiting until it is the same thickness as white lead. I guarantee nothing will beat this at the same cost.

CAST-IRON.

[75927.]—**Small Biunial.**—This query would undoubtedly have been replied to if any one had thought "L. W." was writing seriously; but as it again appears, I venture to remark that any time and money expended on such a lantern as described by "L. W." in No. 1392, and again in the last issue, will be worse than wasted. A lantern is next to useless nowadays unless fitted with standard-size lenses, and capable of exhibiting the standard-sized slides.

H. HILTON, Prof. Lanternist.

[76189.]—**Roof (U.Q.)**—The roof would appear to be none too strong. Molesworth gives the following dimensions for a roof of 35ft. span of similar construction, but without the weight added in your case by the louvres and ventilator. Besides, slates vary somewhat in thickness, and he does not state the factor of safety. Rafter T-iron, 3in. by 2$\frac{1}{4}$in. by $\frac{3}{8}$in.; side tie-rods, 2$\frac{1}{2}$in. by $\frac{1}{2}$in.; central tie-rod, 2$\frac{1}{2}$in. by $\frac{5}{16}$in.; tension rod from ridge, 2$\frac{1}{2}$in. by $\frac{5}{16}$in. This for a roof with a rise of one-fifth of the span and a rise of tie-rod of one-thirtieth.

MISTRAL.

[76202.]—**Teeth and Smoking.**—The black oily deposit on the teeth may be removed by the aid of cream of tartar applied with a tooth-brush. If this is not effectual, apply powdered pumice-stone.

SAN FRANCISCUS.

[76210.]—**Torsion Balance.**—I am extremely sorry that "Student" is not satisfied with my efforts to explain his difficulty. In Coulomb's original experiment the largest angle made by the movable magnet was 24°. Now, if "Student" will glance at a table of sines, he will see that the lines of all angles up to 24° are proportional to those angles up to, at least, the third place of decimals. Coulomb's experiment is by no means a rigidly exact one, but its results were near enough for his conclusions. The solution of the example given by "Student" will not, I fear, help him in his former difficulty, as the conditions are not similar to those in the original torsion experiment with two magnets. There we have to deal with two centres of force, the magnet poles; whereas in his proposed question we must consider a centre of force in relation to a magnetic field. I give him my solution of the question. Thus: (1) The moment due to torsion varies directly as the angle of torsion. This is simply a mechanical force, and here only a convenient method. (2) The moment of earth's field on magnet when at angle θ from the meridian, is HM sin. θ. (3) In the question under two sets of conditions the moments are equal. Thus:

$$\text{Torsion (1)} : \text{torsion (2)} :: \text{Sin.}\,\theta_1 : \text{Sin.}\,\theta_2 :$$
$$\text{In first case torsion} = 100^\circ - 30^\circ = 70^\circ$$
$$\text{In second case torsion} = T^\circ$$
$$\therefore\ T^\circ : 70^\circ :: \text{Sin}\ 90^\circ : \text{Sin}\ 30^\circ$$
$$:: \quad 1 \quad : \quad \tfrac{1}{2}$$
$$\therefore\ T^\circ = \frac{70 \times 1}{\frac{1}{2}} = 140^\circ$$

But the magnet moves through 90° from zero, and 140° torsion being necessary to move it so far, we must turn the torsion head through

$$140^\circ + 90^\circ = 230^\circ.$$

I am afraid the Editor will grumble if we go on any more with torsion experiments, so if "Student" is not satisfied, let him advertise his address, and I'll send him mine. "Student" should buy Kennelly and Wilkinson's "Practical Notes on Electricity," and carefully read pp. 147-165.

IOTA DASH.

[76227.]—**Coil Boiler.**—I don't know why the query should be headed "Coil" Boiler, unless it is an anticipation of the answer; but a water-tube boiler would give better results, and so would a Lancashire with tubes at chimney end. As the figures show, 4lb. of coal is being used per indicated horse-power per hour, which is too much, especially with best hard coal, though there are many [illegible] using more than that per I.H.P. Much depends on the work to be done, and something on the character of the water; but the boiler, if worked at 80lb., would probably give better results. [illegible]

[76228.]—**Cataract.**—It would be waste of time to employ homœopathy for cataract. The proper procedure, if the cataract has matured, is to have it removed by a competent surgeon or oculist. In young persons cataracts may be treated [illegible] without surgical interference; but in the aged they must be operated on.

SAN FRANCISCUS.

[76232.]—**Hand-Bell Casting.**—[illegible] "helpless" queries. Querist cannot even give [illegible] page to which he refers, and leaves it in doubt whether he means the "mixture," the moulding sand, or the alloy to be used for casting the bells. I have referred to the date given, but cannot afford time to wade through a number to find out what "H. B. S." wants, and then probably discover that he could have done it as well, or better, himself.

T. L.

[76233.]—**Organ.**—Two sets of reeds must be used to obtain the Celeste tone, but in the American organ it is not necessary to make one set a trifle sharper or flatter than the other by filing the reeds. It is accomplished by regulating the wind supply by means of the mute. Suppose the mute of one set is opened widely, and the other only just sufficient to pass enough wind to sound its set of reeds, then there is the Celeste. It is sometimes done by cutting holes on the top of the tubes and admitting the wind to one set of reeds in a vertical direction, the mute proper being kept closed. In both cases the effect is to flatten the set of reeds, and so produce the wavy tone when they are sounded with others. ORGANON.

[76236.]—**Neighbours' Pianos.**—I would recommend putting a wall 6in. from the present one, not letting the scantlings touch the neighbour's wall, but fastening them to the floor; then fill the space with straw and mortar in alternate layers.

SAN FRANCISCUS.

[76241.]—**Casting in Type-Metal and Cores.**—I do not follow the query of "Alexander" about cores, but he can easily melt type-metal in an iron ladle over an ordinary fire—no occasion for a crucible. It shrinks a trifle as it cools, but it will take a sharp impression in plaster of Paris.

M. T.

[76242.]—**Engine for Lathe.**—A ½H.P. engine should drive a 4½in. lathe easily. A tubular boiler would be best, but as to what pressure, that depends on the boiler and its owner.

FIREMAN.

[76243.]—**Elastic Composition.** — Soak and melt the glue; beat up with the treacle, and add about 3 per cent. of bichromate of potash. M.

[76249.]—**Agricultural Mechanics.**—Consult the circulars issued by the Royal Agricultural Society, and the catalogues of publishers—Lockwood and Son, for instance. It seems strange that one going in for an agricultural examination should have to ask "what books should be read, &c." Is there not a syllabus published, and are there not classes for students? MARL.

[76252.]—**Self-Centring Chuck.**—It will be necessary to see this chuck before offering advice.

R.

[76253.]—**Gilding Bevelled Photo-Mounts.**—Coat the edges of the mounts with gold size, and when that is nearly dry, lay on gold leaf. Or, paint them with Bessemer's gold paint—bronze powder mixed with varnish. W. P.

[76255.]—**Ocarina.**—The ocarina sounds something between a flute and a whistle, and has been much improved of late years. The compass is not much, and the blowing is much like that of the flute. There is a stall at the Crystal Palace where ocarinas of all sorts can be seen. W. F. D.

[76256.]—**Galvanising.**—The articles must be clean; the melted zinc must be covered with sal-ammoniac, and when the articles are hot and covered with the zinc, they should be removed and swung round to throw off the superfluous metal. If small, they are generally put into a tumbling barrel. SPELTER.

[76257.]—**Engine Query.**—The engine with the longer stroke will, other things being equal, develop the most power. The gearing has nothing to do with it, except to introduce friction. Horse-power can be calculated by the ordinary rules.

VIDEO.

[76260.]—**Diabetes.**—In lieu of wheat bread, use only bread made from gluten flour or almond flour. As to other foods, I append a list:—Admissible: Shell-fish, fish, meats, poultry, game (liver is not), lettuce, celery, cress, cucumber, sprouts, olives, spinach, cabbage, cauliflower, string beans, pickles, beet tops, radishes, asparagus, tomatoes, eggs, cheese, butter, cream (in moderation), filberts, almonds, butter-nuts, coffee, tea, cocoa (without sugar—may be sweetened with glycerine), whisky, dry sherry, skimmed milk. Non-admissible: Sugar, syrups, honey, wheat flour, rye flour, corn meal, oatmeal, sago, barley, tapioca, potatoes, beets, carrots, peas, beans, chestnuts, sweet fruits, chocolate, cider, beer, ale, porter, sweet wines. SAN FRANCISCUS.

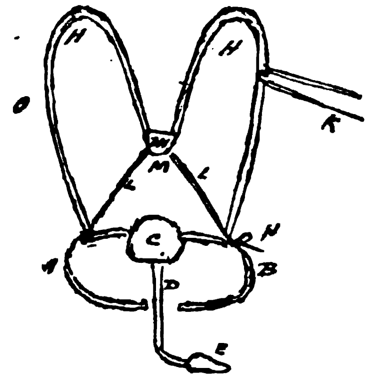
[76260.]—**Diabetes.**—I cannot give a list of the articles of diet indicated by the faculty as most fit for diabetic subjects (probably Dr. Allinson's work advertised in your columns does). This, however, may be of great service to the patient. Let him, while obtaining such a list as he asks, at the same time endeavour to weave into his diet as much of linseed or linseed meal as he can. It may be used in the proportion of ¼ to ½ with desiccated wheat barley or oatmeal for porridge, or it may be cooked and used with meat as a substitute for vegetables of the forbidden sort. Many patients object to use it from its appearance or otherwise, but it may be made palatable with cream or when used with meat by gravy. It may be used between meals instead of lunch by simply carrying a match or snuff-box full of the seeds and eating them when so inclined. The large yellow Ceylon or Indian sort is best. Whatever difficulty may be in the way of making an agreeable or palatable diet of it, there can be no doubt of its being at once nutritious, and the best food weapon with which to fight diabetes.

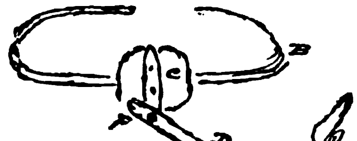
J. B. BROWNING.

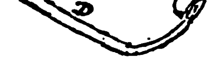
[76264.]—**Piping.**—A flow and return the full length of the building should be sufficient, using 4in. pipe, but nothing is said as to the build of room. If it is a room with much glass exposed to the frosty air, it will necessarily take more heating than one which is all brickwork. The water from a galvanised roof will not injure the boiler. S. M.

[76296.]—**Prolapsus Ani.**—This truss has been worn for 27 years by an intimate friend with the greatest relief and success. A B is a band of steel, C is a cushion, D the spring, E ivory pad. You must make a model of this in guttapercha or cork, or anything else; the reality must be in ivory. Everyone must make a model to suit himself, as no two are alike. Above all things, have the spring at F to overlap ½in. If this be done it will last 30 years; if not, six months. H are braces to slip over shoulders, made of calico 2in. wide; L, tape twisted, running through leather loop M (this I invented twenty years before the Argosy braces), tied in a loop at N. At K there is a piece of narrow tape for tying in front of breast to O, so that wearer may, by opening waistcoat and shirt, tighten or loosen the whole concern. The ironwork is covered with red roan leather. The tapes and braces being tied on with waxed string, they can be renewed in a few minutes at little expense. Don't let the truss-maker give you nasty, stuffy leather straps, and metal buckles that will only disgust you in a week's wear. Wash every night and morning with cold water, and if very painful, with as hot as you can bear it. Keep a little bottle of best olive-oil for ivory pad E, or you may find it will excoriate. Do not use glycerine: it is the very worst for the purpose, and if a doctor tells you to use glycerine, tell him that 30 years' experience proves that it is wrong. You must expect some little trouble before you get the spring the right strength, the pad the right shape, and the tapes the right length. The place where they are attached at A and N must be in balance with point E of the ivory pad. If this is not so, you will have no comfort, for it will work backwards and forwards.

SELF-HELP.







[76349.]—**Ginger-Beer Plant.**—If "E. R.W." cares to pay the carriage of ginger-beer plant, I will forward enough to give him a start. If he will send his name and address, I will send him plant and how I have treated it. G. H. CORBETT.

13, Church-road, Nechells, Birmingham.

[76385.]—**Rain-Gauge Measuring Glasses.**—"Non-Mathematical" ought to have written himself "Non-Arithmetical," and then he would have got the answer he wanted. Instead of getting a direct answer, he got the rule for finding out what he wished to know, which, I think, is far better than being told that a glass 2¼in. wide and 2¼in. deep would only hold ⅜in. of rain, caught in a 5in. receiver. I would advise "Non-Mathematical" to make his receiver 4·7in., or 4 ⅔ $\frac{1}{10}$in. in diam., and then, for a measure, he requires a common 1oz. measure, to be had from any photographic dealer. One ounce of water represents $\frac{1}{10}$in. of rainfall. The advantage of this size is, that should the measure be broken, a new one can be got as accurate as the first, and with no trouble. BON-ACCORD.

[76385.]—**Rain-Gauge Measuring Glasses.** "Non-Mathematical" justly complains that the replies to his query do not give him exactly the information he asks for, which is, practically, Will a vessel of 2¼in. diameter and 2¼in. deep contain as much water or other fluid as another vessel 5in. diameter and 1in. deep? The answer is: No, it must be 4in. deep if 2½ diameter, the rule being simply this: that if one vessel is the half-diameter of a larger one, the smaller one must be four times the depth. We find the area of a circular vessel by squaring the diameter, and then multiplying by ·7854. For instance, 5 × 5 = 25, and 25 by ·7854 = 19 635sq.in.; but as the vessel is 1in. deep, it contains the same number of cubic inches—i.e., 19$\frac{635}{1000}$. Now, 2½ × 2½ = 6¼, and 6¼ × ·7854 = 4$\frac{91}{100}$sq.in., and 4$\frac{91}{100}$ × 2½ = approximately 12¼c.in. only, the cubical content of a vessel 2½ diameter and 2½ deep; but if we take the area of a 2½ circle—i.e., 4$\frac{91}{100}$, and multiply by 4, we obtain 19·635c.in., the cubical content of the 5in. vessel. These results are easily and quickly obtained by logarithms. J. LINSCOTT.

[76385.]—**Rain-Gauge Measuring Glass.**—In my answer last week I misunderstood "Non-Mathematical's" question. I thought he wanted to know what depth in a 4in. measuring glass 1in. of rain collected in a 5in. gauge would fill, and my reply was 1$\frac{9}{16}$in.; but through a printer's error the 1 was omitted. Now his question is plainly put, "Will a glass 2½in. diameter and 2½in. deep, when full, represent 1in. caught by a gauge 5in. diameter?" The answer is No; it will require a glass 4in. deep to represent 1in. of rain caught in a 5in. gauge. "Non-Mathematical" must know that the areas of circles are as the squares of their diameters. A circle one-half the diameter of the other is only one-fourth the area. To make it clear, take his own example in your last issue. A rain gauge 8in. diameter, and measuring glass 4in. diameter; the latter is only one-fourth the area of the former, and consequently will require 4in. in depth to represent 1in. in the former. It is exactly the same with a 5in. gauge and 2½in. measuring glass; the latter is one-fourth the area of the former, and will require 4in. in depth to represent 1in. of rain caught in a 5in. gauge. F. S.

[76412.]—**Batteries and Dynamos.**—It is not exactly E.M.F. that is required to fuse or heat a metallic conductor, but current, E.M.F. being the force which moves this from one place to another. The fine wire of an induction coil carries a current of considerably smaller amount than the primary; but the tension is raised to such a pitch that it jumps, as it were, from the ends of a conductor connected with the terminals when only a short distance apart, and this is what we term the sparking distance. The wire on an armature of a dynamo offers a double path, as it were, to the current, the wire itself not carrying the whole amount. From the foregoing you will see the reason why a short length of wire is melted with the current from a Leyden jar. The resistance of the secondary wire on a coil giving 2in. spark is nearly 4,000 ohms, which, with other reasons, accounts for small current.

F. ASKEW.

[76432.]—**Brass Casting.**—Take a little powdered rosin and dust on to mould with flannel bag; then hold hot plate (red hot) over mould until rosin melts. This will give good sound castings if no iron or steel is in brass. CAST-IRON.

[76433.]—**Testing Internal Resistance of Battery.**—Though you say you have no *tangent* galvanometer, you have bridge and coils. As these are practically useless without some kind of galvanometer, I will assume that you have one of the ordinary horizontal galvanometers usually supplied with the bridge. In the following tests, anything from a lineman's detector to a Thomson or D'Arsonval reflector may be used, according to accuracy required. Shunt method:—Connect-up battery, galvanometer, and coils in circuit; take such resistance, R^1, as gives a convenient deflection, introduce a shunt of known resistance, S, between the battery terminals—this will cause the deflection to fall; reduce the resistance of coils to R^2, so that the deflection returns to its former value, then—

$$\text{R of battery} = S\,\frac{R^1 - R^2}{R^2 + G}.$$

Mance's method:—Taking the bridge diagram is usually shown, insert equal resistances, *a*, *b*, in the proportional arms; galvanometer G in its usual place; insert coils as adjustable resistance R, and battery in place of unknown resistance *x*: connect the battery terminals of bridge with a key, K, instead of with battery as usually shown. To test: Adjust R till the deflection of galvanometer remains constant, whether the key K be open or closed. Should R be adjusted to a resistance higher than that of battery *x*, deflection of G will be greater when K is closed than when open; but if R be less than *x*, closing K will lessen deflection of G. If deflection of G is too great, shunt it till a convenient deflection is obtained. If you cannot understand the above, if you like to write me direct, I will send you a diagram of connections, with full explanation of theory and example. It would take up about a column of "Ours," and I don't think the Editor would care to iusert.

22, Byford-street, Liverpool. R. C. ROYLE.

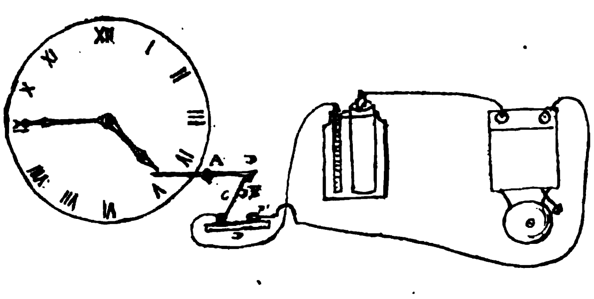
[76437.]—**Battery.**—Try a small bichromate cell with an arrangement for lifting the zinc clean out of the fluid after use. Unless the battery is much used the fluid should last a week without changing.

Wakefield. REYMOND.

[76437.]—**Battery.**—A half-pint potash bichromate-cell, bottle form, would be the best to use in your case; when the cell is not being used pull the zinc out of the solution by the brass rod, so that it is not needlessly wasted, because chromic acid acts on the zinc whether the circuit is open or closed. If you used this cell about half an hour, and then let it rest a few minutes, it would regain its strength, and you could use it another half-hour, and so on. If it were used two hours daily it would last a week with one charge of solution. This cell can be bought for 3s. 6d. of any dealer in electrical apparatus. MECHANICUS.

[76439.]—**Electric Bell to Clock.**—A continuous ringing arrangement can easily be adapted to an ordinary clock, as shown in the annexed cut. A small, rigid brass lever, with a tooth at one end, B, is pivoted at A by a pin driven into the clock-frame at such a point as to be sufficiently depressed by the hour-hand, when it reaches the required hour, as to free the hinged brass falling-piece C. This latter bears at P a platinum stud, which, when the piece falls, rests on another stud, P', making electrical contact therewith. The little base D, to which the hinged piece C and the stud P' are attached, may be of dry wood, or any other insulator. The battery and bell are then connected to the hinged piece C and the stud P', as shown. This arrangement causes the bell to ring directly the hour-hand, by tilting the lever A, causes it to release and let fall the piece C, and the bell continues to ring until this piece is raised or replaced under the detent B.

S. BOTTONE.



[76441.]—**Gregorian.**—After taking to pieces, cleaning, examining, and straightening those parts that were bent, I carefully put together and first tested the large mirror to see if it threw an image of the sun or other object centrally in the tube. To do this I cut a piece of stiff white paper to fit the tube, with four large holes in, like a wheel with four spokes. Placing this about 4in. within the tube, I turned the telescope on the sun, and shading the centre, I found that the image of the sun was thrown accurately on to the centre of the paper, as shown by concentric circles I had made. Next I adjusted both the small specula to slide exactly in the centre of the tube, so as to meet the sun's image. This I tested with compasses. I then made a wire hoop, and stretched two fine cords at right-angles across it. This I fixed in a window with the sky for a background. Pointing the telescope at the centre of the crossed cords (which should be adjusted so that one is horizontal and the other vertical) with the glasses taken out of the e.p., I noticed that the small speculum only returned half the image of the large mirror through the e.p. I altered the screws at the back till this was about right, and finally adjusted it accurately by making the reflected cords in the speculum appear continuous with the real cords seen directly against the sky. By moving the telescope slightly backwards and forwards and up and down, this can be tested with great accuracy. All this I did by daylight, which is easier. In the evening, on pointing the telescope to Arcturus, I found the definition very good, the disc being small and near, and the diffraction rings being very fine indeed. I easily divided ε Boötis the same evening. When a bright star is out of focus, I find, like "A. E. W.," that the image of the small speculum is formed at one side—the right side in my case. I should be glad to know the reason of it. H. WAKE.

[76443.]—**Pressure through Pipe.**—To obtain a pressure of 20lb. per square inch it will require a head of 46ft., and the velocity of flow would be 3,270ft. per minute. It would, therefore, be next to impossible to obtain this pressure with such a small pipe. You would want a fall of about 280ft. theoretically, and internal friction would be so great that it is doubtful whether you would get a fraction of the pressure, even with this tremendous fall.

Wakefield. REYMOND.

[76444.]—**Looking-Glass.**—Make a dead colour of drop- or lamp-black and turps. When dry, apply one or two coats of best copal varnish, put on very thin. H. A.

[76451.]—**Laminated-Armature Winding.—Error.**—In last week's answer, the words "binding over the two first and the two last laminations" should have been "bending." S. BOTTONE.

[76458.]—**Smoke.**—Linseed oil will answer most of the conditions for a dense black smoke, especially if the supply of air is limited.

Wakefield. REYMOND.

[76459.]—**Waterproofing Silk.**—Your querist gives one no idea what he wants the silk for. Take equal parts of sugar of lead and alum, ½lb. each, in a bucket of rain-water; keep stirring. Finally let the sediment settle, and pour off the clear liquid into a separate vessel, and immerse the silk in this for 12 hours. Do not wring it, but let it "drip" dry. This is a good recipe for light overcoats.

H. A.

[76467.]—**Washable Distemper.**—I have tried a good many so-called washable distemper colours in my time, and have not yet found one good one. The "best" is three coats of paint, and by far the cheapest in the end. "Verb sap." H. A.

[76469.]—**Neptune.**—A few further particulars are here given to supplement "H. S. P.'s" remarks. Distance of satellite from Neptune, about 220,000 miles; the satellite does not appear to have received a name as yet, and its diameter cannot be ascertained by reason of the great distance of its primary from the earth, being some 2,688 millions of miles from us, and 2,780 millions of miles from the sun. Diameter of Neptune about 34,500 miles; time of its axial rotation about 10h. 58m., according to M. Camille Flammarion; length of Neptune's year 164 of our years, and 266 days; appearance in a telescope of moderate power, that of a star of between the 7th and 8th magnitudes; orbital velocity of Neptune 3½ miles per second.

AUTOLYCUS.

[76470.]—**Enlarged Measuring Glass.**—I will give "Glatton" the details he requires with pleasure. The whole apparatus should not be more than 5in. high, the condenser tube (from which the compound runs) being barely 6in. The fluid is a dirty-blue colour, very slightly acidulated with sulphuric acid. I mention this to show it is slightly oily, and has a tendency to adhere to the glass. As to the value of the spaces, an avoirdupois ounce of water divided into 10, if about ⅛in. apart preferred.

SUBSCRIBER SINCE 1866.

[76476.]—**Compound Principle.**—If "A.E.B." will think a moment, he will see that if the second cylinder be no larger than the first there will be no place for the exhaust steam of the first to expand into, so that the pressure on both sides of the piston of the first cylinder will be very nearly equal, and it would be therefore no use whatever. AMBER.

[76476.]—**Compound Principle.**—The reason why the second expansion cylinder is of larger diameter than the primary, is, that the steam in the former acts at a much lower pressure than in the latter, 2½lb. being lost from imperfect vacuum. Hence the diameter is increased to compensate for the smaller pressure.

Wakefield. REYMOND.

[76483.]—**Enamelling.**—Enamelling of porcelain, &c., to be done properly, and to stand wear and tear, is done by being coated with the requisite material, and then baked in the oven of a pottery.

H. A.

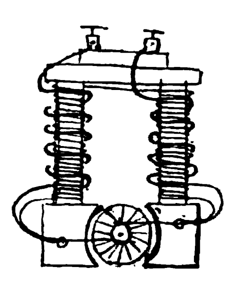
[76493.]—**Artificial Plant Barometer.**—For green, oxide of cobalt boiled in acetic acid, with a little salt added. Rose, oxide of cobalt boiled in acetic acid; add a little nitre. Yellow, equal quantities of sulphate of copper and salammoniac, dissolved in a little water. These solutions are colourless when cold, but become coloured when heated; as also does anything—such as paper, &c.—which is coated with them. AMBER.

[76499.]—**Gold Lacquer.**—Dissolve 1½oz. of shellac, 1 drachm each of anotta and saffron, and ¼oz. of turmeric in ½ pint of spirits of wine. Pale lacquer: 2oz. shellac (fine), ½oz. aloes, and ¼oz. of gamboge, dissolved in 2 pints of spirits of wine.

AMBER.

[76500.]—**Accumulators.**—Perhaps the following description of a small accumulator I saw a short while ago will satisfy "Amateur's" wants:—Out of a piece of $\frac{1}{16}$in. lead, cut 21 pieces, each 4in. square, with a projecting lug for connection at one end, ¾in. in height and ½in. wide. Procure 30 rubber bands ⅛in. thick. Place three of these on each of ten plates perpendicularly, one in the centre and one at each edge. These are to be the positive plates. Place all the plates together, alternately negative and positive, the bands separating them. Let the connections be all on one side, and those of the other at the other side. Stretch a few bands around the plates to clamp them together. Cut in a board two grooves ¾in. wide, ½in. deep, 8in. long, 2¾in. apart, placing one 4in. in advance of the other. Stand the plates on an end so that the lugs form feet standing in the grooves. Pour into the groove very hot lead to the depth of ½in. They are now ready to place in the acid. Take a jar containing about a quart of water, and pour in, very slowly stirring at the same time, 2lb. of sulphuric acid (making it 1·2 specific gravity). Place the plates in a suitable jar, and after the acid is cool pour in enough to cover them. Connect the positive side of the plates with the positive wire of a battery. A 2-cell bichromate battery will answer very well for the charging current. Charging pressure should be not less than 3 volts. Connect cells in series. Occasionally reverse charging-current electrodes. THOMAS W. REAVLEY.

[76502.]—**Connections for Compound-Wound Dynamo.**—TO MR. BOTTONE.—Herewith



sketch. Almost indifferent which wire is laid on first. I generally put the series layers first.

S. BOTTONE.

[76511.]—**Water-Motor.**—If you will state the pressure of water supply, I may be able to give you information; but you can never run a 1H.P. motor from house-tap—in fact, $\frac{1}{10}$ would be nearer the mark, unless you have high pressure.

F. ASKEW.

[76512.—**The Sun and the Earth.**—If a second sun were to take the earth's place in her orbit, the present sun to be supposed fixed, it would be tantamount to doubling the present pull of sun on earth. If μ represent this pull, and as earth's velocity in orbit $v = \sqrt{\frac{\mu}{R}}$, where R is the radius of orbit, the new velocity $V = \sqrt{\frac{2\mu}{R}}$; but taking $\mu = v^2 R$, and eliminating R, then

$$V = \sqrt{2v^2} = v\sqrt{2},$$

and the year would be shortened to

$$\frac{365\frac{1}{4}}{\sqrt{2}} = 258\tfrac{1}{4} \text{ days.}$$

Liverpool, Feb. 13. W. S.

[76514.]—**To Opticians and Lanternists.**—"Inquirer" will only succeed in obtaining his information by "lighting up" and testing the different lenses in various combinations and distances. He will find this to be a far easier and more reliable plan than studying pages of optical theories and diagrams, which his query almost necessitates.

Brighton. H. HILTON.

[76514.]—**To Opticians and Lanternists.**—Two lenses of differing foci will work together. The result of combining the lenses is to shorten focal length; but unless the single lenses are each achromatic, sharpness of definition will not be improved by combining. The benefit of three single lenses is that, by using single or combining, as below, seven different focal lengths can be obtained: 10in. used singly works at 3·3 diameters; 11in. used singly works at 3·6 diameters; 13in. used singly works at 4·3 diameters; 10in., combined with 11in., = 5·25in. focus, works at 1·75 diameter; 10in., combined with 13in., = 5·75in. focus, works at 1·9 diameter; 11in., combined with 13in., = 6in. focus, works at 2·0 diameter; 10in., combined with 11in. and 13in., = 3·7in. focus, works at 1·2 diameter. But this last combination is too short for good results. As the term "works at (so many) diameters" is not a general one, but a product of my own firm, I had better explain. The term means that for a desired diameter of picture the lens will have to be removed from the screen so many diameters of the desired picture — for example, the 10in. lens works at 3·3 diameters; therefore, a 12ft. picture will be given at 3·3 times 12 from the screen, or nearly 40ft.; or, if the 11 and 13 were used combined, the lantern would be two diameters, or twice times 12ft. = 24ft. from the screen. Both the focal lengths and working diameters are only approximately correct, but are sufficiently near for ordinary practice. The working distances or diameters are calculated, supposing the 3in. standard opening slide mat is used. If larger or smaller mats are used, it will be necessary to work nearer or at a greater distance respectively. These lenses are usually mounted in cells deeper than the convexity of the lens, and can be used in combination, with the edges of the cells touching; but the lenses themselves must not be in contact. The convex sides of the lenses should be towards the condenser, whether used singly or in combination. The above lenses should be used with a stop, and are somewhat inferior to the special double combination lenses now supplied by lantern-makers having the most practice. DAVID W. NOAKES.

[76516.]—**Telescope.**—The convex glass (the one with the thinner edge) should be outermost, towards the object. No one can safely advise how to get out the jammed glass without seeing it; but you might warm the outside of the cell, which may cause it to expand enough for the glass to come loose. H. E. H.

[76516.] — **Telescope.**—Gently heat the cell of o.g., when, as brass expands about twice as much as glass, the o.g. will probably come loose. The thin-edged, or "crown" glass, should go to the outside. If the cell really grips the o.g., that would probably account for bad definition. See that the cell has not got bent, or sprung in any way. Tulley was a good maker, and he would send the instrument out all right. It may have had a new o.g.

Whitehaven. H. WAKE.

[76517.]—**To Mr. Bottone**—No; iron bolts will do very well, if varnished first. Put on about 3¾lb. No. 18. You should be able to light six lamps of 16c.p., 50 volts. Connect dynamo in shunt.

S. BOTTONE.

[76520.]—**Hunnings Transmitter.**—I have made a Hunnings transmitter with thin copper plates; it answers very well, and is easy to solder wire to copper. LIBERATOR.

[76520.]—**Hunnings Transmitter.**—I made (for experiment) a Hunnings transmitter from a turned wood tooth-powder box, using a ferrotype diaphragm (2½in. in diameter) in front, and, for a back-plate, merely covering the bottom of the box inside with tinfoil, with a brass screw through the centre as a terminal. The space between (⅞in. deep) was filled with coarsely-powdered coke, free from dust. This transmitted speech with beautiful clearness through about 60ft. of line, with one small Leclanché, no coil, and a small, cheap receiver at the other end. But, as you doubtless know, the patent has not yet expired. MU NU.

[76522.]—**Shooting Stars.**—As "Curious" does not say on which "last night" he saw his meteor, it is impossible to identify it. These solitary, somewhat conspicuous, meteors appear to have been pretty frequent during the last week. The writer has observed several difficult to be assigned to any recognised "radiant." Saturn rises just now a little before 8 p.m., is in the constellation of Virgo, and can be seen, weather permitting, above the east-south-east horizon at about 10 p.m.

H. E. H.

[76523.] — **Dynamo.** — Water is decomposed, oxygen separates at the positive leaden plate, and hydrogen at the negative. The positive plate becomes oxidised, and receives its brown deposit, which is lead dioxide. The negative receives metallic lead. F. ASKEW.

[76523.] — **Dynamo.** — When the current of electricity from the dynamo passes through the acidulated water, it splits it up into its two constituent gases, oxygen and hydrogen. The former being electro-negative, flies to the positive pole, and finding lead there, combines with it, forming pure oxide of lead. As hydrogen does not combine with the lead, the other pole remains unaltered in colour, and, after a while, bubbles of hydrogen will be seen escaping from its surface. S. BOTTONE.

[76525.]—**Oil-Gas.**—A complete oil-gas plant would be very expensive, considering the little amount of light required. Helios gas-making machine will answer your purpose. It consumes very little benzoline, producing good gas. With this apparatus, on account of the low pressure obtained, Argand burners only can be used. You should be very careful in charging the saturating vessels with benzoline, as this is very easily ignited, and explosive when mixed with air.

P. INFANTE.

[76526.]—**Bronze Casting.**—I have not sufficient experience to reply to the whole of the queries of "J. J. H." The best proportions of plaster and Bath-brick are about equal bulk, or, if anything, a rather smaller proportion of plaster. When this is red-hot, the surface rubs very easily, and great care is required in pouring the metal to prevent washing. THOS. FLETCHER.

[76528.]—**Electrical.**—If the carbons are soaked in many waters, and then dried in an oven, they will serve as well as new ones. If they are lead-capped, the lead had better be melted off, as it is nearly sure to be corroded. If you connect your eight magnets in series, 10 pint chromic-acid cells, also connected in series, would do what you require.

S. BOTTONE.

[76530.] — **Voltmeter.**—Use one-fifth the amount of wire for the 10 volts, and half the amount of wire for the 20 volts. The grading is best done by Daniell cells. The sucking solenoid should be curved to the same degree as the swinging scythe piece. S. BOTTONE.

[76531.]—**Magnetising Steel Plates.**—Your steel is not hard enough. Get some of the best shear steel from Sheffield, temper it dead hard, red-hot and cold water. You will find your magnets will hold the magnetism all right then.

S. BOTTONE.

[76531.]—**Magnetising Steel Plates.**—Have you hardened your steel plates? This is a necessity to insure permanent magnetisation. There is a special magnet steel, but the ordinary should answer your purpose. By placing your magnets all N. poles downwards they, by induction, tend to weaken each other. Place them in series, viz., N.S.N.S. downwards, they will strengthen each other. J. W. FERRIER.

[76531.]—**Magnetising.**—The steel must be of the best quality, and tempered glass hard, or it will never retain magnetism. Consult any textbook on magnetism, and you will find various ways of magnetisation for steel. The best plan, if you have a powerful electro-magnet, is to use it in the manner of a horse-shoe permanent magnet; or, better still, fix it (the electro), and move the steel plates over its poles in the ordinary manner. Much information in back numbers. F. ASKEW.

[76533.]—**Microphone.**—I do not think the above would be suited to your purpose. A simple, but well-made pair of Bell telephones should answer. Perhaps an ordinary stethoscope would do as well or even better, if the sounds in the box were not altogether too faint. S. BOTTONE.

[76536.] — **Cleaning Leclanche Zincs.**— I regret that I know of nothing better than soaking in cold water. But the cells should be filled first, if possible, and a little liquor ammoniæ added to the water, then turned upside down in the water. A fortnight or three weeks is sometimes required to loosen the crystals and the zincs. The addition of muriatic or any other acid will dissolve the zincs.

S. BOTTONE.

[76539.]—**Faulty O.G.**—I had a glass somewhat similar to this offered me some time since, and from the flint glass being chipped and its ridiculous performance, concluded that the crown glass had been broken and replaced by another, without regard to curve or refraction. I have since learned that at a sale of scientific apparatus held some time since a great number of the results of the earlier experiments in achromatic object-glass making were disposed of at good prices—*hinc illæ lachrymæ*. Separating the glasses may improve definition, or make matters worse, according as the fault lies with the glasses; so also stopping out the centre portion or round the edges is worth a trial. An amateur cannot attempt anything beyond this.

H. E. H.

[76540.] — **Dynamo.**—Very small armature to get 50 volts from. However, wind it with ¼lb. No. 24 silk, and the field-magnets with 3½lb. of the same wire. Connect up in shunt with brushes. Speed, 2,500 revs. per minute; current, 1 to 1½ ampère. S. BOTTONE.

[76541.]—**Velocities of Falling Bodies.**—In vacuo all substances of all size and shapes fall at the same speed—viz., 9·8 mètres in the first second. In air a retardation takes place owing to the resistance offered, which for equal weights would increase in an inverse ratio to their specific gravities. Have you not seen the guinea and feather experiment, where those two objects are placed in a long tube from which the air is exhausted, when on suddenly inverting tube, the two reach the other end simultaneously. A. E. B.

[76544.]—**Cracked Bell.**—I would suggest turning the bell upside down and filling with paraffin oil, and watching where the oil oozes. A. E. B.

[76544.]—**Cracked Bell.**—I do not know the shape of "Amateur's" bell, or the nature of the fall it got; but let him try it with a pair of calipers and examine the thin parts carefully, as it is there where it is likeliest to have given way; or try it with water, either by filling or dipping it, the water would immediately show on the dry side. The water would get a better chance of showing if he struck his bell with a hammer or mallet.

PATTERN-MAKER.

[76545.]—**Lens-Grinding.**—In reply to C. Canwell's query, I may tell him the process of plate-glass polishing is carried on by numerous cloth or felt rubbers attached to a heavy frame which rests upon the sheet of glass, and is rapidly moved backwards and forwards, a slow motion sideways being given to the glass sheet. Rouge is used for polishing, and I should think the process would be completed in three to six hours. Over a small surface like a 3in. lens, I would advise him to use a lead tool ¼in. thick, covered with pitch, and use best quality rouge; it produces a more brilliant polish than putty-powder. I do not like putty-powder myself; but he can use a mixture of the two, washing each separately before mixing. To encourage his patience, I may tell him we often polish a speculum for 20 to 25 hours before commencing the figuring; but then we use a very much lighter polisher than is used in an ordinary commercial process.

Ramsgate. J. LINSCOTT.

[76547.]—**Grease.**—As the art of lithography depends upon grease not sticking to a damp stone surface, there must be at least one thing to which grease will not stick. A. E. B.

[76547.]—**Grease.**—If "A Novice" would say plainly what he wants to accomplish, he would be more likely to get a satisfactory answer. Grease will not stick to any wet surface or to any porous material, such as brick or fireclay, which has been soaked in water. 999.

[76548.]—**Electrophorus.**—To MR. BOTTONE.—The thickness is not material; anything between $\frac{1}{25}$in. and $\frac{1}{12}$in. will do. S. BOTTONE.

[76548.]—**Electrophorus.**—"Mu Nu" says, in his query, that he found something he wanted in No. 1081, and parenthetically adds "no thanks to the index, though." If he will look again, he will find entered in index to the "Illustrations," Vol. XLII., two references, "Electrophorus, Volta's, 292," and "Volta's electrophorus, 292." What more does he want—except some one to find the reference for him? His other complaint seems justified; but that fault is due mainly to the absurd use of fractions instead of spelling out the words in full, so that there cannot well be a mistake.

A PRACTICAL PRINTER.

[76550.]—**Fuller Battery.**—To MR. BOTTONE.—Can't say, unless I know how much current the motor takes to work it. However, if your motor takes one ampère, the battery should run it for 12 hours right off. It must then be recharged.

S. BOTTONE.

[76551.]—**Screw-Propulsion.** — The loss of power ensues by reason of the churning of the water, especially (which may often be seen when vessels are going out light) when the propeller is only half immersed in the water; but even when totally immersed there is a loss, owing to the water "giving." How soon one tires by walking along a sandy beach, owing to exactly the same reason. Ratio of loss it is impossible to give; probably in no two ordinary cases would it be the same, the pitch and make of the propeller, depth immersed, &c., being variable factors. A. E. B.

[76556.]—**Small Motor.**—It would take too much space to give a description of a small motor. I should advise Mr. La Touche to read the instructions regarding the construction of an electric one (just the thing for him) given at page 390 *Electrical Review*, 1888. P. INFANTE.

[76557.]—**Bunions.**—Purchase a pennyworth of diachylon plaster, cut a piece about 1¼in. in diameter, knotch the edges, warm and apply over part. Don't laugh, but try it; it has afforded me great relief. H. E.

[76559.]—**Electric Lighting.**—To MR. BOTTONE.—Arc lamps (provided they are of correct voltage) can be run in parallel with incandescent lamps, and take the place of a group of these taking a similar amount of current. Beaumont makes a special small-current arc lamp (50v. 1a.) which can be used precisely like an ordinary 50v. incandescent lamp. S. BOTTONE.

[76560.]—**Fireclay.**—If you want a mixture which can be made red-hot, as soon as the fireclay has been put in place, then take water-glass or silicate of soda—i.e., quartz or flint stones dissolved by heat with carbonate of soda. I have used it many years. Z. Y. X.

[76560.] — **Fireclay.** — Probably "A Novice" means silicate of soda. At the suggestion of Mr. A. P. Bower I introduced this mixture for the repair of furnace casings and clay retorts, and it has been introduced as a new thing by several people under various fancy names. For use in red-hot retorts, the dry silicate of soda should be ground in a mill with the fireclay. Where it can be used cold, it is easier to use a mixture of the soapmakers' solution of silicate with the fireclay, and apply it as a mortar. Thos. Fletcher.

[76561.]—**Battery.**—The battery you mention is known as the Bennet iron cell, the negative element being a meat-tin, and scrap zinc the positive. A solution of caustic potash, or carbonate of soda is used to charge it. It is utterly useless for lighting, and much inferior to the Leclanché for bells. E.M.F. about that of the Daniell, internal resistance higher. F. Askew.

[76562.] — **Current for Lamp.** — To Mr. Bottone.—(See also reply 76542).—Since every candle-power in an incandescent lamp requires about 3·5 watts to produce it, and you say your lamp is 2½c p. and marked 4v.; then 2½ × 3½ = 8¾ watts. Now, 4)8·75(2·18. Hence the lamp wants 2·18 ampères to flow through it to cause it to give its full amount of light. S. Bottone.

[76563.]—**Ebonising Deal Sticks.**—Use one or two coats of "Argonaut" or "Jackson's" Ebony Varnish Stain. If laid on quickly and evenly, "G. G." will be quite satisfied with the result. The stain is easily made with shellac, methylated spirit, and dry colour (black) finely ground.
Brighton. H. Hilton.

[76565.]—**Arc Lamp.**—Three ohms will be required for the series resistance; it should be adjustable. Cannot say what the shunt is without knowing size of wire. I should think about 50 ohms. You will not gain anything by cutting a lamp out and putting resistance in. Amber.

[76566.]—**Telescopes.**—It is hardly correct to speak of a single focal length as applied to the case of two mirrors. No single mirror could act in the same way as the two opposite ones; with lenses it is otherwise. A. Gadd.

UNANSWERED QUERIES.

◆

The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.

76063. Influenza, 358.
76068. Great Western Engines, 358.
76100. Air Current, 358.

76222. Hand-Lever Tricycle, p. 419.
76266. London College of Preceptors, p. 450.

The Cremation Society, which has just issued its annual report, announces that the number of cremations at Woking last year was 99, as against 54 in the previous year. At present, Woking is the only place in England that has a crematorium; but another is being erected at Manchester, and Liverpool will have one shortly, while steps are being taken to obtain powers for the erection of another at the City of London Cemetery at Ilford. At present the cost of cremation appears to be about £5, the cremation fees for the 99 having produced £497.

"A Familiar Name" is the very suitable title under which the great pill-king, Mr. Beecham, of St. Helen's, has induced a member of parliament to contribute an entertaining and instructive sketch of his colossal business and remarkable career. Illustrations of the great Pill Palace at St. Helen's adorn the little brochure, and the lesson is that fortune and fame await all who, like Mr. Beecham, have the skill to provide the public with the best of what it wants, and the pluck to spend over a hundred and ten thousand a year in making the fact wisely and widely known.

Lanterns and Accessories.—Messrs. Noakes and Sons, of Greenwich, have issued a very useful catalogue of magic lanterns and lantern accessories, which contains a great deal of information that will be of assistance to many. For instance, there is an essay, entitled "Practical Hints for Practical Lanternists by Practical Men," written by Mr. C. W. Lock and Mr. D. W. Noakes, which is really the essence of practical work with the lantern. Those who use the lantern will find Messrs. Noakes and Son's catalogue a very useful handbook.

QUERIES.

◆

[76568.]—**Coil.**—Will any reader point out the probable cause of clapper sticking to iron core, and will not spark at the platinum screw when *condenser is laid on?* I have been working coil with four pint carbon cells; but the iron core did not seem to have much attraction for the iron clapper, so I thought by adding a condenser it would equalise matters and improve the strength. Condenser is made up of 72 sheets, 5½ by 8¾; also I have added two more pint bichromate cells, and now the coil won't work with condenser on, only draws clapper to core, and there sticks. How am I to balance this power?—it appears six bichromate cells won't do it? The coil is made up as follows—with 6in. brass tube ⅞ outside diameter, filled with soft iron wire, primary wound with four layers of No. 20 silk-covered, secondary about 14oz. of No. 36 silk-covered laid on, the whole well insulated. The coil works with any number of cells, from one to six; but not when condenser is laid on.—Whitby.

[76569.]—**Organ Query.**—Would "Organ Builder" or others kindly inform me how to lighten the touch of a two-manual organ I have nearly completed? The pallets are large, and the springs are required fairly strong; backfalls are pinned centrally, and pallets gape ⅜in. Each manual is tolerable in itself; but when coupler is drawn together with "octave on swell" the touch on great is unbearably heavy. Some recommend a relief pallet. What is the construction of this? Should swell keys dip ⅜in. same as great? What is the usual weight of touch on a two-manual organ when coupled up?—A Midland Amateur.

[76570.]—**Flow of Water in Pipes.**—Will some reader supply me with a reliable rule or formula for calculating the number of gallons of water which will flow through various sizes of pipes—e.g., how many gallons of water will flow through a pipe 1¼in. diam. per minute, with a vertical head of 160 yards? Perhaps some of "ours," who have tested the above, will give us a rule simpler than those in "Molesworth's Pocket-Book."—Wigan.

[76571.]—**To Mr. Bottone.**—I have a small drum armature, 8in. long 1¼in. diameter, built of ·040 soft iron wire, and wound with one layer of 1·2mm. copper wire in six sections, and five turns in each section. Will you kindly tell me what size field-magnet, and what size and weight wire I require to drive it as a motor, and must I tunnel the motors? And will you say if the one described in your book, "The Dynamo," on page 81, will answer as a motor? If so, what battery power I require, and what wire I should put on if I make it of wrought iron?—F. A.

[76572.]—**Induction Coil.**—To Mr. Allsop.—Please give me the dimensions of an induction coil for microphone. No use referring to back numbers, as I am a fresh subscriber. Ought the wire on the magnets to be the same size as the wire of the secondary coil? Mine are wound with No. 36 s.c. copper wire.—Amber.

[76573.]—**Incandescent Lamp.**—To Mr. Bottone.—What is the most economical solution to use in a granule carbon cell? Also, what number of c.p. will the following battery light, and how long will it maintain it if used intermittently? Outer cell 6in. by 8in. high, porous pot 2in by 9in. high; battery of six cells.—Rebma.

[76574.]—**To Mr. Bottone.**—I have made a dynamo of design shown in your book, p. 92. Cog ring armature 4¾in. by 4in., wound 3lb. No. 18; F.M. core, wrought-iron, 6in. by 8in. (round), wound with 12lb. No. 18 wire, but can only get current enough to make red an eight-candle lamp of 40 volts, and the armature gets fixed. Have I resistance enough on F.M core? What do you recommend? What current should it give in volts and amp., and at what speed and power required.—Fixed.

[76575.]—**Wimshurst's Machine.**—I am exceedingly obliged to "J. W." for his kind answers to my questions as to number of jars, &c., to a Wimshurst machine I am making; but, from my own dulness I expect, I do not exactly understand the advice he gives for fixing the glass discs securely to the bosses. I cannot see how, if I cement a vulcanised fibre washer on the glass discs, I can "screw it (the disc) on to the boss." May I ask the favour of an explanation? My discs are 20in. in diameter, in the centre of each I have had a hole 1½in. diameter cut. The bosses are 5in. long, and 4in. in diameter at inner end, and have a projection of 5-16in. in the centre, which will go through the hole in the disc, and project beyond its inner surface full 1-16. These two projections (one in each disc), will keep the discs a little more than ¼ apart. As the bosses are made of a piece of close-grained Spanish mahogany, this will be better, I think, than the vulcanised washers that some recommend. I have been fortunate in securing a nicely polished steel bolt full ⅜in. thick, perfectly straight, and a brass tube that fits it most accurately. As the steel bolt will *pass through both* discs and rest at its extremities on *both uprights*, this must be safer, I think, than merely sticking the discs on to the ends of the bosses, as it seems to me that the weight of the discs would cause the spindles to sway, when only supported at one end. From the badness of my writing, the compositor left out one word in my list of inquiries, and turned two words, "and how," into one—viz., "show." What I want to know, if in using my old frictional electrical apparatus, do I use *both* positive and negative electricity, or, as in the old method, only one? Thus, I have a diamond jar nearly 2ft. high and 11in. in diameter—how should I join that up to machine? Would it discharge itself spontaneously or by a Lane's discharger?—W. H.

[76576.]—**Defective Circulating Boiler.**—I have two or three arched boilers used for domestic purposes which, owing to leakage in arches of each, have been cut out. I have examined boilers, and find them sound except in the sheet at front of arch. I tried to rust some together, but not successful. Can any of "Ours" give a remedy?—Plumber.

[76577.]—**Problem.**—From a point within an equalateral triangle three lines are drawn to each angle, which measure respectively 20, 29, and 60. Determine the side of the triangle.—Ontario.

[76578.]—**Barometer Tables.**—"The Aneroid Barometer," by a Fellow of the R.M.Soc. (published by Houlston, 1879), gives, on pp. 18, 19: "Prof. Airey's new table, which shows the corresponding numbers of elevation in English feet, and of readings of aneroid or corrected barometer in English inches." Prof. Airey starts the zero of his altitude scale at 31in., which appears to me to yield an error of some 900ft. in every reading! Admiral Fitzroy quotes height at sea-level as 27·94, or 760mm. In common sense, therefore, zero must surely be placed at that figure?—or, at least, some authority should give us reliable data upon which all tables and scales may be constructed. Visiting last autumn at the villa of the late Prince Napoleon on the Lake of Geneva, I found that a massive marble barometer at the post in the grounds recorded the level of the lake as 730mm. (28·75), since confirmed by the authorities at Geneva, and by Dr. Marcet, who resides close by at Maligny. As the lake is 1,230ft. above sea-level (Baedeker) I put the altitude scale of my (James Hicks, of Hatton-garden) pocket barometer to correspond with 730mm. (28·75), and I find zero at [illegible] (30·18) instead of 760 (29·93), showing that Swiss sea-level and the Admiral do not agree. If Prof. Airey's table were consulted, zero at 31°, the reading at the 730mm. (28·75) level would give 2,050ft. instead of 1,230! Will some of "Ours" say who has published correct tables to supersede Prof. Airey's? And oblige—Montmartre.

[76579.]—**Boiler.**—I am thinking of putting in a small vertical steam boiler for boiling water. Which sort would be the best for getting up steam quickly? One with two or three cross-tubes, or one with small vertical tubes; also the non-liability to get out of repair, and low consumption of coal.—Inquirer.

[76580.] — **Mechanical Telephone.** — Will any reader kindly give working drawings, and particulars for making and fitting-up the above? The distance between the instruments would be about 50 yards.—J. F. G.

[76581.]—**Conical Roundabout.**—Can any of your readers inform me how to make a conical roundabout, such as used by photographers to exhibit their specimen photographs in window? also what is used to make it revolve?—R. S. B.

[76582.]—**Star Maps.**—Would "F.R.A.S." or Mr. Sadler kindly inform me if there is a better star atlas than Proctor's large edition? I suppose Argelander's is out of print, and very expensive when procurable. I want one showing the position of stars down to about 8 or 9 mag.—H. A.

[76583.]—**Watch Cylinder.**—Being an amateur, I would be obliged for directions on the proper manner of putting in a new cylinder in a Geneva watch. How is the brass piece surrounding it to be treated, and has it to be removed off the cylinder?—Tiro.

[76584.]—**To Mr. Fletcher.**—Would Mr. Fletcher kindly give reference to any published account of his experiments on the oxychlorides?—Iota Dash.

[76585.]—**Kiln.**—Please oblige by giving me the cost of building a 12-chamber Hofman kiln, each chamber to hold 10,000 bricks. Also the quantity of bricks, lime, and sand it will take, and the height of chimney.—Brick.

[76586.]—**High and Low-Pressure Engine.**—Would someone acquainted with the same give me sizes of cylinders and stroke, and sketch of one that would give ¾H.P.? I am wanting something light and compact, and hints that would be beneficial—work with 70lb pressure.—A Reader.

[76587.]—**Filter Cleaning.**—I have a filter of the London and General Water Purifying Company, Limited. Can anyone tell me how to cleanse or re-fill it at home?—J. F. M.

[76588.]—**Cylinder Temperature.**—Does the temperature at which a gas-engine cylinder is worked at in any way affect its efficiency? I have three engines (two Otto's and one Cycle), and I can regulate them all.—Amber.

[76589.] — **Heat Calculation.** — Will "W. S., Liverpool," or someone else, kindly show how the ratio *r* is arrived at, as given by reply in No. 1386 to former query, asking the rise in temperature in Centigrade units in compressing adiabatically 1,000c.ft. of air at 50 Fahr., taking this time the odd number 2,079c.ft. to 988c.ft.? And what would be the difference in heat evolved, supposing the same quantity of oxygen was compressed to the same volume?—Thermos.

[76590.] — **Hydraulic Formula Wanted.** — Thanks to "Glatton" for his reply to 76475. Thomson's formula, $C\sqrt{H^5} \times 2{\cdot}54$, is for cube feet flowing per second, H being the height in feet. I require formula for the height given in inches, and the flow in feet per minute.—Bothered.

[76591.]—**Drum Armature.**—Having made a small drum armature, I would like to know the amount and gauge of wire to put on the F.M.'s? The dimensions are as follows:—Spindle 5-16 diam., on which a wooden cylinder, ⅝ diam., is fixed, and on this iron washers, 1⅝ diam., 8in. long; A. wound with 25 yards No. 28 s.c. in ten sections, there being about 8 yards dead wire. I intend using the F.M. castings of one of your 16c.p. machines. Could I mount the whole machine on a brass base-plate? Please give output and speed, and what I will ask for when buying the lamp.—Amateur.

[76592.]—**Deafness.**—The readers of the "E.M." who may be suffering as I am are under great obligations to Mr. Engert for his communication published in your issue of the 12th inst., and I feel sure that these obligations would be added to if he would give some little detail as to the manner of applying friction for the cure of deafness, as, for instance, What kind of brush should be used? What parts should the friction be specially applied to, and how often, and for how long at a time? And also whether the scalp should be rubbed to induce the growth of new hair?—Sufferer.

[76593.]—**Wire Screws.**—Having to use some thousand of pieces of gold and compo. wire in making small screws, the pieces of which we get are about 18in. long, being bent to part of a circle, can any of "Ours" say which is the best way to draw it down to smaller dia.? also to make it straight, like the lengths of steel wire we get at the toolshops.—W. W. W.

[76594.]—**Small Cogwheels.**—Will some kind reader tell me how to make small cogwheels, with flanges 1in. in diameter? I have tried casting in gunmetal, but cannot succeed. Can I cut them in a lathe? Any information will oblige.—P. S.

[76595.]—**Accumulators.**—To Mr. Bottone.—I have made some accumulators according to your instructions in back numbers. The plates are lead, and pasted with red-lead paste and sulphuric acid, ten plates in each cell, 4in. by 2½in.; and having no means of testing the sp.gr. of sulphuric acid, I do not know how to mix it to suit the above. I have the ordinary commercial acid (wholesale price about 2d. per lb.), and wish to mix it to bring the sp.gr. to 1,200. Would you kindly tell me how much water to add? Also, whether one of the above cells would light a small fairy-lamp, and whether it could be charged with two or three Bunsen cells, outer jars 2½in. by 3in. deep, as I doubt whether these are large enough?—H. Robinson.

[76596.]—**Plastic Material.**—To Mr. Fletcher.—I am obliged for answers *re* oxychloride; but it was just what I did not want, above everything, and tried to anticipate. For very small jobs at home sand-moulding is a tedious, troublesome, unsatisfactory process, and is like walking 20 miles by road instead of going by train. I want to try what can be done with some plastic material, and am prepared to work the matter out experimentally myself. From what I am told on good authority, the Yankees in America, and makers of very small fine castings in this country, have a very much-improved method, and regard sand-moulding as a relic of the past—for very small, fine work. Do you happen to know the composition of the class of materials much used in gasworks, such as Sellar's cement, plutonic cement, &c.? I don't say these would answer the purpose, but there would be no harm in trying. I can remember Sellar's for about 20 years, so the patent must be out long ago.—W. M.

[76597.]—**Compressed Air.**—Will any of my fellow readers give me the reason why a compressed air-pump, after standing, say, 24 hours, exhausts water? We have one in our mine, and this causes a deal of discussion.—Constant Reader.

[76598.]—**Reed-Organ Tuning.**—Will "Organon" further assist by describing the most simple and efficient way to construct a complete tuning and voicing apparatus, giving the different pressures required for the number of rows of reeds?—Spring.

[76599.]—**Launch Engine.**—Will any reader kindly tell me what size engine and boiler I shall require to drive a screw launch 12ft. long by about 4 by 6 beam? If possible, I should like to use a single oscillating cylinder engine and an upright boiler. Also what size shaft and propeller I should require to drive it at a good speed?—W. H. W.

[76600.]—**Removing Grease from Cloth.**—Three years ago I bought of a man in the streets of Nottingham a small piece of what resembled chalk (I don't remember the "fancy name" he had for it), which very quickly removed grease from clothing, &c. It was used dry, by simply rubbing it on the greasy places, and when the white powder thus deposited was brushed off, the grease disappeared with it. I am unable to obtain it now. Can anyone tell me of what it was composed, or tell me of anything else which would act in a similar way?—E. G.

[76601.]—**Power of Engine.**—What is the power of an horizontal engine 4in. stroke, 1¼in. bore?—W. S.

[76602.]—**H.P. of Engine.**—I have an engine cylinder 2in. bore, 3in. stroke, what H.P. would I have working with 50lb. steam-pressure?—New Reader.

[76603.]—**Pinhole Camera for Copying Plans.**—Having a number of fine plans to copy to a uniform size, and not having money for a lens, I should like to know if a pinhole can be used for plates about 15in. by 12in.? How can I find the respective distances between plan, pinhole, and plate, so that the plate is just filled? Also how long an exposure would be required as compared with a landscape lens $\frac{f}{8}$? Is there any dry plate specially adapted for this work?—Poor Man.

[76604.]—**Bichromate Battery.**—To Mr. Bottone.—As a considerable portion of the small amount of spare time I have available for experimenting is consumed in setting up and taking down the battery, &c., I shall be obliged if you will tell me (1) if the plates be lifted out of the solution and left hanging over it will crystals form, seeing it is not bichromate of potash, but your depolariser, got from you, which I use? (2) Would the solution become weaker by being thus left exposed? (3) Would the brass clamps be apt to become dirty through chemical action, from any slight vapours rising, or otherwise? (4) Would any other bad effects arise from leaving the plates thus suspended over the solution?—A. T.

[76605.]—**Chalk.**—What is chalk? of. A. Geikie says it is derived from the remains of Foraminifera, Echinoderms, Molluscs, and other marine animals. On p. 544, however, it is stated that on breathing into lime-water the "turbidity or milkiness is due to the formation of finely-divided chalk." Can chalk be made by breathing into lime-water?—Veritas.

[76606.]—**Coloured Lamp Signs.**—How are the coloured lamp signs, seen in London, worked? They are electrical incandescent lamps in glasses of different colours, and the current is switched on intermittently first to lamps of one colour, then to those of another, and the name of the place or of the piece being played is so spelled out.—Lux.

[76607.]—**Telescope.**—What would be the best form of telescope possible, regardless of cost, for the following purpose: For use in bright daylight on land; to examine an object critically not more than a quarter of a mile off. It must not be too large to be portable.—Conquest.

[76608.]—**Heat.**—(1) How many units of heat are given up by cooling 800 kilos of HCl, 200 kilos of steam, and 500 kilos of air from 200° C. to 50° C.? (2) A solution of HCl boils unchanged at 110° C.; it has a specific heat of ·88°. Calculate the amount of heat required to raise a litre of such a solution from 10° C. to its boiling point. The specific gravity of the acid is 1·1. (3) What is the latent heat of sulphuric acid vapour?—Student.

[76609.]—**Medical.**—Would some reader give me advice, and recipe if possible, in the following case: Six years ago I went under an operation for an abscess in a hospital. I was kept in there for more than 12 months, and it has never ceased discharging since. It discharges about a tablespoonful a day now. I have had it to nearly dry up, but then it breaks out again. It was caused, in the first place, by a strain. I am a mason by trade, and it is very unpleasant having this discharge to contend with. If some friend could help me I should be very thankful, as it keeps my back very weak, and draws the leg up.—Owbridge.

[76610.]—**Dissolving Lanterns.**—What is the average candle-power of oxy-hydrogen jets, as used in 4in. lecture lanterns? Also candle-power of the new oil flat-wick lamps?—Amateur.

[76611.]—**Lantern Slides.**—I have to make a number of slides of maps from the originals. Which particular kind of dry-plate should be used? Can I do better with a lens or with a pin-hole? Also, should I take the slides direct, or take a 15 × 12 first, and then reduce from that?—Amateur.

[76612.]—**Gas Generator.**—Will "Draughtsman, the Patent Light Co." give a rough sketch and dimensions of gas generator described in his reply of Jan. 29 to 76269? Also quantity of camphor and ether to be added. Is this gas explosive? Is there any risk of explosion when making and using?—and if so, what precautions are to be taken?—Mudville.

[76613.]—**Weighing Platforms.**—I should be very pleased if some reader would let me into a few wrinkles on repairing weighing platforms; sharping centres: levelling and squaring; what kind of square is used.—K. K.

[76614.]—**Leaded Glass for Windows.**—I wish to know how the soldering is done to the lead strips used in making up leaded-glass windows. I understand ordinary tin and zinc soldering, but have not worked in lead.—Hove.

[76615.]—**Electro-Magnet.**—What quality of wire should be used to magnetise to saturation for an electro-magnet, having limbs 2in. diameter by 12in. long, wrought iron? I have 40 ampères at my disposal, with 4 volts pressure.—A. B.

[76616.]—**Three Manual Reed-Organ.**—I have a single manual "Karn" organ with 10 stops, to which I wish to add two more manuals and pedals. Will "Organon" or any reader please inform me how to plant the reeds, of which I purpose putting four half-sets in each manual, and two or three sets of 30 notes each in pedals; or, if possible, more in the manuals, providing I can do so without enlarging the present case? What tone reeds would be best suited? also which would be the best form of coupling manuals and pedals, and if octave-couplers to each manual would be any advantage? Would it be necessary to have balance-keys; and if the existing bellows would be of sufficient power to work the three manuals? In fact any information on the subject would be most useful. I have sought everywhere for a book on reed-organs, but cannot obtain one. I need hardly say that I wish to economise space as much as possible.—J. W. D.

[76617.]—**To Mr. Bottone.**—Will you kindly tell me how to charge two Daniell batteries, and the way to connect them to slinging rods across vat for electro-plating, as I cannot get a spark from them the way I have connected them—viz., one zinc to one copper cylinder?—R. Garrod.

[76618.]—**Microphone.**—I have made a microphone as described by Mr. Allsop in No. 1382, p. 77 of the "E.M.," but cannot produce speech. Any rubbing or scratching noise near the microphone is distinctly heard in the receiver. Will you also say what size and resistance of wire I ought to wind a telephone coil with to get good results?—H. E. R. W.

[76619.]—**Mould for Brass Casting.**—I have tried casting brass in a plaster of Paris mould, but find that the metal bubbles up when poured into the mould (an open one), and large air bubbles are formed on the under surface of the casting, although the mould is perfectly dry. Can anyone explain this or suggest a substitute for the plaster of Paris? Is moulding sand suitable for small castings?—W. W.

[76620.]—**'Scape Wheel.**—Would "G. T. C.," reply 76380, give a suitable size of 'scape wheel for regulator? Also whether the four-legged or the double-three is the best? also if the pallets are filed up together? How is the lifting obtained across the line of centres—are lifting pieces attached to the pallets by screwing, hard soldering, or other means, as I understand (from Lord Grimthorpe's book) them to be cut from one piece, and the only one I have been able to see appears to be so made? I should be glad to have some idea as to what a pallet should weigh for a clock with a seconds pendulum of about 40lb. The clock I propose making would not perhaps, strictly speaking, be a regulator, as it will have to transmit an electric current at least every 15 minutes, perhaps oftener, so that I should want a weight slightly in excess of that required to drive the clock.—L. J. R.

[76621.]—**Coins.**—I shall esteem it a favour if any reader can tell me the country with which the following Continental coins should be placed: No. 1, silver; 1-12 thaler, 1742, obverse, crown and C.E.; reverse, German or Danish inscription. No. 2, copper; 1 brod, date 1800. No. 3, 1 stuber, date 1783. No. 4, small leaden; obverse, a Maltese cross, with date 1771 between limbs of cross; reverse, winged arm brandishing dagger. No. 5, copper; no value; obverse, under crown a shield divided per pale two rampant lions facing each other; legend "In Deo est spes nostra"; reverse, Gel: Ria: 1794. The last I presume is a Netherlands coin, but I shall be glad of "tips." I may add that I have tried with success the recipe for cleansing coins given me by "Eos" in reply to my query No. 75916.—Numismatist.

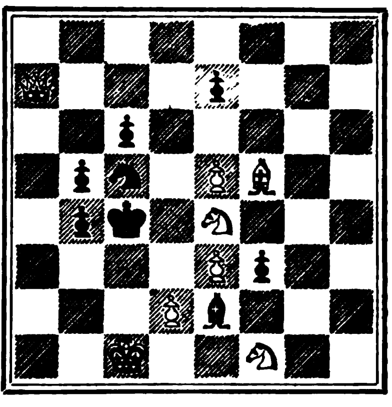
[76622.]—**Products of Combustion of Gas-Stoves.**—To Mr. Fletcher.—In the discussion on this subject I notice that Mr. Fletcher states that the products of combustion of a Bunsen burner are less injurious than those of a common burner. Will he then explain why in his own Price List he expressly insists on the necessity of a flue in those of his gas-fires using the former, while remarking that in those using the ordinary illuminating burner a flue need not be employed? If he would precisely describe in what the difference of the combustion products consists, it might throw light on the point. Then, again, we have Clark's and other kinds of siphon stoves which condense certain of the acid fumes and discharge them with a good deal of water into the receptacle below the burner. What are the *remaining* products that are *not* condensed, and cause the peculiar smell noticeable when these stoves are burning? I find a lighted match is instantly extinguished when held over the outlet at the top of the stove. Surely if the fumes put out a light they must be injurious to health; yet it is said that delicate plants, which are so sensitive to gas-combustion products, are *not* affected. The whole matter wants clearing up.—A. S. L.

CHESS.

All communications for this column to be sent to the Chess Editor, at the office, 332, Strand.

PROBLEM MCCXCIV.—By W. T. Hurley.

Black.



White. [8 + 8.

White to play and mate in three moves.

Solution to 1292.

White.	*Black.*
1. Kt-Q 8.	1. K takes P (*a*)
2. Kt-K B 4	2. K-Q 3
3. Q takes P mate.	
	(*a*) 1. Kt-B 4 (*b*).
2. Q-K 5 (ch), &c.	
	(*b*) 1. B-Q 5 (*c*) or Kt takes R, &c.
2. Q takes P (ch), &c.	
	(*c*) 1. R, B or P takes Kt or R-Kt 5 or P takes P (*d*)
2. B takes P, &c.	
	(*d*) 1. Q-Kt sq, &c.
2. Kt takes P (ch)	

Also 1. K Kt takes P (ch), and 1. R-B 7

NOTICES TO CORRESPONDENTS.

Correct solutions to 1291 by H. Fellows, G. H. Inson (best 2-er so far), and R. W. Houghton (key move very much like that of 1284); to 1292 by H. A. Froom (second solution), A. G. Fellows (ditto), and H. Fellows (ditto).

A. Anderson.—In 1290 the Kt cannot move to Q 3, nor can B K move to K Kt 5.

H. A. Froom.—It is a solution competition, but solutions from those who have not entered are welcome. It is concluded with the present problem, and very shortly a fresh tourney will be started, of which due notice will be given.

J. F. Moon.—1292 can be done, and unfortunately too much so.

The Solution Tourney concludes with the present problem, 1294. The award will be given in three weeks. As there are several Tourney problems over, which have been sent in during the competition, the Problem Tourney will continue until they have all been published.

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ANSWERS TO CORRESPONDENTS.

⁂ All communications should be addressed to the Editor *of the* English Mechanic, *332, Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries, put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, February 17, and unacknowledged elsewhere:—

S. S.—Gilbert.—W. J. Burton.—Firebox.—Thornfield.—A Ten Years Subscriber.—T. M.—Sam Farrar.—H. G. Dixon.—R. A. C.—Shunt.—Remitron.—Sivad.—X.—R. W.—Grindstone.—H. G. Suggett.—F. A. M.—Tom Hagues.—C. E. Peebles.—G. J. B.—W. T.—L. F. Awde.—Inquirer.

F. E. Spiller. (We hardly think you can expect the patent agent to return the money. He has done his work, and it is not his fault that the Controller of Patents declines to register.)—D. E. C., Buenos Aires. (There is no object at all about perpetual motion, because the idea is an absurdity. No apparatus has yet been discovered which will supply motive power for nothing. Dircks's "Perpetuum Mobile"—London: E and F. N. Spon—gives a good historical account of the various inventions.)—P. Bonsor. (We do not know who makes the form of draught excluder referred to; but suppose it can be obtained from any of the firms who deal in rubber goods. Try the Britannia Company, 32, Cannon-street, E.C.)—Talavera. (Given many times. One part glue, four parts glycerine, and sufficient whiting.)—Herbert Lear. (You do not say how fine the lines are to be; but in the back volumes descriptions are given of ruling-machines for drawing lines on glass plates for microscopical testing purpose, and for diffraction gratings. A diamond spark or point must be used.)—R. L. M. (Diagrams of gas and water meters will be found in back volumes. Some little power is absorbed in working them, no doubt; but it is so small as to be negligible in making any calculations. 2. As a rule, in all engines the higher the speed the greater the power.)—Artist in Difficulty. (The mounts are cut by running a knife round the metal guide, except in standard sizes, which are often stamped out, when the edges are not bevelled.)—B. H. (The noise is most likely caused by air in the pipes. It would be necessary to examine the fittings before an explanation could be given of the balls dashing about furiously. You might try the effect of reducing the pressure by means of a tap on the service pipe.)—Karl. (At any of the grindery and leather warehouses, we suppose; but see Hints No. 4 above.)—W. H. Monk. (We do not think there is any substance of the kind, if by "elastic" it is meant to stretch and resume its shape again. Does "transparent" mean perfectly clear? Gelatine rendered waterproof by means of chromic-acid might suit.)—T. R. D. (Use tannic acid in good glue, or acetic acid in ordinary paste; but there are several recipes in back volumes.)—Compo. (What do you mean by "liquid solder"? The fittings are soldered to the compo. pipe in the ordinary way.)—Constant Reader. (You must braze the parts together with spelter and borax. See Replies in recent numbers, or the indices in back volumes.)—Novice. (Mix the ground colour to the consistency desired with turps and boiled-oil, using more oil than turps if required to dry with a gloss, and more turps than oil if required "flat.")—English Mechanic. (Templeton's "Engineers', Millwrights', and Machinists' Practical Assistant," Crosby Lockwood and Son, will probably suit; or Templeton's "Workshop Companion," or Molesworth's "Engineer's Pocket-book," E. and F. N. Spon.)—Engineer. (We do not know of such a work. There are several articles on the subject in back volumes, and we believe the Dowson Company publish a descriptive pamphlet of the patent process.)—Convex Lens. (When the camera obscura is in the form of a room or tent, and the objects are reflected down on to a table, the cap is fitted with a prism which acts as a condensing lens and as a mirror. In Porta's form it is merely a box with a short tube carrying a double convex lens. Illustrations can be found in works on physics, if you have not back volumes. Ask for "Ganot's Physics" at the free library in your town.)—Countryman. (Thanks for the note. Spots are frequent now, and that observed was probably the same as mentioned in the letters referred to. A large one has been visible for some days.)—H. H. W. (See many replies in recent numbers. At least six cells would be required, and they would be very expensive in working, their expense and durability depending on the work done.)—Screw. (Try a little paraffin-oil applied with a feather round the heads of the obstinate screws. Or heat them with a blowpipe, or a red hot poker.)—Toothless. (See Hints No. 4, above. Almost all ironmongers keep mincing-machines in stock.)—Tyro. (Please see an elementary work on optics, or make an experiment with a telescope or lenses. To "bring the moon to a distance of about 100 yards" is worth trying for.)—D. W. L. (Copyrights are registered at Stationers' Hall, Ludgate-hill. A copy of the picture or publication must be presented, and a fee of 5s. be paid. The clerk will give all information; but each photograph must be separately copyrighted.)—One in a Fix. (One of the mechanical pianos or organs would do.)—Chorac. (Better obtain advice from an ophthalmologist, for the eyes are too valuable to be trifled with—especially to a young man of 19.)—Louis Morris. (The scoring is correct. There is a good work on cards and card games published at 170, Strand. W.C.)—Robert Wingate. (The letter referred to was brought out by those recently given on the construction of incubators. See the numbers for Oct. 16 and 30, and subsequent numbers in this volume.)—E. C. (Please see many replies about dynamos in this and previous volumes. It is impossible to say what a dynamo can do when the only particulars given are its price.)—Progress. (See replies in recent numbers, or put the question direct to those who supply dynamos and accumulators.)—Devonshire. (There is much information on soap-making in back volumes; but perhaps Watt's work on "Soap-making," published by Crosby Lockwood and Son, will suit.)—Graph. (Print with the proper ink, and transfer in the same way as with handwriting. Look through the indices for references to other methods.)—J. Hutchinson. (Perhaps it has more whiting or barytes than is absolutely necessary; but the recipe has been frequently given.)—Plumber. (Several illustrations of double dovetailing have been given. The useful method is described in March 12, 1875.)—New Subscriber. (Hertz's experiments in Nov. 1, 1889.)—X. (Use glass, porcelain, ebonite, or guttapercha. Metal is not suited for the purpose. See any manual treating of the subject.)—Beginner. (Loomis's work is a good one, and, of course, "Celestial Objects for Common Telescopes." A 3in. telescope, or even a good binocular, will do to begin with. See many hints on the subject in back volumes.)—G. B. A. R. (No space for a revival of the "fastest train in the world" controversy.)—Rev. W. Miles Barnes (Thanks; will use in an early issue.)—Grateful. (We know nothing of him. We should inquire of the local police about any man who had had our money fifteen months and neither returned it nor sent the goods.)—B. A. (W. Watson and Sons, 313, High Holborn. 2. Apparatus is of little use in such cases. Join a volunteer corps or a good gymnasium.)—G. H. Armstrong, Pelaw House, Chester-le-street. (We replied to you in this column on Feb. 5, that if you could describe what you wanted to ask Mr. Bottone in words, we would insert your query; but that we could not spare half a page for the illustration of a faulty telephone simply to find what was the matter with it. Now, "cease to take the paper in" if you like! We have discharged all the staff, and countermanded next week's supply of paper in a fit of panic!)

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Medical **Induction Coil** and **Battery** in Walnut case, complete with handles and accessories, value 30s.—Below.

2½in. **Electric Bell**, in Walnut case, quite new, value 5s.—Below.

Will Exchange above for a 3½ or 4in. centre **Lathe**, with slide-rest, or offers.—W. H. Jackson, 64, Norton-street, Grantham.

Exchange for Engineer's Vice, Taps, and Cash, a very strong Launch Boiler, brass tubes, worked at 40lb., and horizontal engine, 3in. cylinder, 6in. stroke, never used.—31, Grange-road West, Birkenhead.

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Dynamo, 40c.p., Coils, Lamps, Switches, and Sundries, lot value £8. Exchange safety bicycle.—H., 55, Fenwick-road, East Dulwich.

Musical Box or Symphonion, plays any number of tunes by clockwork, in black polished case, speed regulator and 12 tunes supplied. A £3 instrument, nearly new. What offers?—Below.

Dulcimer, 33 notes with 3 wires each, plated screws, and pair of beaters, quite new. What offers in exchange to value of 20s.?

Bicycle, 5½in. Coventry Machinists, not much used; cost 7 guineas. What offers in exchange?

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Two long-distance **Magneto Electric Bells** for Telephones, automatic switch, lightning arrester, polished cases, silver-plated fittings, perfect. Offers photographic.—10, Grundy-street, Radcliffe, Manchester.

Will exchange vertical double-action oscillating **Engine**, nearly half-horse, in perfect order, for good air gun, telescope, or offers in exchange to value 20s. Seen by appointment.—Electrician, 7, Wharton-road, W. Kensington Park, W.

Woodhouse and Rawson's **Waste-Oil Filter** (new), cost 70s., 260 Nos. English Mechanic, Old Rapier, quantity of books. Exchange offers invited.—Godfrey, Adelaide-street, Keighley.

7in. centre **Lathe**, strong wood bed, 6ft. long, face-plate, rests, tools, and belt 20ft. Exchange safety, piano, or American organ.—Particulars from John Knaggs, 24, Zetland-road, Loftus, Yorks.

Meerschaum Pipe, finest quality, case, tobacco pouch to match, and money. Like exchange for good medical coil.—9, Whyburn-street, Hucknall Torkard, Notts.

Will exchange nearly new **Automatic Knitting** Machine (84 cylinder) with ribbing attachment, counter, instruction book and accessories, cost £8 15s., for lathe or electrical goods to value.—G. Pyke, 15, Edgehill-street, Reading.

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Blacksmiths' Tools.—New files, small circular saws, lathe standards and bed, silver lever watch. Offers fretsaw, slide-rest.—10, Scarsdale-road, Dronfield, Sheffield.

"**Bourne on the Steam-Engine**" for castings of Siemens Dynamo, complete, 3in. armature. Wanted, also 20 and 22 Wire.—W. H. H., Downhead-road, Crediton.

Opera Glass, powerful, in case, nearly new, cost 15s. 6d. Will exchange for small Printing Outfit, or offers.—A. Sherren, Collingwood-terrace, South Shields.

Wanted, self-centring Chuck, 2 to 3in. diam. Exchange first-class Lantern Slides.—Charcoal Works, Bispham-street, Liverpool.

Camera, Lancaster's quarter-plate, with rectigraph lens and stand. Exchange good half plate Camera.—Fenwick, 55, Wardle-street, Manchester.

First-class **Magic Lantern**, sheet, and 150 slides, for launch boiler, harmonium, or piano.—Leith, 6, Trafalgar-street, Greenock, Scotland.

Telescope by Holland, Field-Glasses by Troughton and Sims, three Electric Bells, Pulvermacher Galvanic Chain Battery, Automatic Electric Light Switch.—E. W. Young, Aylesbury.

Wanted, 5in. Foot Lathe (screw-cutting preferred). Exchange new first-class ballhead diamond Safety, cost 18 guineas.—Page, 12, Queen's Head-street, Islington.

Small **Pistol**, two or three year's "English Mechanic," few Coins.—Particulars, J. W. Dalbell, The Mount, Matlock.

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New **Photographic Apparatus**, everything complete, value 50s.; also Rifle, Water Motor, Drilling Machine, Pneumatic Indicator. All offers on approval. Stamp for particulars.—Above.

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Wanted, two Induction Coils for transmitters. Give church pattern Electric Bell, good condition.—Stent, below.

Wanted also, two Ader Telephone Receivers. Give good exchange.—Alfred Stent, Junr., Havant, Hants.

Will exchange ½H. **Horizontal Engine**, not quite finished, for ½-plate RR lens.—E. Brown, 434, Wandsworth-road, Clapham.

I have a 10c.p. **Dynamo**, portable Bell Set, 2 square Bunsens, Lamp and Switch. Exchange.—Lockyer, Merstham, Red Hill, Surrey.

Electric-Motor Battery. Exchange.—W. Lockyer, Merstham, Red Hill, Surrey.

JUN 26 1941